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Credit rationing of Polish farm households: a theoretical and empirical analysis

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Studies on the Agricultural and Food Sector in Central and Eastern Europe

Martin Petrick

Credit rationing of Polish farm households

A theoretical and empirical analysis

IAMO
INSTITUT FÜR AGRARENTWICKLUNG IN MITTEL- UND OSTEUROPA
STIFTUNG DES ÖFFENTLICHEN RECHTS

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A theoretical and empirical analysis

Studies on the Agricultural and Food Sector
in Central and Eastern Europe

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Credit rationing of Polish farm households
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by
Martin Petrick

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Halle (Saale), in May 2004

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LIST OF ABBREVIATIONS

ARiMR	Agency for Restructuring and Modernisation of Agriculture (Agencja Restrukturyzacji i Modernizacji Rolnictwa)
BGŻ	Bank for Food Economy (Bank Gospodarki Żywnościowej)
CAP	Common Agricultural Policy of the European Union
CEECs	Central and Eastern European Countries
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GMM	Generalised Method of Moments
GUS	Central Statistical Office (Główny Urząd Statystyczny)
IAMO	Institute of Agricultural Development in Central and Eastern Europe
IMR	Inverse Mills Ratio
IQR	inter quartile range
IRR	internal rate of return
ML	maximum likelihood
MRiRW	Ministry of Agriculture and Rural Development (Ministerstwo Rolnictwa i Rozwoju Wsi)
NIE	New Institutional Economics
NPV	net present value
ODR	Extension Centre of Agriculture (Ośrodek Doradztwa Rolniczego)
OLS	ordinary least squares
WLS	weighted least squares

LIST OF IMPORTANT SYMBOLS

B	speed of adjustment coefficient in the flexible accelerator
b	parameter
C	collateral
c	consumption bundle
E	initial endowment; equity
e	random error term
f	production function
G	distribution of investment returns
g	density of investment returns
H	Hamiltonian function
I	investment volume
K	credit volume
$\overline{K}$	credit volume under rationing
k	credit-rationed yes/no
L	Lagrangean function
M	household income
N	sample size
P	success probability of investment project
p^c	price of the consumption bundle
p^{xk}	price of the input that requires credit financing
p^{xnk}	price of the input that requires no credit financing
p, p^y	output price
R	gross repayment including interest rate
r	interest rate
r^*	shadow interest rate under rationing
S	subsidy
T	public transfers
t	time
u	utility function; random error term
W	wealth of borrower
x^k	variable input that requires credit financing
x^{nk}	variable input that requires no credit financing
y	investment return; farm output
y^s	project return in case of success
Z	capital stock
z^h	household characteristics

z^y	fixed production inputs
$\boldsymbol{z}$	explanatory variables
β	parameter
γ	menu of contracts; parameter of the Probit model
δ	time preference rate
ε	random error term
ζ	dummy variables
η	Lagrangean multiplier
θ	risk parameter
Λ	liquidity surplus of the credit-rationed household
λ	Lagrangean multiplier; costate variable
μ	Lagrangean multiplier
π	profit
ρ	(total) return
ρ^*	marginal willingness to pay for credit
Φ	distribution of the standard normal distribution
ϕ	density of the standard normal distribution

MONETARY EQUIVALENCE

1 Polish złoty (zł) = .2366 euro (€) (annual average exchange rate in 1999)

1 INTRODUCTION

The completion of this monograph falls in a period where the accession talks between Poland and the European Union (EU) have reached their final stage. One of the last and most difficult issues to be settled concerned the agricultural sector and the extent to which the Common Agricultural Policy (CAP) of the EU will come into force on the first day of Poland's EU membership. Regardless of the precise conditions under which Poland will join the EU, there is a widespread agreement that the development problems of Polish agriculture will remain on top of the economic and political agenda for the years to come. The objective of the first subchapter is to introduce into these problem-areas and to acquaint the reader with some of the structural weaknesses of the farm sector in Poland, notably its low productivity, the low investment level in agriculture, and the limited progress in structural change. A frequently cited reason for the dissatisfactory performance of the sector is farmers' insufficient access to credit. Indeed, government action on rural credit markets has figured prominently over recent years, primarily in the form of interest subsidies. Subchapter 1.2 gives an overview of recent public measures. Drawing on this background information, subchapter 1.3 introduces the notion of credit rationing which will serve as the leitmotif and major analytical concept throughout the monograph. Based on this, the central research questions of the study are presented. The following subchapter 1.4 briefly summarises the main controversies of the scientific debate on the topic and attempts to identify the borders of current wisdom. The final subchapter 1.5 provides an overview of the subsequent analysis.

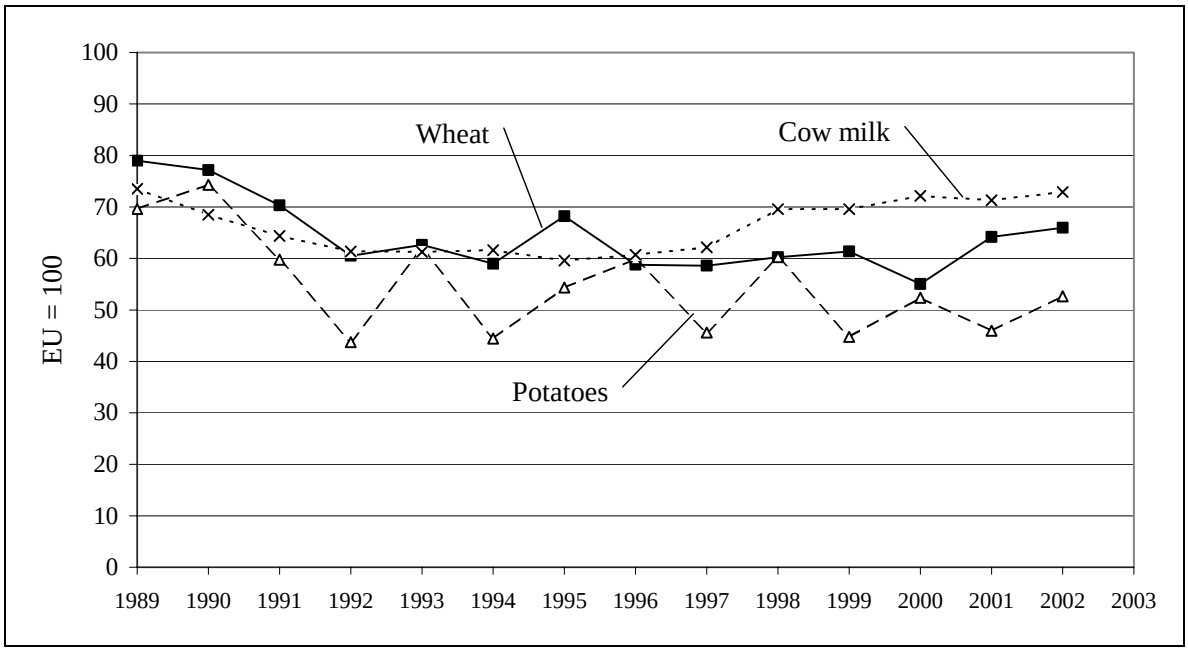
1.1 Current development problems of the Polish farm sector

In this subchapter I wish to outline a number of key development problems of agriculture in Poland, based on official statistics. It is intended to highlight the main structural weaknesses of the sector in an economic perspective and thus to provide a motivation for the further research in this study.

I focus on three problem areas which I will attempt to illustrate by statistical information:

1. the comparatively low productivity of farms,
2. the low level of investment in the agricultural sector, and
3. the limited progress in farm growth implying slow structural change.

Figure 1-1: Yields of selected agricultural products 1989-2002 (Poland in percent of EU average)



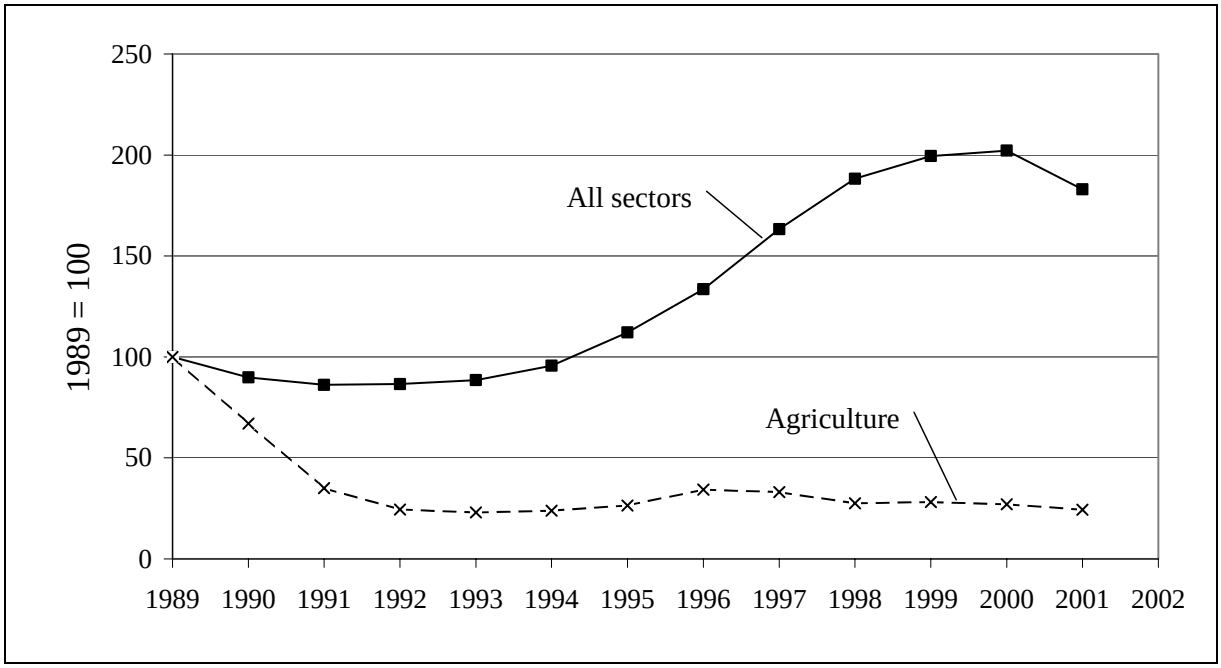
Notes: Wheat and potatoes as yield per ha, milk as annual yield per cow. Data for 2002 is provisional.

Source: Author's calculations based on FAO (2003).

Figure 1-1 compares annual average yields in Poland with the aggregate current members of the EU over 1989-2002. The figure includes data for wheat, potatoes, and milk, three major products of Polish agriculture. All yields range between 40 and 70 percent of the EU reference, and are thus clearly below the EU average over the whole period. Apart from a significant decline between 1989 and 1992, wheat and potatoes show no distinct trend and the relation to the EU standard is subject to notable annual fluctuations. In contrast, milk yields steadily converged with EU figures since 1995.[1] Milk yields were at 73 percent of the EU average in 2002. Overall, *agricultural productivity for the three key products shown is substantially below the EU average*. A similar picture could be drawn for many other agricultural products. It is highly unlikely that this productivity gap is the result of differing natural conditions (PETRICK et al. 2002, p. 207).

[1] In an instructive cross-methodological comparison of measures of competitiveness, FROHBERG (2000, p. 59) finds that Poland's livestock production indeed tends to outperform its plant production in terms of international competitiveness.

Figure 1-2: Investment in the agricultural sector compared with all sectors in Poland 1989-2001 (1989=100)

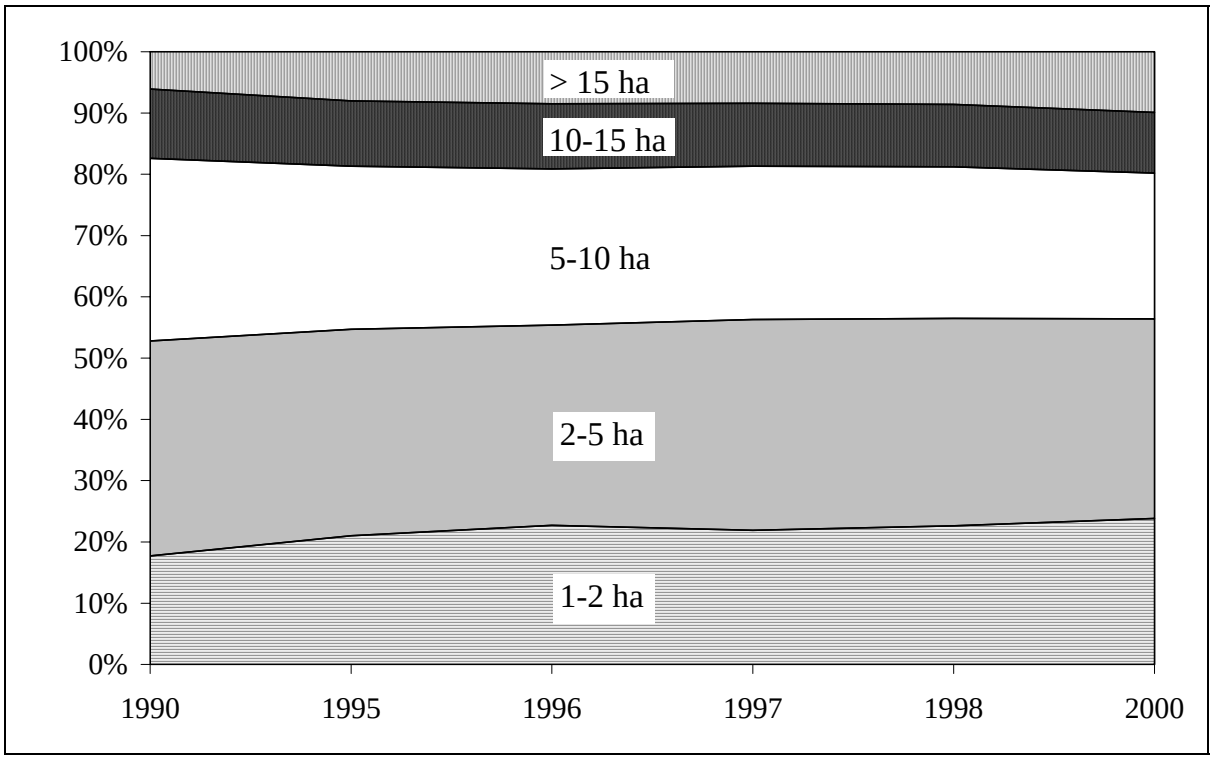


Notes: Indices in constant prices.

Source: Author's calculations based on GUS (2002 and earlier issues).

Figure 1-2 illustrates the development of investment outlays in agriculture as compared with all sectors of the Polish economy between 1989 and 2001. Whereas investment expenditures in constant prices of all sectors more than doubled between 1989 and 2000, investment in agriculture stagnated at about 30 percent of its 1989 value since 1992. Only in 2001, also overall investment declined. Compared with the initial situation at the beginning of the political reform period, *modernisation and growth in agriculture has hence lagged far behind* the rest of the economy. Taking into account the fact that agriculture was among the most undercapitalised sectors already during socialism, this result is even more remarkable.

Figure 1-3: Distribution of farm sizes in classes 1990, 1995-1998, 2000



Notes: Individual farms according to amount of land cultivated.

Source: GUS (2001, p. 27).

The importance of different size classes within the group of individual farms in Poland is displayed in Figure 1-3. Individual farms in the definition of the Central Statistical Office of Poland (Główny Urząd Statystyczny, GUS) comprise privately owned farms cultivating more than one hectare of land (GUS 2002, p. 342). This is the currently predominant farm type in Poland (see PETRICK 2001, pp. 9-13). Here I neglect regional differences, which are illustrated in more detail in section 3.2.1 below. A general impression from the figure is the overwhelming importance of small-scale farms in Poland. Over the entire decade, more than 50 percent of all holdings registered as individual farms cultivated less than 5 ha, and more than 80 percent cultivated less than 10 ha. Furthermore, Figure 1-3 shows that, between 1990 and 1996, there was a slight increase in the groups of farms smaller than 2 ha and larger than 15 ha at the cost of medium-sized farms. Between 1996 and 1998, the share of size classes remained almost stable. Only between 1998 and 2000, there was again a very slight increase in the smallest and largest farm size classes. Overall, to the extent that it manifested in changes of land resources per farm, there was virtually *no structural change* in the Polish farming sector since the beginning of reforms in 1990. In addition, the minimal changes visible in the statistics show no uniform shift to-

wards larger farm sizes. On the contrary, the importance of the smallest farm size class even increased.[2]

The structural deficiencies of the Polish farm sector as presented previously go hand in hand with a *low remuneration of labour* in agriculture. Individual farms in Poland are usually operated by the labour force of a family. A large number of small-scale farms therefore employ a substantial amount of labour, with the result of a quite high man/land ratio. Dividing the labour force working on individual farms (only full-time workers) by the total amount of land under cultivation on these farms results in a man/land ratio of 26.7 persons per 100 ha of agricultural land in 1996.[3] This number is grossly supported by more recent survey data on small-scale farms as given in PETRICK et al. (2002, p. 206). The latter study also presents a comparison with two German Länder, namely Mecklenburg-West Pomerania and Bavaria. The average man/land ratio per farm in these regions was 1.31 and 4.17 annual work units per 100 ha, respectively, in 1999.[4] The tremendous differences imply a remuneration of family labour from agriculture that is thirteen to fifty times lower in Poland than in Germany, depending on the regions compared, whereas average salaries across all sectors differ only by a factor of five (PETRICK et al. 2002, p. 212). A part of this is attributable to the different policy environment in the two countries. Even so, it is clear that structural weaknesses of the Polish farm sector are largely responsible for the unfavourable economic situation of the agricultural labour force in Poland, both in intersectoral and international comparison. Also including part-time workers, the labour force living on individual farms made up 21.2 percent of the total Polish population in working age in 1996.[5] Every fifth adult Pole is hence immediately affected by the situation in the agricultural sector.

---

[2] Changes *within* the group of farms larger than 15 ha are not shown in Figure 1-3, although they were significant. In particular, formerly state-managed collective farms were broken up during the transition period, which led to a decline in the average farm size and hence an increase in the number of farms larger than 15 ha (see section 3.2.1).

[3] This calculation is based on agricultural census data given in GUS (2001, pp. 28; 62). The number of full-time workers on individual farms was 3,723.4 thousand, the area under cultivation 13,972 ths. ha in 1996.

[4] One annual work unit equals the labour input of one adult person employed full time over the whole year.

[5] GUS (2001) reports that there were 4,843.7 ths. persons employed on individual farms (full-time plus part-time) in 1996 (p. 62). The total number of persons in working age in the same year was 22,820.0 (men and women, p. 57).

Solving the structural problems of Polish agriculture is therefore of utmost political importance. But how can these deficiencies be tackled? It has been a widely held view among economists and politicians that *farmers' limited access to finance* is one of the major obstacles to a more favourable development of the farm sector in Poland. Right from the outset of market reforms in Poland, experts stressed the crucial role of credit access. Supply of *working capital* was regarded as decisive for maintaining sufficient levels of input use and hence securing or even increasing productivity levels in agriculture (DEQUIN 1990, p. 488). Furthermore, it was pointed out that worsened availability of *long-term loans* led to a sharp decline in agricultural investment (KOWALSKI 1993, pp. 350; 353). At the same time, access to investment finance was seen as a precondition for modernisation and growth of farms (DEQUIN 1990, pp. 487-488).

A vivid picture of credit shortages in the Polish peasant farm sector in the early 1990's was drawn by ZBIERSKI-SALAMEH (1999, pp. 194-196). According to this author, farmers' credit needs to finance current production or even investment were largely frustrated due to poorly designed official assistance, a lack of management skills to draw sophisticated business plans, or the fact that credit access was tied to personal connections with former socialist authorities. The following passage summarises the author's impression (p. 196):

> "Despite the government's programmatic commitment to modernize and restructure agriculture – specifically its preferred private subsector – few financial resources were extended to peasants for renewal of their production cycle, and none were offered for expanding and modernizing their farms. For expansion and modernization, peasants were expected to generate their own funds through increased productivity (which the other constraints precluded)."

ZBIERSKI-SALAMEH suggests that this lack of credit had three major implications for farm households (1999, pp. 204-205): (a) distress sales of land to ensure financial liquidity, (b) increased efforts to find off-farm employment, and (c) a general extensivation of production by switching to what she calls 'closed-cycle production', which means a minimum of market integration. Since smallholders had pursued extensive production anyway and large-scale farmers probably still faced the most favourable credit access, particularly *medium-sized farms* (7 to 15 hectares) were hit by credit shortages. Subsequent land sales led to a fragmentation of medium-sized farms and an increase in the number of smaller and larger farms, as reported in Figure 1-3 for the period 1990-1995.

A decade after the beginning of transition, analysts still suggested that lack of credit may significantly restrict productivity enhancement and structural change in Polish agriculture. MOOSBURGER et al. (1999, p. 364) argue that a well-

targeted, governmentally supported credit supply could ease the implementation of profitable farm investment. A similar position is taken by CZERWIŃSKA-KAYZER (2000, pp. 6-7). WOŚ (1999, p. 7) contends that 80 percent of Polish farmers cannot afford self-financing of farm growth, which implies that funds have to come from external sources.

In the early 1990's, farmers' protests increasingly put the government authorities under pressure to intervene on rural credit markets. It may be noted that the 'Samoobrona'-movement ('Self-Defense'), which was among the leaders of the anti-EU campaign in Poland, originated as a group of commercially oriented agricultural producers with high debt liabilities.[6] In the sequel, substantial measures were undertaken by the Polish government to improve the supply of funds to the farm sector. Government action culminated in the establishment of the Agency for Restructuring and Modernisation of Agriculture (Agencja Restrukturyzacji i Modernizacji Rolnictwa, ARiMR) in 1994, which since then has the task of channelling preferential credits into the sector. The following subchapter will describe in more detail the governmental credit policy in rural Poland.

1.2 Policy action on rural credit markets in Poland

The major form of state intervention on rural credit markets in Poland is the extension of preferential loans to agricultural producers.[7] Borrowers pay only a part of the commercial interest rate, whereas the remainder is paid by the government. There is hence a *subsidy on interest rates*. A second form of intervention is by *loan guarantees*. However, the budgetary importance of the latter is small as compared with the subsidies (less than one tenth). Furthermore, guarantees are primarily used for specific price stabilisation schemes, and are almost exclusively granted to farms in the public sector (at least until 1996, according to CHRISTENSEN and LACROIX 1997, pp. 18-19). I therefore focus mostly on the interest subsidy programme in the following.

Since 1994, preferential credits have been handed out by the Agency for Restructuring and Modernisation of Agriculture (ARiMR), which in the following years provided more than 30 different credit lines for various purposes

[6] The Samoobrona was founded by Andrzej LEPPER, a farmer from the Northeast of Poland who allegedly accumulated interest liabilities of close to 1 billion zł on a loan of 280 million zł (ZBIERSKI-SALAMEH 1999, p. 219).

[7] Overviews of credit market intervention in Polish agriculture are provided by CHRISTENSEN and LACROIX (1997, pp. 17-20), POGANIETZ and WILDERMUTH (1999), and CZERWIŃSKA-KAYZER (2000).

(CZERWIŃSKA-KAYZER 2000, p. 9). These credit lines comprised loans for working capital, basic investment, land purchases, investments by young and beginning farmers, sector programs (milk, cattle, poultry, etc.), loans to resume farm production, loans to restructure debts, and also loans to create non-farm jobs in urban and municipal areas (CHRISTENSEN and LACROIX 1997, p. 18). Special credit schemes aiming at market stabilisation for agricultural products included subsidised credit for cereal purchases and commodity loans for large farmers who store their harvest. The government apparently aimed at *targeting* the different credit lines by varying the volume and the extent of subsidisation (POGANIETZ and WILDERMUTH 1999, p. 537). The different credit lines are grouped into the two major categories "working capital" and "investment". In 1999, the last year covered by the detailed farm-level analysis below, subsidies on working capital loans amounted to 423 mln. zł, whereas investment loans were supported by 771 mln. zł (OECD 2000, pp. 106-107). Not regarding expenses for the farmers' social insurance fund, these payments made up 38 percent of the budget of the Ministry of Agriculture and Rural Development (Ministerstwo Rolnictwa i Rozwoju Wsi, MRiRW) (see MRIRW 2000).

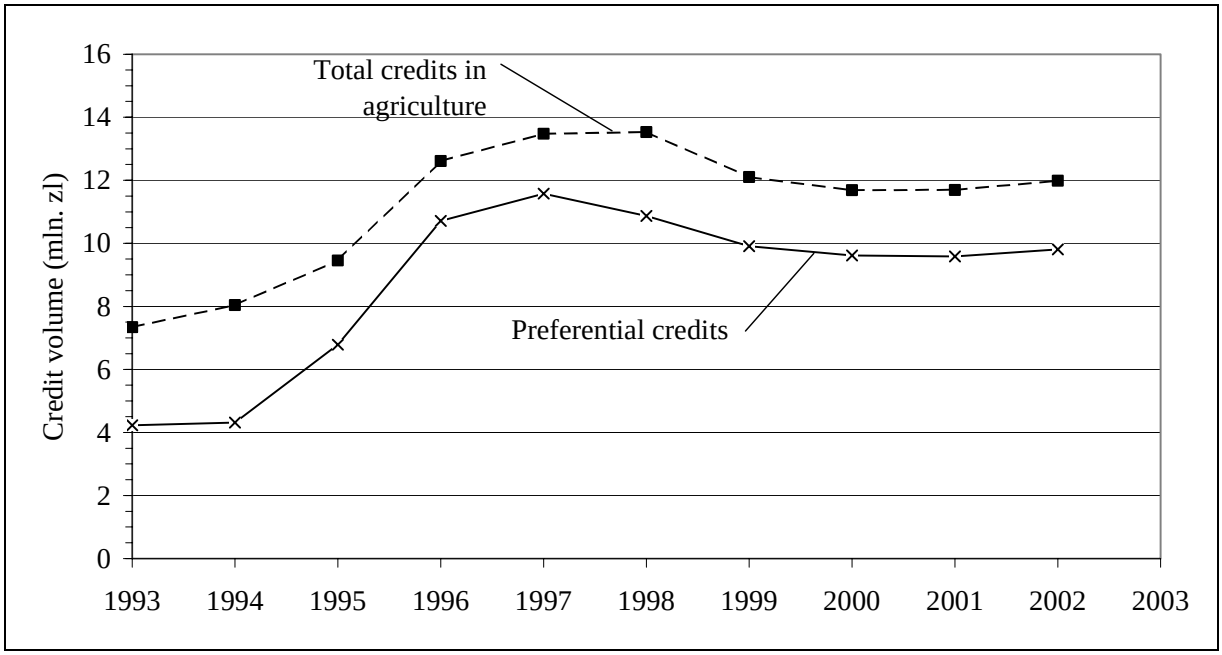
In 1999, preferential interest rates were in part lower than 6 percent p.a. (see section 4.2.2). In the same year, the rediscount rate for commercial bank loans was between 13.9 and 24.4 percent (NBP 2000). The inflation rate was at 7.3 percent (GUS 2000). Interest subsidies hence led to a substantial reduction of interest costs for farmers, even implying negative real interest rates.

Preferential loans under the government programme are extended through the existing network of banks. In Poland, there are two types of lending organisations specialised on agriculture, namely the Bank for Food Economy (Bank Gospodarki Żywnościowej, BGŻ), and the system of cooperative banks (KLANK 1999). However, preferential credits can also be received via almost all of the commercial banks in Poland. The *BGŻ* was the primary channel for financing state-managed agriculture during the socialist period, which implied that the bank inherited quite a number of bad loans in the course of market reforms. Similar to other formerly state-owned banks in Poland, there were several attempts to comprehensively restructure or liquidate the BGŻ during the past decade. However, this was successfully blocked, inter alia by agricultural lobby groups. Local *cooperative banks* had often been founded prior to the second World War, and existed under the umbrella of the BGŻ during socialism. In 1990, most of them left the BGŻ in order to form regionally oriented cooperative banking structures (WENZELER 1999, pp. 128-129; 196-200). Even so, their reconsolidation has remained incomplete to date. Furthermore, KHITARISHVILI

(2000) provides evidence based on a stochastic frontier analysis that the efficiency of Polish cooperative banks lags behind international standards. Whereas the general privatisation and liberalisation activities in the Polish banking sector have proven largely successful (RUTKOWSKA 1998, p. 66), agricultural banking is still an exception. Recent years have seen a general decrease of the importance of the traditional rural financial institutions (BGŻ and cooperative banks), whereas commercial banks – partly backed by foreign investors – expanded into rural areas (KLANK 1999, p. 41).

The procedure for obtaining loans is as follows. Prospective borrowers have to submit a loan application at a local bank branch, together with a business plan describing the envisaged use of the loan. The latter is usually evaluated by the public extension service ODR (Ośrodek Doradztwa Rolniczego, Extension Centre of Agriculture) prior to loan application. The bank then applies for subsidy payments at ARiMR. The bank bears the full default risk of the loan and therefore is also responsible for screening and monitoring of borrowers as well as possible enforcement of repayment or liquidation of collateral (POGANIETZ and WILDERMUTH 1999, p. 539). In contrast to other transition countries, mortgaging loans is less of a problem because most of the land remained in private property during the period of socialism. Accordingly, mortgaging is currently a commonly used instrument to collateralise loans (PROSTERMAN and ROLFES 2000, pp. 128-129). However, as stressed by KARCZ (1998, p. 96), the reliability or reputation of a borrower as indicated by previous punctual repayment of loans is at least as important for obtaining credit as is the sufficient availability of collateral.

Figure 1-4: Outstanding volume of total and preferential credits in the agricultural sector 1993-2002 (in 1999 prices)



Notes: Credit volume as outstanding on 31 December. Monetary values in 1999 prices, using the consumer price index.

Source: Author's calculations based on unpublished data of National Bank of Poland.

Figure 1-4 depicts the outstanding amount of total and preferential credits in the agricultural sector between 1993 and 2002. Monetary values are given in 1999 prices. The foundation of ARiMR marked the start of a phase of rapid credit expansion, with growth rates of the preferential credit volume of almost 60 percent in 1995 and 1996. In 1997, the volume of subsidised credits reached a peak, whereas it declined in the following years. This is consistent with the fact that the number of credit lines for agriculture and the volume of public funds earmarked for subsidising interest rates were considerably cut down in 1998 (CZERWIŃSKA-KAYZER 2000, p. 12). Since 2000, the volume of preferential credits has been almost stable in real terms.

In the phase of credit expansion, the share of preferential credits in the total credit volume temporarily increased from 53.7 percent in 1994 to 85.9 percent in 1997, whereas it decreased afterwards. This is evidence for a *crowding-out effect*, which means that borrowers turned to the cheaper government loans although they would have also borrowed under fully commercial terms. However, it seems that the total amount of credit outstanding was mainly driven by the changes in governmentally sponsored credit supply.

Comparing the tremendous shift in credit use as presented in Figure 1-4 with the moderate changes in investment outlays as reported in Figure 1-2 suggests that the effects of credit expansion on investment were rather dubious. The previously cited growth rates in credit volume of about 60 percent stand opposite to a growth in investment in agriculture of only 11.0 and 29.5 percent in 1995 and 1996, respectively. In 1997, investment even declined by 4.5 percent as compared with the previous year. Indeed, it appears to be the case that the strong public support to credit expansion did not result in a significant mobilisation of additional funds for investment. Even worse, POGANIETZ and WILDERMUTH (1999, p. 540) provide some evidence that subsidised credit funds were in fact *diverted to non-productive purposes*, for example for renovating residential buildings and their technical infrastructure. Significant changes in farm productivity compared to the EU as a response to increasing credit availability in Poland are likewise not visible (Figure 1-1). The only exception might be milk, where a slight but steady improvement materialised after 1995.

The tentative analysis suggests that positive impacts of governmental credit market intervention on the structrual problems described in subchapter 1.1 are in no way evident. It seems even unclear whether access to credit is in fact the bottleneck which is constraining farming operations to a significant extent. Two questions therefore emerge from the preceding discussion, which provide the major motivation for this study. First, *is there* a problem of credit access existing in the Polish farm sector, and second, if yes, does the public intervention programme contribute to *solve* this problem? These questions will be taken up in the following subchapter.

1.3 Resulting research questions

After having unfold the structural weaknesses of Polish agriculture and the extent of government intervention on credit markets in the previous subchapters, it is now possible to explicitly state the research questions that guide this study. However, before doing so I want to introduce a major term which will serve as the connecting thread throughout the monograph. It is the notion of *credit rationing*. This notion abounds in the recent literature on credit market problems, particularly in developing and transitional economies, although it is by no means used in a uniform way. For the moment, in line with a common sense understanding, I simply use credit rationing to describe a situation in which prospective borrowers cannot obtain as much credit as desired or no credit at all. A more detailed examination of the literature and a more precise definition of the term will be the subject of subsequent sections (see in particular subchapter 2.1).

Taking the notion of credit rationing as summarising a potential problem on rural credit markets in Poland, the central research questions of this study can be divided into two broad groups as follows:

1. Does credit rationing provide an *explanation* for the structural problems of Polish agriculture as outlined in subchapter 1.1? What is the relationship between credit use and production and investment outcomes in the farm sector?
2. Could the prevalence of credit rationing therefore serve as a justification for *governmental intervention* on Poland's rural financial markets? What can be learned with regard to the economic impact of this intervention?

The two key issues of the following analysis are therefore the search for an *explanation of structural deficits* and an investigation of the *impact of policy measures*. Both issues may be addressed from at least three directions: (a) theoretical reasoning, (b) experience from other countries that had similar problems and/or implemented similar policies, and (c) empirical evidence from Poland based on the experience made in the country so far. In this monograph, I focus on the first and the third of these directions. Direction (c) appears to be a most natural way to examine the Polish case. In addition, it seems indispensable to try to put the empirical analysis on a solid theoretical fundament, particularly since theoretical aspects are less frequently dealt with in empirically oriented studies on transitional countries. In contrast, the literature has produced quite some (albeit often controversial) knowledge on how rural credit policies worked in other countries, so that I confine myself to a brief overview in the following subchapter.

1.4 Controversies in the literature and limitations of current wisdom

This subchapter aims at giving an overview of the research field and highlighting the border of current wisdom. As introduced previously, I distinguish three strands of literature dealing with credit rationing and governmental credit policy, namely theory, international experience, and specific research on Poland. As far as the first and the third strand are covered, I give only brief introductions which are substantiated in later sections of this monograph.

1.4.1 Theoretical controversies regarding credit rationing

The traditional assumption of neoclassical economic theory is that markets clear and there is no rationing. Any excess demand or supply is eliminated by the 'invisible hand' of the price mechanism. This stands opposite to real world observations of, for example, persisting unemployment or credit rationing. Although

explanations of these phenomena have been sought and proposed for a long time, only recently did economists seriously call into question the general applicability of the standard textbook model to certain types of markets. Drawing on pioneers such as AKERLOF (1970), a branch called the 'economics of information' developed models in which persistent excess demand could be established due to an *asymmetric distribution of information* between market participants. With regard to credit rationing, STIGLITZ and WEISS (1981) is a frequently mentioned paper.

The major contribution of this branch of literature is the demonstration that "contractual arrangements [...], and in this sense 'institutions', can be analyzed through the use of the basic behavioural hypothesis of neoclassical economics: self-interest as expressed by homo oeconomicus. [...] The result is a genuine extension of the neoclassical standard model" (FURUBOTN and RICHTER 1997, p. 249). Although this can be regarded as an important theoretical progress, the implications are less comforting. As soon as information asymmetries are introduced, most of traditional welfare analysis breaks down. As shown by GREENWALD and STIGLITZ (1986), in economies with imperfect information, market equilibria are rarely efficient. This implies that much of received economic reasoning (such as "government intervention on competitive markets is welfare decreasing" or "unfettered markets are efficient") loses its basic foundation.

The question is hence whether the neoclassical standard model of clearing markets is a permissible simplification. Are credit markets really distinct from markets for chairs, tables, or pencils (JAFFEE and STIGLITZ 1990, p. 838)? The decision has particularly serious consequences due to the fact that, once information asymmetries are allowed for, the models do not provide clear-cut policy advice anymore. A recent case in point is the interrelatedness of credit rationing and underinvestment. From a standard neoclassical perspective, one would assume that, by its very name, credit rationing necessarily implies too little investment as compared with a first-best solution. DE MEZA and WEBB (1987; 2000) show that this is in no way the case, since credit rationing may both imply too much or too little funding. Whether one or the other applies in a given real-world situation is therefore an a priori open question. Compared with the standard welfare arguments usually put forward by trade theorists when it comes to an assessment of border protection or customs regulation, the economics of information provide much less straightforward guidance. There are hence theoretical controversies on two levels: whether information asymmetries are a relevant phenomenon at all and, if yes, what their implications are.

1.4.2 International experience on rural credit policies

Government intervention on rural credit markets has figured prominently both in developed and developing countries over decades. For this reason, it is no surprise that there is a considerable amount of literature dealing with this topic. It is not the aim of this section to do justice to all these contributions. However, I want to sketch at least the major arguments that might be relevant for the subsequent analysis in this monograph.

In the Western world, governmental intervention on credit markets is a widespread instrument to support national farming sectors. State-administered loan programmes for agriculture include the 'cooperative Farm Credit System' (created in 1916) and the 'Farm Services Agency' (formerly the 'Farmers Home Administration', created in the 1940s) in the U.S. (BARRY and ROBISON 2001, p. 557), and the 'Einzelbetriebliches Förderprogramm' (farm support programme, founded in 1973) or the 'Agrarkreditprogramm' (agricultural credit programme) in Germany (LANDWIRTSCHAFTLICHE RENTENBANK 1996).[8] The support measures in these programmes usually encompass interest subsidies, public grants, or public loan guarantees, or a mixture of these elements.

In developing countries, credit programmes sponsored by governments or international donor organisations to boost agricultural production became of major importance after World War II (for an overview see ADAMS 1995). Many of these programmes were characterised by strict interest controls or ceilings on loan interest rates, additional subsidisation, and extensive loan targeting. The latter was pursued by making credit access conditional on the use of certain input or technology packages, supervision, or the affiliation with specific borrower groups. More recently, under the heading of 'rural microfinance', there was a shift towards public support of financial institutions serving various types of rural clientele, including women or small-scale enterprises in general.

After the implementation of market reforms, many governments in Central and Eastern European Countries (CEECs) and the Former Soviet Union (FSU) also introduced new, seemingly market conform intervention measures. Specific problems of these countries include the accumulation of debts inherited from former state enterprises, absence of mortgage facilities due to lacking land registers, and low farm profitability as a result of deteriorating agricultural terms of trade (SWINNEN and GOW 1999). However, the policy instruments used resemble

[8] The latter two have now merged as 'Agrarinvestitionsförderungsprogramm' (agricultural investment support programme), see BEUERMANN et al. (1996, p. 152).

those in other countries, for example loan guarantees, interest subsidies, or the establishment of specialised lending institutions for agriculture (for an overview see OECD 1999).[9]

It needs hardly any explanation that public support on credit markets is usually welcomed by the beneficiaries. Likewise, from the view of the policymaker, it is a popular, politically expedient, and often relatively easily administered policy instrument (BARRY and ROBISON 2001, p. 559). To the contrary, economists tend to be much more sceptical with regard to the economic rationale of such programmes. However, serious and comprehensive evaluation of credit programmes is an often costly, methodologically difficult, and sometimes politically undesired task. Despite the more critical attitude of most economists, there is neither a uniform opinion with respect to the reasonable extent and usefulness of government intervention on credit markets in general nor on the impact of specific policy measures on the performance of supported enterprises and projects. Some of the critical issues in evaluating these programmes as stressed in the literature may be summarised as follows:[10]

1. It is often claimed that governmental credit support helps to *improve the competitiveness and the income generation potential* of farm enterprises. However, ex-post evaluations of state administered credit programmes have shown that they often *fail to achieve their objectives*. Beneficiaries frequently neither improved the efficiency of their operations vis-a-vis the non-beneficiaries, nor were incomes significantly increased. It seems hence questionable whether government agencies are more successful in selecting promising and economically viable borrowers for their loan programmes than commercial banks. Arguments in favour of these programmes stress their importance for supplementing rural incomes. However, distributional effects of loan programmes are often such that existing inequalities are even reinforced.[11]

2. If the problems of credit access are related to a *lack of collateral*, interest subsidies will not lead to an improvement. Public loan guarantees have been

[9] A general discussion of transition-specific problems of rural finance can be found in BLOMMESTEIN (1998), KOESTER (2001), and SCHRIEDER and HEIDHUES (1998).

[10] For overviews of these arguments see ADAMS (1995), BRAVERMAN and GUASCH (1993), PEDERSON and KHITARISHVILI (1997), and SWINNEN and GOW (1999).

[11] See for example BRÜMMER and LOY (2000) and STRIEWE et al. (1996) on Germany. ADAMS et al. (1984) and VON PISCHKE et al. (1983) contain numerous cases from developing countries.

proposed as a solution in these cases, since they are supposed to lift credit constraints induced by collateral requirements. However, they may increase the level of defaulting loans due to incentive problems of their own. These may result from the fact that banks have less incentive to properly screen borrowers, a kind of moral hazard by banks (KRAHNEN and SCHMIDT 1994, pp. 70-72).

3. Low interest rates and other types of preferential treatment have been proposed as a *financial buffer* for enterprises in an economically difficult transition period. However, favourable loan terms and soft budget constraints might also give *wrong signals* to enterprises which need restructuring, particularly if they allow an undue postponent of that task (PEDERSON and KHITARISHVILI 1997, p. 27)

4. Interest subsidies and other government expenditures on loan support might in fact lead to *higher* interest rates if they induce *increasing government borrowing*. This runs counter to the goal of reducing interest rates.

5. The provision of preferential funds may often involve a lot of bureaucracy and hence imply a substantial *transaction cost component*, which has the character of a fixed cost for the borrower. Smaller loans therefore become relatively more expensive, which leads to the perverse effect of further restricting small farmers' credit access, just the problem the policy was meant to alleviate. Similar effects result as a consequence of interest rate ceilings (GONZALEZ-VEGA 1977).

6. The *fungibility of credit* usually makes specific loan targeting impossible. Subsidised funds may substitute for own funds, thus implying little additionality as a result of government intervention. Furthermore, funds may be diverted to other purposes which were unintended by the government (VON PISCHKE and ADAMS 1980).

7. Preferential loans are often claimed to improve the access to finance for certain groups of borrowers. However, in the longer run they are *detrimental to the development of alternative financing sources*, such as trade credit or the formation of self-help groups. They result in little demand for loans at market rates and therefore reduce incentives to become engaged in any innovative activitiy to raise credit.

8. *Existing financial intermediaries* are often *economically strangled* by repressive financial policies which impose low interest rates on loans and deposits,

since intermediaries are unable to attract sufficient funds and are not allowed to demand cost covering prices for their services.

9. Support programmes starting as short-term responses to specific situations of crisis frequently *become permanent programmes* because they (a) create expectations on the part of the beneficiary that they will be continued or repeated, (b) create their own constituency and are for political reasons difficult to remove afterwards, and (c) become incorporated into prices for less mobile production factors such as land and hence raise production costs for new producers, and therefore demands for their continuation (SWINNEN and GOW 1999, p. 39).

Overall, the experience suggests that there are many potential pitfalls for government intervention on rural credit markets. Even so, the policy recommendations drawn from this experience span from suggesting slight modifications of existing programmes in order to avoid the most serious problems up to a total abolishment of governmental credit promotion.[12] This corresponds with the ambiguity of policy recommendations based on theoretical reasoning, as outlined in the previous section. It is no surprise that the basic positions concerning government intervention on credit markets are widely varying, as the following two quotes may illustrate:

> "There *is* a role for the state in financial markets; it is a role motivated by pervasive market failures. In most of the rapidly growing economies of East Asia government has taken an active role in creating financial institutions, in regulating them, and in directing credit, both in ways that enhance the stability of the economy and the solvency of the financial institutions and in ways that enhance growth prospects" (STIGLITZ 1994, p. 50, italics in the original).

> "In summary, there may be good arguments for intervention, and some may be based on market failure. But as one unpacks each argument, the realization grows that, given the current state of empirical evidence on many relevant questions, it is impossible to be categorial that an intervention in the credit market is justified. Empirical work that can speak to these issues is the next challenge if the theoretical progress on the operation of rural credit markets is to be matched by progress in the policy sphere" (BESLEY 1994, p. 45).

A general lesson is hence that serious policy advice will have to take the specific conditions within a country or region into account. The following section aims at summarising the current wisdom on the Polish case.

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[12] In Germany, the first position seems to be taken for example by BEUERMANN et al. (1996) and MÜLLER and P.M. SCHMITZ (1996), whereas the latter standpoint is represented by ALBERS (1983) and STRIEWE et al. (1996).

1.4.3 The state of knowledge concerning rural credit in Poland

The basic characteristics of the Polish rural credit market were already described in subchapter 1.2, I therefore concentrate on the existing knowledge regarding *credit rationing* and the *effects of governmental credit promotion*.

The current wisdom regarding both issues is very limited. Apart from the more anecdotal evidence provided by ZBIERSKI-SALAMEH (1999) as mentioned previously, a recent World Bank study (2001) is the only publication I am aware of which explicitly deals with the issue of credit rationing of Polish farm households. The section on credit (WORLD BANK 2001, pp. 63-85) is concerned with the question why Polish farmers borrow so little. Two hypotheses are put forward (pp. 65-66): (a) farmers do not request loans because, due to uncertain expectations about the future, they have no viable investment projects available, and (b) farmers want to borrow but rural credit markets in Poland fail, with the result of rationing, either in the form of quantity rationing or due to prohibitively high direct (interest, fees) and indirect (paperwork, travelling) costs of borrowing. Based on survey results, it is reported that many of the farmers interviewed regard hypothesis (a) as valid. If this were true, this suggests in my view that there is nothing wrong with the credit market in Poland. However, the study also argues that there is evidence in favour of the second hypothesis. About one half of all borrowers in the survey said that they wanted a larger loan on the same term as the loan they received (p. 66). Furthermore, dummies indicating the voivodship the respondent lives in turned out to be highly significant in regression analyses of borrowing and investment behaviour. This is interpreted as evidence against the uncertainty hypothesis, since uncertainty due to macroeconomic factors should more or less evenly apply to all regions of the country. In addition, in a bivariate Probit model, current income turned out to be a significant determinant of the investment decision. In the view of the author, this suggests the existence of a financial constraint (p. 85). However, the latter finding might be objected due to the unclear causal relationship between income and investment (this is admitted by the author himself, p. 83, see also section 3.2.2 below). Furthermore, the reported regression results surprisingly omit the income variable discussed in the text.[13]

There is hence some, albeit provisional, evidence that credit rationing is a significant problem in rural Poland. However, the World Bank study does not es-

[13] This might be due to an editorial mistake. Curiously enough, the tables with the regression results (Tables 3.8 and 3.13 on pp. 78; 84) do not contain any income variable, although one of the major conclusions of the study rests on precisely this variable.

tablish any causal relationship between credit rationing and government intervention on credit markets in Poland.[14]

A number of authors call the economic rationale of government intervention on Polish credit markets into question, but their arguments usually rest on general theoretical reasoning or on aggregate statistics, as presented in previous subchapters. CHRISTENSEN and LACROIX (1997, pp. 19-20, 33-35) argue that the costs of government intervention by far exceed their benefits, based on a very rough estimation and plausibility considerations. Accordingly, they recommend to phase out the programme (pp. 43-44). A similar approach is taken by SCHRADER (1996). He suggests that, although capital needs in the agricultural sector are large, the sector still is in a better shape than other sectors of the Polish economy. According to his view, this is due to the fact that interruptions of production processes were much less severe than in many other industries, major parts of the capital stock had not to be written off, and the key production factor land underwent no depreciation at all. Furthermore, SCHRADER contends that capital subsidisation leads to a substitution of labour by capital, which he regards as counterproductive in an environment of high (hidden) unemployment. He therefore also advises to abolish the credit subsidies (p. 28).

A recent paper by JÓZWIAK (2001) aims at assessing the microeconomic effects preferential credits had, based on a sample of book-keeping farms. The author compares the performance of several groups of borrowing farms with a control group of non-borrowing farms. He finds that borrowing farms in general realised a higher income growth than non-borrowers but at the same time increased the intensity of family labour on their farms more strongly (p. 26). Unfortunately, the relatively simple with-and-without comparison does not allow to control the simultaneous influence of several determinants. It is hence difficult to judge whether increased incomes are due to borrowing or due to a higher labour intensity. Furthermore, his results may be subject to selectivity bias (see section 3.2.2 below).

JÓZWIAK (2001) also finds evidence that subsidised credit funds were used for non-productive purposes, although he does not further explain what is precisely meant by this (pp. 24-25). He suggests that an annual fraction of preferential credits varying between 23 and 48 percent was diverted between 1993 and 1997.

[14] There is a current work by LATRUFFE and FRASER (2002) exploring the effects of government intervention on credit rationing in Poland. At present, this work is solely based on a theoretical model. Depending on various parameter choices, policy implications differ, so that no ultimate conclusions with regard to the Polish case could be drawn.

Furthermore, he suggests that preferential credit promotion after 1995 led to a *decrease* in the diversion of funds (p. 26).

In summary, apart from a general criticism of public credit market intervention, the empirical evidence regarding the impact of the preferential credit programme in Poland is meagre and ambiguous. Furthermore, the problem of credit rationing of Polish farm households still awaits a rigorous empirical examination. This assessment is shared by other researchers, and could even be extended to other CEECs, as the following quote from TANGERMANN and SWINNEN (2000, p. 198) demonstrates:

> "As far as factor markets are concerned, much research has studied land reform processes, legal provisions concerning land markets and restructuring of enterprises. [...] [M]ore issues are unresolved in understanding structural changes in the agricultural labour and *capital markets* in CEECs and their implications. They are the least understood aspects of the transition process in agriculture, although many studies suggest that they are key factors in CEEC agricultural productivity growth, output recovery and rural development in general" (emphasis added).

1.5 Organisation of the monograph

The study attempts to address the research questions stated in subchapter 1.3 both theoretically and empirically. The theoretical analysis is pursued in chapter 2. Chapter 3 develops a research methodology that aims to make the theoretical considerations fruitful for the empirical investigation of the Polish case. In chapter 4, the results of this investigation are presented. The final chapter 5 synthesises the findings and aims to place them in the wider context of current economic research. Furthermore, based on the results of the analysis, a number of policy recommendations are derived. Overviews of the contents of single chapters are given at the beginning of each chapter.

It is one of the central aims of this monograph to *combine* a theoretically motivated discussion of credit rationing with a rigorous empirical application of this concept. Given the diversity of the literature and the complexity of the methodological approaches, this is a challenge for both the author and the reader. Tentative experience suggests that the reader faces two particular challenges. The first is to comprehend what is actually meant by credit rationing. A basic definition that can be used as a reference point throughout the monograph will be given in section 2.1.1 below. However, the definition of credit rationing is intimately linked to the theoretical view of the world one is willing to adopt. Since I could not spare the reader this critical debate, he or she should expect that the given

definition is scrutinised and challenged throughout the entire chapter 2. The quick reader is advised to turn to the summary sections, in particular 2.1.6, pp. 47 et seq., and 2.2.4, pp. 74 et seq. Furthermore, the fact that theory-based definitions can rarely be applied directly to real world observations made it necessary to take up again the discussion on defining credit rationing in the methodological chapter. Different methods of analysis even required different operational definitions of credit rationing. The reader will find a summary of these in section 3.3.2, pp. 145 et seq.

The second challenge for the reader is due to the separation of the material into three major chapters dealing with theory, methodology, and empirical results, respectively. Although this appears to be a quite conventional and commonly employed structure, it conceals an alternative way of organising the study. This alternative is suggested by the three major analytical approaches used in the thesis, which each focus on specific aspects of the theoretical discussion. The three approaches analyse, in turn, (a) the determinants of being credit-rationed, (b) the effects of credit rationing on farm output, and (c) the effects of credit rationing on farm investment. The following matrix aims to make transparent where these three approaches are located in the monograph and hopefully contributes to a better orientation of the reader.

The quick reader is offered the alternative to have a look at one of the journal articles that emerged from the thesis and which cover its major scientific contribution. PETRICK (2004) contains an analysis of credit rationing and its effects on farm output, PETRICK (2004a) focuses on the effects on farm investment, and PETRICK (2004b) presents an overview of methods for measuring credit rationing.

Table 1-1: Major analytical approaches of the study and where they are presented in the text

Approach	*Relevant theoretical discussion*	*Development of empirical research methodology*	*Presentation of empirical results*
Analysis of the determinants of being credit-rationed	Subchapters 2.1 and 2.2, pp. 23 et seq.	Section 3.3.3, pp. 146 et seq.	Subchapter 4.1, pp. 163 et seq.
Analysis of the effects of credit rationing on farm output	Section 2.3.1, pp. 77 et seq.	Section 3.3.4, pp. 149 et seq.	Subchapter 4.2, pp. 171 et seq.
Analysis of the effects of credit rationing on farm investment	Section 2.3.2, pp. 91 et seq.	Section 3.3.5, pp. 157 et seq.	Subchapter 4.3, pp. 184 et seq.

Source: Author's depiction.

2 CREDIT RATIONING IN THEORETICAL PERSPECTIVE

The aim of this chapter is to address the questions raised in subchapter 1.3 from a theoretical perspective: how can credit rationing be understood and explained on theoretical grounds? How does credit rationing affect production and investment outcomes of farm households? Can the prevalence of credit rationing serve as a justification for government intervention? I proceed in several steps: subchapter 2.1, by undertaking a journey through the current literature, attempts to clarify what precisely is understood as 'credit rationing' in theory. Subchapter 2.2 aims at consolidating a number of the issues involved by presenting a theoretical model that explains credit rationing as a result of asymmetric information between market participants. Subsequently I discuss the robustness and the resulting policy implications of this approach. Subchapter 2.3 examines the effects credit rationing has on production and investment decisions of farm households in different static and dynamic settings. Particularly the last subchapter will also provide an important background for the empirical approach to be discussed in chapter 3.

2.1 Forms and sources of credit rationing

2.1.1 Defining credit rationing

In subchapter 1.3, I introduced a common sense understanding of the term credit rationing. It can be restated as follows: *credit* is a means to enable investment by solving a liquidity problem. The liquidity problem arises from the fact that outlays triggered by the investment precede (expected) future returns. Investment in turn is guided by certain higher-level goals such as profit or income generation. Credit *rationing* is understood as a situation where a *lack* of sufficient credit inhibits desirable investment, since the liquidity problem cannot be solved. That is, credit rationing is seen as the reason for too little or underinvestment.

To be more precise is not without difficulty, since there are various definitions of credit rationing used in the literature (this is discussed by JAFFEE and STIGLITZ 1990, pp. 847-849, and LEATHERS 1990, p. 782). However, to provide a common reference point for the discussion in this chapter, it seems useful to further distinguish credit rationing and underinvestment as follows:

> A potential borrower is regarded as being *credit-rationed* if his *private* demand for credit persistently *exceeds* the loan amount offered by the lender, with the loan terms showing no tendency to change. A credit market outcome

is characterised by *underinvestment* if the level of investment carried out by borrowers is persistently *below* the *socially* desirable level.

This definition deserves a number of comments. First, a difference is made between private and social desirability. The former is related to the goals of the individual borrower, whereas the latter is concerned with the goals of the society as a whole. These may sometimes harmonise and sometimes not, as is discussed below. Similarly, credit rationing may sometimes imply underinvestment and sometimes not. The qualification 'persistently' is used here to exclude situations of sluggish adjustment or short-term market dynamics, which are not the focus of this research. My interest is in stable or equilibrium situations of credit rationing.

If credit rationing is believed to be present in a given real-world situation, the preceding tentative definition suggests three major questions: first, which circumstances constitute an ideal situation of *absent* credit rationing, in which all – privately or socially – desirable investment is carried out? Second, what are the *reasons* for the observed deviation from this ideal? Third, is it possible and does it make sense to *intervene* in order to (re-)establish the ideal situation?

An answer to the first question would hence provide an important analytical benchmark. This benchmark of an ideal or first-best situation would allow to assess the degree of credit rationing in terms of a deviation from the so defined ideal. Possibly it would also give some hint regarding the rationale behind this deviation, which in turn would be helpful for those who consider intervention. They would know how much intervention is necessary and could perhaps also measure the success of their endeavour. In the following, I therefore try to clarify the first question of what is the benchmark that establishes the presence or absence of credit rationing before, in the course of the chapter, I discuss the second and third questions concerning the reasons for credit rationing and the possibility of intervention.

2.1.2 The benchmark case of a perfect capital market

Since Adam SMITH's notion of the 'invisible hand', economists have been fascinated by the ideal of a competitive market that achieves a best possible solution to the resource allocation problem of society. Seeming like a paradox, in this ideal situation, prices coordinate the otherwise independent activities of purely self-interested participants in such a way that everybody's welfare is maximised. The modern formalisation of this notion is the general equilibrium theory advanced by ARROW and DEBREU (1954). Almost all contemporary reasoning in

economics takes this neoclassical model as a benchmark (SCITOVSKY 1990, p. 135, cited in BRANDES et al. 1997, p. 24):

> "Ever since the paradox was first noted, generations of economists have admired, taught and argued it, and the Arrow-Debreu theory of general competitive equilibrium is the culmination of the profession's long struggle to understand fully all its conditions and implications".

According to MAGILL and SHAFER (1991, p. 1524), much of economic theory can be viewed as a study of the causes and consequences of market *failure*, where the Arrow-Debreu theory provides the idealised framework in which markets function at their best. In fact, this is precisely the approach taken in the current chapter. In line with the given focus of interest, I will therefore outline the major assumptions and implications of a *perfect, neoclassical capital market*, before challenging them in later sections.

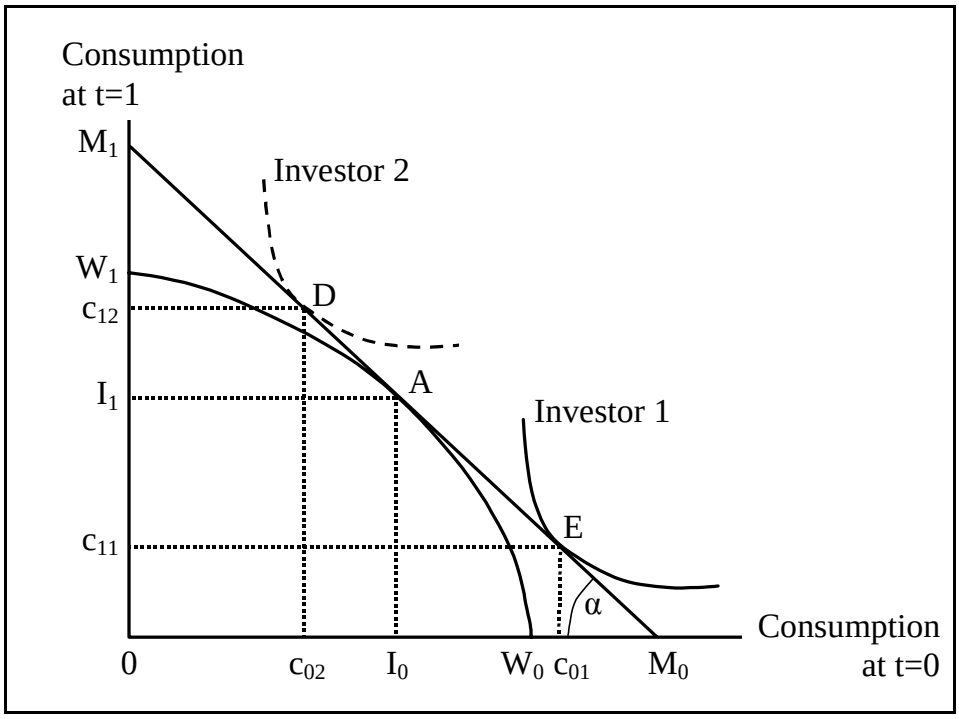
In the following, the capital market is understood in an abstract sense as the place where *payment streams* are traded (see SCHMIDT and TERBERGER 1997). The important fact is that payment streams are traded *intertemporally*. Earlier payment streams are traded for later ones. If the payment stream is such that, in view of the single market participant, outlays precede receipts, one speaks of investment (or lending); if the reverse holds, one speaks of financing (or borrowing). Investment and financing, lending and borrowing are treated as completely symmetric. Intertemporal trade is useful since payments have different values at different times, due to varying time preferences of market participants. The difference per period is the *rate of interest*. It says in percent per period how much the value of a later payment exceeds that of an earlier payment. Payment streams may differ in terms of maturity or due date.

In analogy to the neoclassical model of a competitive economy, a number of key *assumptions* are made that establish the existence of a perfect capital market (see ROBISON and BARRY 1996, p. 34): there are no barriers to entry, no participant can influence the interest rate, transactions are costless to complete, relevant information about the exchanged payment streams is widely and freely available, payment streams (within given maturity classes) are homogenous, and they are continuously divisible. For the moment it is also assumed that expectations are certain, that is only payment streams are regarded which will be made with perfect certainty.

Under these conditions, there is *one interest rate* at which payment streams of given maturity and due date are traded. This interest rate represents the opportunity cost of capital for all market participants. Under the further assumption that

actors behave in a utility maximising or rational way, it is possible to analyse the activities on a neoclassical capital market in a graphical model of intertemporal choice due to FISHER (1930), see Figure 2-1. In the model, a rational investor – for example a farmer – facing a perfect capital market is endowed with initial wealth and productive investment opportunities. His problem is to maximise intertemporal utility by making optimal investment, financing, and consumption decisions. Objects of utility are consumption levels today and in a given future period.

Figure 2-1: The perfect capital market and optimal intertemporal choice



Source: Modified from ROBISON and BARRY (1996, p. 35).

In Figure 2-1, the two axes represent consumption opportunities at time t=0 (present) and time t=1 (future). The investor begins at time t=0 with wealth $0W_0$ which may be consumed or invested (the subsequent exposition follows ROBISON and BARRY 1996, pp. 34-37). Wealth $0W_0$ can be invested in (a) a set of productive investments ordered according to diminishing returns along line W_0W_1; or (b) a financial investment with a rate of return $r = tan\ \alpha - 1$, assumed to exceed zero, along parallels of the line M_0M_1. Initially, the return on productive investments exceeds return r. Therefore, the rational actor makes productive investments by moving along curve W_0W_1. The profitability of the productive investments relative to the financial investments can be compared at each level of

investment. The comparison is between the diminishing marginal internal rate of return (IRR) on the former given by the slope of W_0W_1 (which is –(1+IRR) and the market interest rate given by the constant slope of M_0M_1 (which is –(1+r)). The future value of an euro invested in productive investments is equal to the (negative) slope of the productive investment curve. The future value of a current euro invested in the financial market is equal to the (negative) slope of the financial market line.

Beginning at W_0, the optimal level of productive investments is eventually reached at point A, where the marginal IRR on productive investments is equal to the market interest rate r. The optimal level of productive investment, $I_0W_0=0W_0 - 0I_0$, yields consumption opportunities equal to $0I_1$ at t=1. The optimal level of financial investment, $0I_0$, yields I_1M_1 at t=1. This combination of productive and financial investments has a present value of $0M_0$ or a future value of $0M_1$. The net present value (NPV) described by point A equals the discounted value of future returns less the initial investment:

$$NPV = \frac{0I_1 + I_1M_1}{1+r} - 0W_0 = W_0M_0 .$$

An important result is that at the optimal level of investment, all productive investment is undertaken that adds to the investor's NPV. At point A, an *equilibrium* is reached, since there is no incentive to change investment plans anymore. Therefore, in equilibrium, *those productive investments are made that maximise investors' NPV*. Furthermore, *all productive investments are made whose IRR exceeds the market interest rate*.

The optimal investment decision is solely determined by the rates of return on productive investments relative to the market interest rate. Now I consider the investor's desire to consume quantities of goods c_0 now and c_1 in the future. The investor's utility function, $u(c_0,c_1)$, and indifference curves have no influence on the optimal investment under these perfect market conditions. However, the utility function does determine the trading activities (lending or borrowing) that yield a utility-maximising combination of present and future consumption for the investor, given the optimal level of investment. For example, Investor 1 in Figure 2-1 has a strong time preference for current consumption, as indicated by the location of his indifference curve in the diagram. He will undertake productive investments to point A, and then move in the reverse direction by *borrowing* $0c_{01} - 0I_0$, moving along the financial market line M_0M_1 until tangency is achieved with the highest attainable indifference curve. In contrast, Investor 2, who has a weaker time preference, will invest in point A and then *save* $0I_0 - 0c_{02}$

additional funds moving along the line M_0M_1 until tangency with her indifference curves occurs at D.

The detailed allocation can be seen in Figure 2-1 for both investors. The preferred consumption choice for Investor 1 (c_{01},c_{11}) is indicated by point E. To reach E, the investor allocates part I_0W_0 of his initial wealth to productive investments, leaving $0I_0$ of initial wealth for consumption. The optimal consumption plan is then attained by borrowing amount I_0c_{01}, so that present consumption equals $0c_{01}$. The amount of the loan plus interest given by $c_{11}I_1=I_0c_{01}(1+r)$ is repaid from the returns of the productive investment at time point t=1, leaving the desired consumption level $0c_{11}$ at t=1. Thus, the utility-maximising consumption levels at point E are $0c_{01}$ at t=0 and $0c_{11}$ at t=1.

The preferred consumption choice (c_{02},c_{12}) for Investor 2 is indicated by point D. To reach D, the investor allocates part I_0W_0 of her initial wealth to productive investments, then saves $c_{02}I_0$, so that present consumption equals $0c_{02}$. The amount saved plus interest given by $I_1c_{12}=c_{02}I_0(1+r)$ increases future consumption possibilities to $0c_{12}$. Thus, the utility-maximising consumption levels at D are $0c_{02}$ at t=0 and $0c_{12}$ at t=1.

In the end, both investors have the same present values of investment decisions on the one hand, but different utility-maximising financing and consumption decisions on the other. In the presence of a perfect capital market, *investment and consumption decisions are thus separable*. For both investors, at optimal points D and E in Figure 2-1, the slopes of the financial market line, the productive investments line, and the indifference curves are equal. Thus, equality occurs among the investor's marginal rates of utility substitution between present and future consumption, the market interest rate, and the marginal investment return. In analogy to the neoclassical equilibrium model, these are the conditions under which the capital market operates *efficiently*.

If there are many investors trading on the capital market, it provides the important service of allowing a redistribution of people's consumption opportunities over time through lending and borrowing. The prevailing market clearing interest rate reflects the time preferences of investors given their present levels of wealth and their investment opportunities. In equilibrium, all productive investments with a positive contribution to NPV are undertaken, all investors realise their utility maximising consumption bundles given their resources, and therefore all gains from intertemporal trade are exhausted. This situation is said to be *Pareto-optimal*, since consumption opportunities cannot be reallocated to make someone better off without making someone else worse off.

In summary, the assumption of a perfect capital market in connection with rational behaviour has three major implications:

1. All productive investment that yields at least the market interest rate is undertaken. In equilibrium, rational actors maximise the net present value of their investment portfolio.
2. Investment decisions are made independently of consumption and financing decisions. Individual preferences thus do not influence which investments are undertaken. (These first two implications are known as the *Fisher Separation Theorem*).
3. The perfect capital market allows an efficient, Pareto-optimal allocation of payment streams. Both the private and the social optimum are reached.

It may be added that these results hold even if expectations are uncertain, as long as the assumption of a perfect capital market is maintained. In its most general form, the Arrow-Debreu model allows an equilibrium under uncertainty, since every possible future state is covered by a so-called state-contingent claim, and perfect insurance is possible (ARROW and HAHN 1971). Also without such an assumption, MODIGLIANI and MILLER (1958) have shown that the market value of a firm facing a perfect capital market is independent of its financial structure. This holds even if firms differ in their business risk. Therefore, the firm's financial policy is irrelevant for its investment decisions. This is the *Modigliani-Miller Theorem*, which can be viewed as a counterpart, with a given degree of uncertainty, to the above mentioned Fisher Separation Theorem (see SCHMIDT and TERBERGER 1997). Finally, SHARPE (1970) has demonstrated in his Capital Asset Pricing Model (CAPM) that under explicit consideration of risk, investment projects can be evaluated in separation from financial decisions. Hence, without going into the many details, the assumption of certain expectations is not crucial for the central neoclassical result: in the presence of a perfect capital market, there is an objective criterion concerning which investment projects should be carried out. Sufficiently profitable projects (taking into account a risk premium) can and will be financed. Therefore, for the moment, I will not consider the aspect of uncertain expectations further,[15] while coming back to it in section 2.1.5.

Due to its desirable properties, the perfect capital market will serve as the benchmark for further reasoning on credit rationing. Coming back to the consid-

[15] I also do not discuss the various concepts of risk and information efficiency prevailing in the capital market literature (see e.g. FAMA 1976 and SHARPE and ALEXANDER 1990).

erations of the introductory section 2.1.1, it becomes clear that in a perfect capital market, all investment projects can be financed *as long as they yield at least the given market rate of interest*. However, these are precisely the projects that contribute positively to the investors NPV, so that there is no excess demand and hence no rationing. Even if the investor prefers not to invest his own wealth into the project (as Investor 1 in Figure 2-1 does), sufficiently profitable investment will nevertheless be undertaken via funding from the capital market. For the investor, there is no problem of financing, since he is completely indifferent as to credit versus equity funding. Based on these theoretical reflections, the following definition emerges:

> On the basis of the neoclassical model of a perfect capital market, I define *credit rationing* as being *absent* if all projects are undertaken whose return is at least as high as the market rate of interest.

An 'ideal' situation is thus established that implies no credit rationing. Indeed, the definition includes an important restriction. In case that an investment project does not yield the necessary rate of return equal to the market interest and hence cannot be credit funded, there is no credit rationing. Such a project is inefficient and would be a waste of money (see SCHNEIDER 1992, p. 629). As an implication, inefficient projects are sorted out by the market mechanism *without any government intervention*.

2.1.3 Problems with the neoclassical view of a perfect capital market

The definition given in the previous section under which circumstances there is *no* credit rationing might be regarded as being not fully satisfying. For example, it remains unclear what should be used as 'the' market rate of interest. What if no single market rate exists? Does credit rationing automatically prevail in all cases not fully in compliance with the assumptions of the neoclassical model? To answer these questions, a more operational definition of credit rationing is clearly desirable. In fact, the attempt to be more precise about the *presence* of credit rationing is intimately linked to the query of how realistic the neoclassical model of a perfect capital market is. Most people would probably agree that the conditions under which such a market emerges are hardly met in reality. Not the least observations of phenomena such as credit rationing have fuelled scepticism with regard to the appropriateness of this model. In essence, in the neoclassical model, *credit rationing is assumed away*. By definition, there is no credit rationing in a perfect capital market.

At this point, a key dilemma becomes visible: in the just presented mainstream theory the problem to be analysed does not occur. Hence, apart from defining a benchmark, neoclassical theory appears to be of little value in explaining real-world observations such as credit rationing.

Which are the consequences of this insight? The issue of how to deal with observations that seem irreconcilable with the orthodox view of perfect markets in fact denotes a fundamental crossroad in contemporary economic theory. I want to sketch three ways out of the dilemma:

1. *Ignore the problem*. The first solution is to disregard problems of credit rationing or to downplay their importance. This is the view of neoclassical capital market theory. Its representatives – key contributors such as FISHER, MODIGLIANI and MILLER, and SHARPE have already been mentioned in section 2.1.2 – maintain the assumption of perfect capital markets throughout their analyses.

2. *Extend the neoclassical model in an appropriate way*. Proponents of this solution agree with members of the first group that the insights of the neoclassical model have relevance for the study of economic behaviour. Their strategy is to *gradually modify* the model to allow the occurrence of phenomena impossible in the pure neoclassical world. In doing so, formal and/or mathematical notation is usually retained. Since many researchers of this group will become relevant in later sections of this chapter, I only mention STIGLITZ as a key contributor (a recent overview of his work is his 2002 paper).

3. *Abandon the neoclassical model altogether*. In its extreme version, the third way completely denies that the frictionless, perfect market model has anything meaningful to say about economic events in the real world. In this respect, DEMSETZ (1969, p. 1) speaks of a “nirvana approach”. Representatives of this group thus attempt to explain economic behaviour in a *principally* different manner than the neoclassical model, for example by the assumption of bounded rationality and opportunism (such as O.E. WILLIAMSON; see e.g. 1985 and 1993). A formal analysis in mathematical terms is usually rejected, though research topics often parallel those of the former way, e.g. with respect to a comparative analysis of institutional settings alternative to the perfect market. Within the focus of financial issues, research on ‘behavioural finance’ seeks to identify and explain behaviour inconsistent with the rationality postulate (see THALER 1993).

Both the second and third way are usually classified as belonging to the broad 'institutionalist' field of economics, which is why a clear cut border between the two may be difficult to draw. It is beyond the scope of this chapter to give a detailed overview of the different branches of the so-called 'New Institutional Economics' (NIE). The reader is referred to the comprehensive survey in FURUBOTN and RICHTER (1997), especially chapters 4 and 5.

The principal approach of this monograph is very much in favour of the second way. This line of reasoning will therefore be examined with some detail in subsequent sections. The rationale behind this decision is as follows. Since the investigation of credit rationing is the declared objective of the current study, it is obvious that the first way makes little sense to follow. However, to completely call into question the neoclassical foundations of economic theory, as suggested by the third way, seems to be unwarranted as well. In particular, there exists no unified theory which may take the place of a central reference comparable to the neoclassical tradition, and which is equally well analysed, understood and accepted. Therefore, I explicitly maintain the neoclassical model as a benchmark, as already indicated above. It will serve as an important background for the further discussion of credit rationing, similar to most of the theoretical credit rationing literature. Positions that are critical of a merely gradual modification of the neoclassical model will be taken up from time to time in later sections.

2.1.4 Extension 1: positive transaction costs

If credit rationing does not occur in the neoclassical model, it is natural to suspect that this may be due to the specific assumptions underlying the model. In this and the following section, I will therefore investigate the consequences of relaxing two major assumptions made so far (section 2.1.2), namely (a) transaction costs are zero, and (b) relevant information about the exchanged payment streams is widely and freely available.

Transacting on markets involves costs in addition to the nominal price of the good to be purchased or sold – this intuitively plausible statement might be illustrated by a passage from COASE (1960, p. 15), who was among the first to point out the importance of positive *transaction costs*:[16]

> "In order to carry out a market transaction it is necessary to discover who it is that one wishes to deal with, to inform people that one wishes to deal and on

[16] My attention was drawn to this passage by FURUBOTN and RICHTER (1997, p. 43), who however only cite the first sentence. The first conceptual treatment of transaction costs supposedly was COASE (1937).

> what terms, to conduct negotiations leading up to a bargain, to draw up the contract, to undertake the inspection needed to make sure that the terms of the contract are being observed, and so on. These operations are often extremely costly, sufficiently costly at any rate to prevent many transactions that would be carried out in a world in which the pricing system worked without cost."

Transaction costs are the result of activities necessary for search and information gathering, bargaining and decision making, and supervision and enforcement of formal or informal contracts (FURUBOTN and RICHTER 1997, pp. 44-45). They can be regarded as the economic equivalent to friction in physical systems (O.E. WILLIAMSON 1985, p. 19). Clearly, these costs have a close connection to the fact that individuals are *not fully informed* about the good to be traded, the other market participants, or the practical and legal aspects of concluding contracts. Though not all transaction costs are due to imperfect information (e.g. time expenses for waiting or transportation costs), it is useful to examine the effects of positive transaction costs and asymmetric information jointly. For the moment, however, I concentrate on the cost dimension. COASE already mentions an important consequence of these costs: *nonzero transaction costs can make trade activities prohibitively costly that would have been carried out otherwise*. Do transaction costs therefore constitute a case of rationing?

Before discussing this question, I first want to raise a second question that has caused some confusion in the literature, namely: can transaction costs be *measured*? And if yes, having in mind the introductory remarks of section 2.1.1, does this measure provide a yardstick that allows the quantification of credit rationing as a deviation from the neoclassical ideal?[17]

At first glance, this suggestion seems to be quite reasonable. In fact, both with regard to credit markets in general and to *rural* credit markets in particular, economists have stressed the importance of transaction costs. BENSTON and C.W. SMITH (1976) regard transaction costs as the ultimate reason for the existence of financial intermediaries such as banks.[18] With respect to rural credit markets, a strand of literature closely associated with the so-called Ohio State school of rural finance stresses the importance of non-interest loan transaction costs prevalent in developing countries (ADAMS and NEHMAN 1979; various contributions in ADAMS et al. 1984). According to ADAMS and NEHMAN (1979, pp. 6-7), loan transaction costs may include first of all loan charges collected by

[17] I discuss these questions already here in the theoretical chapter since they are central to an understanding of the nature of the concept 'transaction costs'.

[18] Curiously enough, banks have no role to play in general equilibrium theory, where they are superfluous (FREIXAS and ROCHET 1997, section 1.2).

the lender beyond interest payments, such as application fees, forced purchase of other lender services, bribes, or compensatory balances, secondly costs due to negotiations with someone outside the formal lending agency, such as extension staff, local officials, or cosigners, and finally travel and time expenses which may be substantial in rural areas and at certain times, e.g. in planting or harvesting periods. This list suggests that loans made to rural inhabitants can be regarded as quite transaction cost intensive from the borrower's point of view.

These costs certainly can be measured, at least as long as they are actual cash expenses. There are several contributions in the literature presenting figures of loan transaction costs arising in rural credit markets of various countries.[19] Furthermore, writers of this tradition have claimed that loan transaction costs are the *ultimate reason for credit rationing* of certain types of borrowers, particularly small farms (CUEVAS and GRAHAM 1986; LADMAN 1984; R.L. MEYER and CUEVAS 1992).[20] It appears thus useful to formally investigate which consequences the introduction of transaction costs on loan markets has.

In relation to the loan size, positive transaction costs cause an increase in the effective interest rate a borrower has to pay, since they add to the nominal interest. Similarly, they reduce the effective rate a saver may obtain. They thus drive a wedge between, in this case, saving and borrowing rates. The general result is a *price band* between actual sale and purchase prices the decision maker faces (see HIRSHLEIFER and GLAZER 1992, pp. 375-387; SADOULET and DE JANVRY 1995, pp. 149-159; 254-5). The consequences can be analysed in the graphical model presented in section 2.1.2 as follows, see Figure 2-2.

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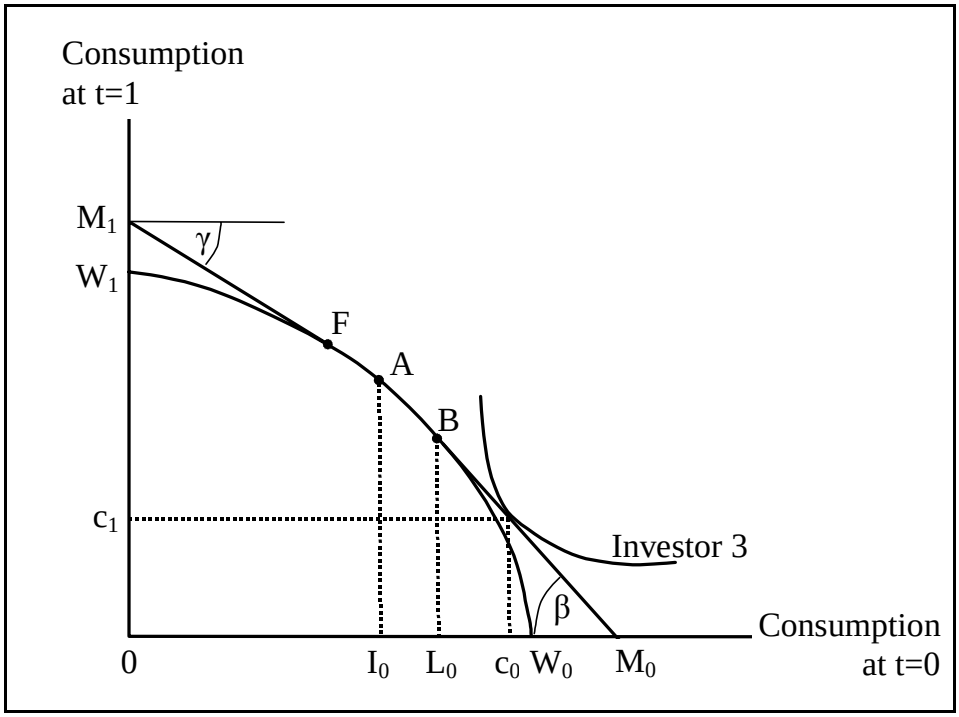
[19] See ADAMS and NEHMAN (1979) on Bangladesh, Brazil, and Colombia, various contributions in ADAMS et al. (1984) mainly on Latin America, CUEVAS and GRAHAM (1986) on Bangladesh, Ecuador, Honduras, Panama, and Peru, AHMED (1989) on Bangladesh, R.L. MEYER and CUEVAS (1992) on Bangladesh, Dominican Republic, Honduras, Niger, Philippines, and Togo, and OLOMOLA (1999) on Nigeria.

[20] There is a tension between the use of the term credit rationing in the cited Ohio State school literature and the more formal agency literature as presented below. While the latter – in accordance with the definition given in this monograph, section 2.1.1 – clearly sees credit rationing as a *quantity* restriction, the Ohio State school writers seem to imply that rationing works through a *price* mechanism (via transaction costs). The only way to reconcile these two views is by regarding a borrower's demand for credit determined by a hypothetical first-best interest rate. In case the borrower actually faces positive transaction costs, she can afford less than the first-best credit volume, which restricts the quantity borrowed and might hence be interpreted as an excess demand. See the further discussion here and in Approach 1 of section 3.1.3.

Figure 2-2: Intertemporal choice with positive transaction costs



Source: Author's depiction.

In Figure 2-2, the investor has available the same set of productive investments according to line W_0W_1 as in Figure 2-1. However, the financial market line is now split. The investor can borrow money at the interest rate $r_b = tan\ \beta - 1$ and save money at the rate $r_s = tan\ \gamma - 1 < r_b$. Furthermore, in comparison to Figure 2-1, $r_s < r < r_b$. Hence, all reasonable combinations of consumption bundles at time points t=0 and 1 are depicted by the line M_0BAFM_1. Under these conditions, which is the optimal volume of productive investment? The answer clearly depends on the time preference of the investor. An investor with a weak time preference would probably prefer a point on the line FM_1. In this case, he will save money at t=0 for consumption at t=1. Relevant for him is thus r_s, and he would productively invest W_0F. An investor with a strong time preference, such as Investor 3 in Figure 2-2, would probably choose a point on the line M_0B, in which case she would borrow at rate r_b, invest W_0B, and consume (c_0,c_1). Both investors could calculate a NPV by using their relevant interest rate for discounting. For Investor 3, the NPV is W_0M_0. Finally, an investor with a medium time preference may prefer point A. He has to directly compare his time preference with the IRR of his productive investment, since no useful NPV can be calculated.

Hence, an important result is the following:

> With positive transaction costs, *investment decisions cannot be made in separation from consumption decisions*. There is *no objective criterion* concerning which productive investments should be made, since the relevant discount rate (if one exists at all) depends on the preferences of the investor.

Suppose now that Investor 3 wishes to productively invest I_0W_0 – the optimal amount with zero transaction costs – but needs to consume $0c_0$ at t=0 in Figure 2-2, since this is an indispensable subsistence bundle without which Investor 3 cannot survive. At the borrowing rate r_b, he would obtain L_0W_0 from the loan market. Hence, *there remains a financial gap* of size $I_0L_0 - c_0W_0$. This is precisely the case where nonzero transaction costs prevent otherwise profitable investment. To decide whether there is any persistent excess credit demand as compared to the ideal situation in Figure 2-1 or whether credit allocation in the presence of transaction costs is socially inefficient ultimately *depends on the interest rate taken as benchmark*. Positive transaction costs distort the unambiguous benchmark of the ideal, neoclassical world in such a way that a definite judgement cannot be made any more.

One way out of this dilemma could be to simply accept transaction costs as a fact of life and treat them similarly to conventional production or transportation costs – as was implicitly done in the analysis so far. Without severe difficulties, 'transaction activities' could be included in an otherwise unchanged neoclassical trade model (see the example in FURUBOTN and RICHTER 1997, section 2.4). With a given (convex) transaction technology, rational decision makers would economise on transaction costs, this would slightly affect the optimal solution of the model, but the property of Pareto-optimality – given positive transaction costs – would be preserved. By such a model, interest spreads as in Figure 2-2 can be explained. However, the problem of evaluating investment projects as just demonstrated emerges, which is why the situation is simply declared as being 'constrained-efficient' or 'second-best' as compared to a world with zero transaction costs. Taking the problem of Investor 3 as an example, it would be regarded as socially constrained-efficient in a second-best world that his desired investment I_0W_0 cannot be carried out, while in a first-best world it would clearly be inefficient to refrain from doing so. On the private level, taking one or the other interest rate as appropriate discount would end up in the same dilemma.

As DAHLMAN (1979) has pointed out, a fundamental difficulty arises from this logic (see also DE ALESSI 1983, p. 69). If all constraints of the real world are

taken as given, a situation can *always* be described as Pareto-optimal: "if it exists it must be optimal, and if it does not exist it is because it is too costly, so that it is optimal too" (DAHLMAN 1979, p. 153). As a result, any reasonable benchmark in terms of efficiency or optimality disappears.

Taking stock, the previous discussion can be summarised as follows: there are examples of transaction costs on loan markets that can be and are measured. However, the introduction of given transaction costs into the formal analysis at the same time undermines the previously established criterion of efficiency.

> I conclude that a judgement concerning the presence of credit rationing in a world of positive transaction costs is impossible *as long as the nature of these costs is not investigated further*.

One decisive question to be posed during this investigation is, as FURUBOTN and RICHTER (1997, pp. 62; 460-1) made clear, which transaction costs or *which additional constraints of the real world are unavoidable* and which can be circumvented. The next steps in the analysis are therefore guided by the following two issues: (a) a closer examination of the nature or the determinants of transaction costs, and (b) the search for an operational rule that allows to assess whether transaction costs are avoidable.

Before going into the details of the former issue, I want to call the reader's attention to an important source of transaction costs regarded as being 'avoidable' by many economists who are in favour of financial liberalisation and deregulation. This source is *government intervention*. In previous decades, intervention on financial markets often took the form of foreign exchange controls, interest rate ceilings, high reserve requirements, and the suppression of private capital markets; thus overall leading to a situation of financial repression (FRY 1995, pp. 20-21). Under these conditions, it is quite plausible that potential borrowers find that they either cannot borrow as much as they would like to at current interest rates or are unable to borrow at all (DRISCOLL 1992, p. 68). Therefore, many economists would probably agree with BALTENSPERGER (1978, p. 180) that "legal [...] constraints on loan term adjustments may lead to rationing and certainly may have undesirable efficiency results." This is also the major argument of the Ohio State school of rural finance. Writers in this tradition make (in their view avoidable) transaction costs caused by overly restrictive government regulation directly responsible for credit rationing of rural borrowers (see ADAMS 1993; CUEVAS and GRAHAM 1984 and 1986; LADMAN 1984). In this view, the best intervention to mitigate credit rationing is to *remove* existing financial policy measures.

Over recent years, policies of financial liberalisation have figured prominently world-wide (see CAPRIO et al. 2001). They were also an important step in the transition process of the CEECs. How far liberalisation is still due on the Polish rural credit market has been briefly addressed in section 1.2 and will be taken up again in the discussion of the empirical results of this thesis. For the moment, I will not elaborate further on policy issues but come back, on a theoretical level, to the question of the nature of transaction costs.

Indeed, possibly as a consequence of widespread liberalisation policies, there is now a substantial volume of literature investigating the causes of credit rationing on *unrestricted* financial markets. Compared with the literature emphasising measurement or observation of transaction costs, which was regarded previously as not fully satisfying in theoretical terms, this line of research is primarily concerned with more abstract and formal models. It is thus quite close in spirit to conventional, neoclassical equilibrium theory and belongs to a research programme usually called 'agency theory', 'principal-agent analysis', or 'economics of information' (for an overview see BAMBERG and SPREMANN 1987). As was indicated in section 2.1.3, this research programme attempts to *extend* the neoclassical model in an appropriate way to make it more flexible for explaining real world events, without throwing all its major assumptions overboard. As the names suggest, the basic premise of this literature is that there is an *asymmetric distribution of information between decision makers*, which constitutes the so-called *agency problem*. Economic actors have to be treated differently according to their information status, which is why the distinction between *principal* and *agent* is introduced. As subsequent sections will show, this is tantamount to a much more comprehensive analysis of a variety of institutional arrangements than possible in the orthodox, neoclassical framework.[21] The next section will outline some basic elements of this theory.

2.1.5 Extension 2: asymmetric information

The consideration of asymmetric information between market participants has opened a wide arena of economic research that today represents a major branch of institutional economics. One of the earliest contributions in this line of research was AKERLOF (1970), who demonstrated the effects of unknown quality of used cars on outcomes of the second-hand automobile market: the fact that there are 'lemons', that is used cars of a poor quality which cannot be distin-

[21] In the terminology of O.E. WILLIAMSON's Transaction Cost Economics, this analysis would be described as assessing alternative 'structures of governance'.

guished from high-quality cars by potential buyers, may lead to a complete breakdown of the market. Already in this paper a second market receives attention where similar problems may occur: the market for credit, on which lenders have only limited information about the 'quality' of borrowers, that is their honesty, reliability, or trustworthiness with regard to the due repayment of the loan.[22] It may pay the opportunistic borrower to *pretend* to be honest, and take the money and run after he received the loan. As a result, the lender will think twice whom he will grant a credit. In this case, the lender is called the *principal*, and the borrower is the *agent*, due to the differential information they possess about each other. In this way, a peculiar type of uncertainty is reintroduced into the analysis.

Later research made clear that the effects of asymmetric information distribution may reasonably be classified according to the *sequence of actions* of principal and agent. As a consequence, principal-agent problems are often cast in game theoretic terms (see RASMUSEN 1994, part II). With regard to credit markets, there are three key problems a lender must contend with: the lender must (a) ascertain what kind of a risk the potential borrower is (the problem of *adverse selection*), (b) make sure she will utilise the loan properly, once made, so that she will be able to repay it (*moral hazard*), and (c) learn how her project really did in case she declares her inability to repay (*costly state verification*).[23] Accordingly, one can distinguish informational asymmetries that are ex ante (adverse selection), interim (moral hazard), or ex-post (costly state verification) to the borrowing transaction (FREIXAS and ROCHET 1997, p. 16). I will characterise the three phenomena in turn:[24]

1. *Adverse selection* in loan markets arises when borrowers have characteristics that are unobservable to the lender but affect the probability of being able to repay the loan. A farmer may be in a better position than the bank to assess

[22] Such phenomena also figure prominently on the *labour* market, on which other early papers of the asymmetric information tradition focus, for example SPENCE (1973) and STIGLITZ (1974). AKERLOF, SPENCE, and STIGLITZ were awarded the Nobel prize for their work in 2001.

[23] Here I 'borrow' from the successful formulation of GHATAK and GUINNANE (1999, p. 197). They mention as a fourth important problem the *enforcement* of the loan contract, which is omitted here since it is not directly related to asymmetric information.

[24] I draw mainly on GHATAK and GUINNANE (1999). Other expositions of the principal-agent problem with increasing degree of complexity are HOFF et al. (1993), NEUBERGER (1998), BRANDES et al. (1997), FURUBOTN and RICHTER (1997), KREPS (1990), and RASMUSEN (1994). This list does not claim to be comprehensive.

whether his soils and his abilities justify investment in a fruit tree plantation. If the bank, therefore, cannot discriminate between borrowers, low-risk investment projects might be withdrawn from the market if they are only offered the *average* loan contract conditions. This in turn worsens the average quality of the loan applicant pool from the point of view of the bank, which is a process of adverse selection. The presence of high-risk borrowers in the market thus exerts a *negative externality* on low-risk borrowers. In the extreme case, the result is zero trade, as in AKERLOF's (1970) lemon example. Hence, both lenders and low-risk borrowers have an interest to *overcome* the informational asymmetry. This is however not costless, since it involves expenses on *screening* or *signalling* activities (see SPENCE 1973 on the latter). In credit markets, these are particularly widespread: lenders demand collateral that can be seized in case of loan default, borrowers are required to finance part of the investment by their own wealth, or they must show extensive business plans, third-party guarantees, or income statements. According to KREPS (1990, p. 651), if the informed side takes the active role, one speaks of signalling (e.g. by offering a third party guarantee), while screening is present if the side without information proposes a menu of contracts (e.g. including different interest-collateral combinations) among which the informed side selects. These mechanisms will be explored in a more formal way in later sections of this chapter.

2. *Moral hazard* is related to the fact that, once a borrower has taken a loan, the project's payoff depends in part on the borrower's effort. This may be not directly observable by the bank. Since, absent collateral, the borrower does not fully internalise the costs of project failure, there are incentives for him to maximise his personal welfare to the detriment of the lender. If the project outcome involves some randomness, such as weather events, the agent can always argue that a poor result was attributable to forces beyond his control and, thus, not his fault. Moral hazard occurs if the borrower does not take those actions that make repayment of the loan most likely: though the farmer cannot affect whether there *is* early frost that potentially destroys his blossoming cherries, he can affect the *losses* he incurs by taking precautionary action, even if this requires additional effort. Countermeasures include active and costly *monitoring* of agents by the principal, aiming at preventing opportunistic behaviour.

3. *Costly state verification* is necessary if lenders cannot easily check whether borrowers who say they cannot fully repay are indeed unable to do so. For the bank to accept partial repayment may prevent it from breaking even,

likewise does it incur costs to verify the actual project outcome. To solve the double problem of false reporting and costs of state verification, TOWNSEND (1979) has demonstrated that the optimal solution is a so-called *standard debt contract*: the borrower promises a fixed repayment, and the bank seizes the entire cash flow of the project when the borrower claims she cannot repay. However, if information asymmetries regarding project outcomes are pronounced, potential auditing costs may be assessed as being too high, so that again no loan contract materialises at all.

It probably became clear that asymmetric information is not an unalterable fact, but it is costly to counteract and sometimes impossible to fully overcome. Hence, a demand for services or institutions that help to mitigate the negative consequences of asymmetric information is likely to emerge. This in turn provides a rationale for the existence of *financial intermediaries*, which are superfluous in a world with perfect information. As may be intuitively plausible, there will be economies of scale in screening, monitoring, and auditing (as well as in risk diversification), which fosters the creation of specialised firms offering these services. In fact, it may be efficient for borrowers to form 'information sharing coalitions' in order to signal their quality to investors, an argument that can explain the emergence of specialised financial intermediaries (LELAND and PYLE 1977). Similarly, they may emerge if it pays individual lenders (or savers) to delegate the monitoring activity to a specialised institution, instead of performing it themselves. This is the 'delegated monitoring' theory of financial intermediation (DIAMOND 1984; for overviews see FREIXAS and ROCHET 1997, NEUBERGER 1998, and RÜHLE 1997).

Summing up, the introduction of informational asymmetries considerably complicates the neoclassical model of the capital market. Although their effects were only sketched briefly so far, it is obvious that they undermine the traditional role of the price as the single allocation mechanism if the quality of the good in question (here: investment projects to be financed) depends on its price (the interest rate; see STIGLITZ 1987). Therefore, non-price allocation mechanisms such as collateral, but also honesty or reputation come into play. Interlinkages between different markets may arise, for which trade credit is an example (JAIN 2001). New sorts of externalities emerge. A whole set of institutions in the area of financial intermediation is the response to prevailing informational asymmetries. As was already suggested, even in the presence of such institutions, markets are still unlikely to function perfectly. Some markets, particularly those involving risk, will be missing, and many other markets will be thin and thus imperfectly

competitive (HOFF et al. 1993). The possibility of *credit rationing* is one of the ultimate consequences.

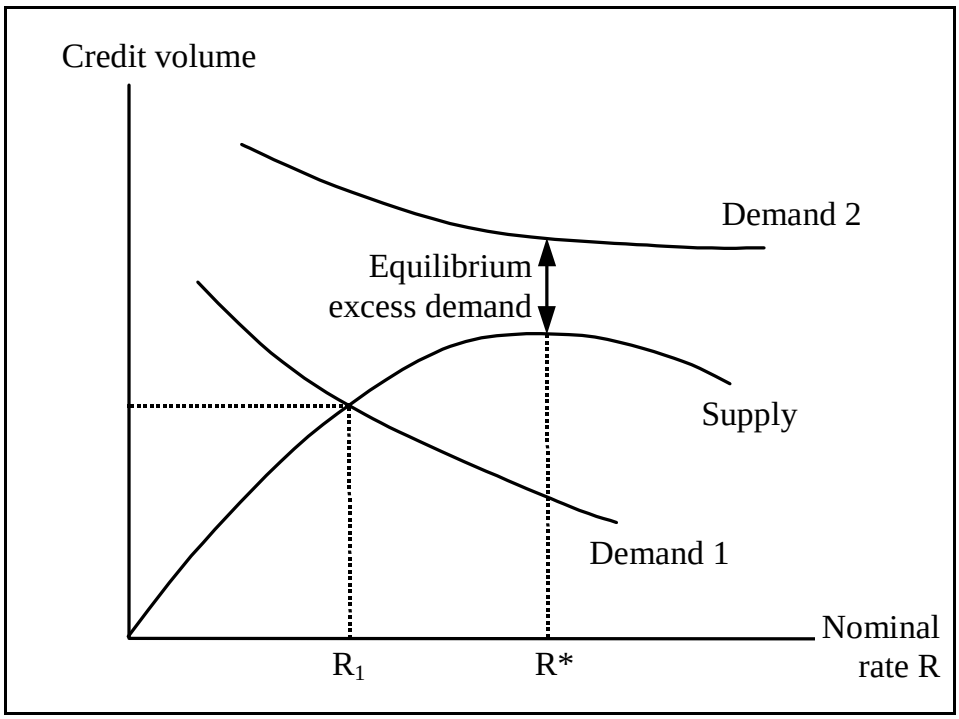
It has been demonstrated in the literature on agency theory that each of the three phenomena of asymmetric information explained above *taken alone* may lead to credit rationing in a particular narrow sense. See the contributions of STIGLITZ and WEISS (1981) on adverse selection and moral hazard and S.D. WILLIAMSON (1987) on costly state verification. I will examine some of these rather stylised and abstract models in more detail in subchapter 2.2. In this literature, credit rationing is understood as the fact that a borrower's demand for credit is turned down, even if this borrower is willing to pay *all the price and non-price elements* of the loan contract (BALTENSPERGER 1978, p. 173). Non-price elements include collateral, borrower's equity, a stable customer relationship, or the length of the loan period. Quite in line with the definition given in section 2.1.1, a situation is thus characterised as 'pure' or 'equilibrium' credit rationing if there is a persistent excess of demand over supply with price and non-price terms showing no tendency to clear the market (STIGLITZ and WEISS 1981, pp. 394-5; JAFFEE and STIGLITZ 1990). In the extreme case, apparently identical borrowers' access to loans is simply by chance, or randomised (BESANKO and THAKOR 1987, p. 678).

The relationship between credit volume and interest rate may be depicted in a supply and demand diagram as in Figure 2-3. The decisive property of supply is that it is *backward bending*, as shown in the figure. Subchapter 2.2 will demonstrate in more detail under which circumstances such a backward bending supply schedule may occur – for example, it may reflect an adverse selection effect of a rise in the interest rate. For the demand schedule 1, a competitive equilibrium exists, characterised by equality of supply and demand, so that the nominal rate R_1 clears the market.[25] However, for the demand schedule 2, supply and demand curves do not intersect. An equilibrium with credit rationing will then occur, characterised by the interest rate R^*, in which credit is allocated by means other than the interest rate.[26]

[25] Throughout this monograph, R is gross repayment including interest, and r is the interest rate, such that $R = K(1+r)$, with K the amount borrowed.

[26] Following KEETON (1979) as cited in FREIXAS and ROCHET (1997, p. 155, fn. 2), it may be reasonable to distinguish two types of rationing. *Type I rationing* occurs when *all* borrowers receive credit but are restricted in the size of the loan they obtain; *type II rationing* occurs when borrowers have only randomised access to the full loan size they demand, so that *some* borrowers obtain the loan they demanded while others obtain no loan at all. If

Figure 2-3: Equilibrium credit rationing



Source: Adapted from FREIXAS and ROCHET (1997, p. 140).

This situation is clearly a substantial deviation from the perfect capital market model which was established as a benchmark in section 2.1.2 above. Much less clear are two related key questions:

1. Does such rationing *actually exist* as an important phenomenon in reality?
2. If it exists, does it provide a case for *government intervention*?

There is an intensive debate in the current literature concerning both questions, since they are still not answered satisfactorily (see BALTENSPERGER and DEVINNEY 1985 and HUBBARD 1998 on the first, and BESLEY 1994 and DRISCOLL 1992 on the second question). Therefore, most of the remaining analysis in this thesis is devoted to further exploring them. I will briefly outline the crucial issues of both questions in the following, before going more into the details in later sections.

To demonstrate that pure credit rationing actually exists requires clarification on two fronts. First, it may be asked *how robust* models of equilibrium credit ra-

projects are indivisible, rationing is always of type II. If projects are divisible, rationing would be of type I under decreasing returns to scale, and of type II under increasing returns to scale (FREIXAS and ROCHET 1997, p. 140).

tioning are on theoretical grounds. Since most models work with rather restrictive and stylised assumptions, this may be a central objection, which will be discussed in subchapter 2.2. Second, it is necessary to develop *empirical tests* that conclusively verify or reject the propositions of the models. A fundamental problem in this respect is to find an operational definition of credit rationing that fits into the restrictive assumptions of the theory. Since laboratory experiments are largely impossible in empirical economics, it is probably difficult to isolate certain determinants of credit rationing, if the phenomenon has been operationalised after all. Furthermore, these determinants have to convincingly represent the presence or absence of asymmetric information. Questions of an empirical strategy to detect credit rationing are the focus of chapter 3.

If there is still a long way to go before pure credit rationing as an empirical fact can be verified, it appears even more difficult to think about reasonable government intervention. In theory, the presence of asymmetric information seems to imply that there is almost always space for 'constrained' Pareto improvements via tax policy (GREENWALD and STIGLITZ 1986). With regard to credit rationing, JAFFEE and STIGLITZ (1990, p. 868) state that "A market equilibrium with credit rationing [...] is not Pareto efficient in general, even when account is taken of the costs of information." However, *which type* of policy is optimal is often impossible to determine since even simple theoretical models generate irreconcilable implications once the assumptions of the model are slightly modified (see DE MEZA and WEBB 1987 and subchapter 2.2 of this monograph). HOFF et al. (1993, p. 19) argue that, as a result of asymmetric information, the justifications for market interventions grow in number but also in complexity and side effects. They plausibly assume that, if asymmetric information is at the core of market failures, better information and more transparency in markets and institutions will be at the core of any solution. However, it is quite an open question whether governments possess an advantage over private agents in dealing with these problems, for example in gathering information on the varying probabilities of default in the loan market (STIGLITZ 1987a). In the end, government intervention aimed at mitigating problems of asymmetric information may create even new agency relations.[27] Practical policy advice might thus be difficult to give. An even more anti-interventionist position is taken by BALTENSPERGER (1978, p. 180) who says:

[27] An example is the introduction of public guarantee schemes for rural borrowers. The international evidence suggests that these programmes tend to result in severe problems of moral hazard and increasing default rates (GUDGER 1998).

> "Endogenous constraints based on imperfect information and screening [...] should not be seen as a factor causing inefficiencies and distortions. Rather, they represent an efficient response of the market to the existence of certain cost elements present in the loan market but not in the usual 'textbook' market, namely information and transaction cost elements found in any market with heterogeneous goods (such as, e.g., the labour market, the housing market, the insurance market, and many more). They can certainly not be the rationale, therefore, for any corrective regulatory measures."

According to this view, although the private demand for funds may exceed the loan offers, this is not regarded as socially undesirable.

Looking back, the following becomes clear:

> Agency theory has much to say about the nature and the determinants of transaction costs. However, whether these costs do indicate an inefficiency or even provide a rationale for intervention appears almost *impossible to judge a priori*.

Issues of policy intervention will be taken up again in section 2.2.3 and subsequent chapters of the monograph.

Finally, it is interesting to see how the notion of transaction costs (or 'agency costs', to mention a term used by several writers) changes its meaning in the literature on agency theory (see TERBERGER 1994, pp. 125-134). Along with a shift towards theoretically more sophisticated, often highly stylised models goes an increasingly abstract understanding of these costs, up to the point where they are regarded as a superfluous concept at all. A case in point is the paper by JENSEN and MECKLING (1976) concerning the separation of ownership and control in a corporate firm. These authors define agency costs as the sum of (a) monitoring expenditures by the principal, (b) bonding expenditures by the agent (similar to signalling activities explained above), and (c) the residual loss, which can be regarded in a general sense as the difference between the hypothetical welfare in a first-best world and the welfare actually attained when transaction costs are positive and total welfare is not truly maximised by the actions of the agent. The difference between the first- and second-best solution are the gross agency costs. However, these costs can *never be measured*, since the first-best outcome is generally unknown. As a result, the notion of transaction costs can only be used reasonably in a *metaphorical* sense (see the dispute between SCHNEIDER 1987 and SCHMIDT 1987 and section 3.1.2 below). In the end, endogenising the entire institutional structure and thus giving due attention its specific information and incentive problems may make the quantification of these costs an exercise in

futility, as HELLWIG (1988, p. 200) has noted (cited in TERBERGER 1994, p. 133, fn. 131):

> "...when there is incomplete information, Coasian transaction costs depend on the precise nature of the strategic interactions and cannot be assessed prior to a full analysis of the system. After such an analysis, when one understands the system anyway, it is not clear what additional purpose the concept can serve."

Essentially, a precise measurement of transaction costs is impossible since the correct opportunity costs of transaction activities are unknown. As long as the institutional arrangement used to determine the value of an alternative activity is unclear, these opportunity costs cannot be calculated.[28] If the optimal institutional arrangement is known, the exact volume of transaction costs accruing in the second-best situation provides little additional value. Therefore, the notion of (measurable) transaction costs plays almost no role in formal agency theory.

Somewhat surprisingly, O.E. WILLIAMSON, the 'inventor' of the term 'Transaction Cost Economics', also does not aim at measuring transaction costs, although he acknowledges empirical work (1985, p. 22):

> "Empirical research on transaction cost matters almost never attempts to measure such costs directly. Instead, the question is whether organizational relations (contracting practices; governance structures) line up with the attributes of transactions as predicted by transaction cost reasoning or not."

Measurement of transaction costs will again be an issue when it comes to quantifying interest rates faced by farmers in Poland in subchapter 3.3, where an empirical model of household decision making is considered. However, in the light of the preceding discussion, it seems unjustified to regard transaction costs in the sense of actual cash or time expenses *per se* as a useful measure of credit rationing.

Before examining one of the well established models of equilibrium credit rationing, I now want to summarise the hitherto gained knowledge concerning the classification and assessment of different types of credit rationing.

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[28] This also qualifies the results of WALLIS and NORTH (1986) concerning the measurement of transaction costs in the American economy. They attempt to measure these costs by adding up the value of services of what they call transaction industries, with the result that the percentage share in GNP of these costs more than doubled between 1870 and 1970. As TERBERGER (1994, p. 127, fn. 113) argues, this approach disregards opportunity costs, since it only shows that more and more coordination activity is delegated to specialised industries from which it is purchased afterwards. According to TERBERGER, what this documents is an increasing division of labour within the economy, which indirectly suggests the *reduction* of coordination problems.

2.1.6 Summary and conclusions for further research

This section attempts to synthesise the answers found in theory so far on the questions emerging from a common sense understanding of credit rationing. In section 2.1.1, credit rationing was regarded as a situation where a lack of sufficient credit inhibits privately desirable investment. The questions brought up were: is there an ideal situation of absent credit rationing? What are the reasons for any observed deviations from this ideal? Is it possible to intervene in order to re-establish the ideal situation?

In section 2.1.2, the benchmark model of a perfect, neoclassical capital market was established, which has the desirable property of guaranteeing that all sufficiently remunerative investment projects can be financed. Moreover, funding is independent of the wealth of the investor who runs the project. The perfect capital market achieves a best possible solution (in the sense of Pareto-optimality) to the allocation problem of society. It provides an objective criterion on which projects shall be carried out (which are therefore 'desirable'): those projects qualify for funding that yield at least the (single) market rate of interest. In this form of capital market, there is no credit rationing. Furthermore, no intervention is necessary, because all privately and socially desirable investment is made.

The merit of this model – that it entails no credit rationing *by definition* – was regarded as a weakness as well (section 2.1.3). In the real world, there may be various interest rates, and it may be doubtful whether all profitable investments are really always funded (according to DRISCOLL 1992, p. 78, this typically is in question with regard to students, small businesses, and farmers). The ideal, neoclassical model was therefore viewed as not very helpful in analysing these everyday observable problems. Suitable extensions of the model were thus sought in the literature.

The first extension was the explicit consideration of positive transaction costs (section 2.1.4). Transaction costs can explain the existence of differing interest rates, but they also decay the objective criterion concerning which projects are socially desirable to finance at all. To escape this dilemma, it is necessary to distinguish between avoidable and unavoidable transaction costs – which however requires a new, 'objective' criterion. It was hence regarded as indispensable to further investigate the nature and the causes of transaction costs. For many economists, particularly those transaction costs seem definitely avoidable that are the direct consequence of governmental intervention, which should therefore be reduced as far as possible.

In section 2.1.5, as a second extension, the consequences of asymmetric information between agents on the credit market were studied. Phenomena of adverse selection, moral hazard, and costly state verification establish quite plausible reasons for the prevalence of positive transaction costs. Furthermore, a host of institutional arrangements that are unnecessary on a perfect capital market but do exist in the real world – such as financial intermediaries – can be explained as a response to these informational asymmetries. However, the role of the interest rate as an objective decision criterion is fundamentally shaken, since interest changes may affect the quality of the investment projects ready to be financed. Whether this is a justification for government intervention largely depends on the precise situation and is thus open to doubt. If there *were* a Pareto-improving policy measure, then the costs arising from imperfect information clearly could be regarded as avoidable. However, just because there *are* widespread problems of asymmetric information, this question is most difficult to answer.

As a synthesis of the discussion, and for further reference, the following three sources of credit rationing may be distinguished:

1. *Interest rate rationing:* A project cannot be credit funded because it does not yield the market rate of interest. In the neoclassical market model, this is neither privately nor socially efficient and should *not* be called credit rationing. In a model with positive transaction costs as part of the effective interest rate, there may be credit rationing if transaction costs are avoidable. This is a crucial issue if the costs are a result of government regulation, so that the next paragraph applies. Furthermore, the interest rate may be influenced by asymmetric information, so that the next but one paragraph applies.

2. *Government intervention:* A project cannot be funded because of governmentally imposed regulations that restrict access to funds for certain types of borrowers, or imposes interest ceilings so that the interest rate cannot adjust to appropriately reflect demand and supply. This is usually regarded as inefficient and may be viewed as an (avoidable) form of credit rationing.

3. *Asymmetric information:* A form of pure or equilibrium credit rationing occurs that results in randomised funding of apparently identical projects. It is usually discussed in the framework of (rather stylised) models of asymmetric information. There are authors who argue that this is a socially efficient response to the existence of transaction costs. Others regard it as inefficient and show that, in a theoretical model, there are policy interventions that achieve Pareto-improvements.

Unfortunately, all these forms or descriptions of credit rationing are intimately linked to a certain view of the world, or a given theoretical perspective. They are therefore of only limited value for empirical analysis and practical policy advice. Nevertheless, it appears possible to extract some generalised conclusions from the previous theoretical discussion. In my view, from a pragmatic standpoint that aims at empirically investigating the presence and the determinants of credit rationing, the following lessons can be learned (they are purposively formulated without precision):

1. A comparison between *observable interest rates* on loan markets on the one hand and *rates of return* of investment projects on the other may serve as a (possibly rough) guideline for assessing to which extent, in a given situation, there are substantial deviations from the perfect market model. In case that a large number of sufficiently profitable projects cannot be credit funded, this indicates the presence of credit rationing and may also point to the possibility of underinvestment.
2. The problem of *asymmetric information* between borrower and lender is likely to play a significant role as a determinant of credit rationing. It will be worth investigating to which extent and at what costs signalling, screening, monitoring, or auditing activities can overcome this problem.
3. Government policy has to be looked at critically. It may *improve* access to credit, but in many cases regulation or intervention may be the ultimate *source* of credit rationing. With regard to lesson 1, it will be of particular interest how far government policy systematically influences interest rates or returns of projects.

These thoughts will be made more precise at the end of the following subchapter, in which I want to examine a number of issues only briefly touched upon in previous sections in more detail and more formally. This may provide the reader with a flavour of the style of argumentation in the literature on agency theory, but also with an impression of the difficulties of formalising real-world problems.

2.2 Equilibrium credit rationing due to asymmetric information

After having unfold in a mostly literary way the major issues of a theoretical analysis of credit rationing in the previous subchapter, I now aim at investigating a number of selected problems more formally, and thus more akin in style to the rather abstract literature on agency theory. However, although the discussion

will be more formal than in subchapter 2.1, an attempt is made to use mathematical notation only to a moderate extent.

I take as a starting point the model of credit rationing by STIGLITZ and WEISS (1981), thus largely ignoring the theoretical literature prior to this seminal work. The reader interested in earlier developments is referred to surveys such as BALTENSPERGER (1978) and BALTENSPERGER and DEVINNEY (1985). After an outline of the model, I go on, based on the relevant literature, to question the premises of the model and explore the effects of changes in the assumptions. This will lead up to a discussion of policy implications and an overview of the theoretical literature concerning countermeasures to credit rationing.

2.2.1 Credit rationing in the model of STIGLITZ and WEISS (1981)

The central objective of STIGLITZ and WEISS (1981) is to demonstrate the possibility of a stable equilibrium where demand for loans exceeds supply with no tendency for the interest rate to clear the market (see Figure 2-3). In this situation, banks deny loans to borrowers who are observationally indistinguishable from those who receive loans (STIGLITZ and WEISS 1981, p. 394) although all market participants behave in a rational, profit maximising way. The ultimate reason for this form of credit rationing is that banks have only *limited information* about the riskiness of projects to be financed. This fact can explain the existence of a *bank optimal interest rate*, beyond which, at an increasing interest rate, the loan supply of the bank actually *decreases*. In the following, I concentrate on the case where a rise in the interest rate leads to an *adverse selection* process regarding the pool of loan applicants (section I of STIGLITZ and WEISS 1981).

STIGLITZ and WEISS (1981) consider the lender-borrower relationship on a loan market as follows. They assume that the bank faces a group of prospective borrowers, each of whom holds a project with uncertain outcome to be credit funded. Borrowers and lenders are risk neutral, and the supply of loanable funds available to the bank is unaffected by the interest rate it charges borrowers. Banks act as price setters on the credit market and as quantity setters on the deposit market. They simultaneously choose a capacity of funds on the deposit market and a nominal loan rate in such a way that their profit is maximised, taking as given the return demanded by depositors and the loan rates set by other banks (see FREIXAS and ROCHET 1997, p. 140).

Projects are assumed to be not divisible, that is, unless a borrower is successful in getting a loan, the project cannot be carried out. For simplicity it is assumed

that the amount borrowed for each project is identical. However, for each project there is a probability distribution of gross return *y* which cannot be altered by the borrower. All projects have *the same mean return* but differ by a *risk parameter* θ, which *only the borrowers know*. The bank thus cannot ascertain the riskiness of an individual project, but it knows the statistical distribution of returns among the population of potential borrowers. Let the distribution of returns be $G(y,\theta)$ and the density function $g(y,\theta)$. Greater θ corresponds with greater risk in the sense of mean preserving spreads. This implies the following (see ROTHSCHILD and STIGLITZ 1970): in case that $\theta_a < \theta_b$, if

$$\int_0^\infty yg(y,\theta_a)dy = \int_0^\infty yg(y,\theta_b)dy$$

then for a given return $\tilde{y} \geq 0$,

$$\int_0^{\tilde{y}} G(y,\theta_a)dy \leq \int_0^{\tilde{y}} G(y,\theta_b)dy,$$

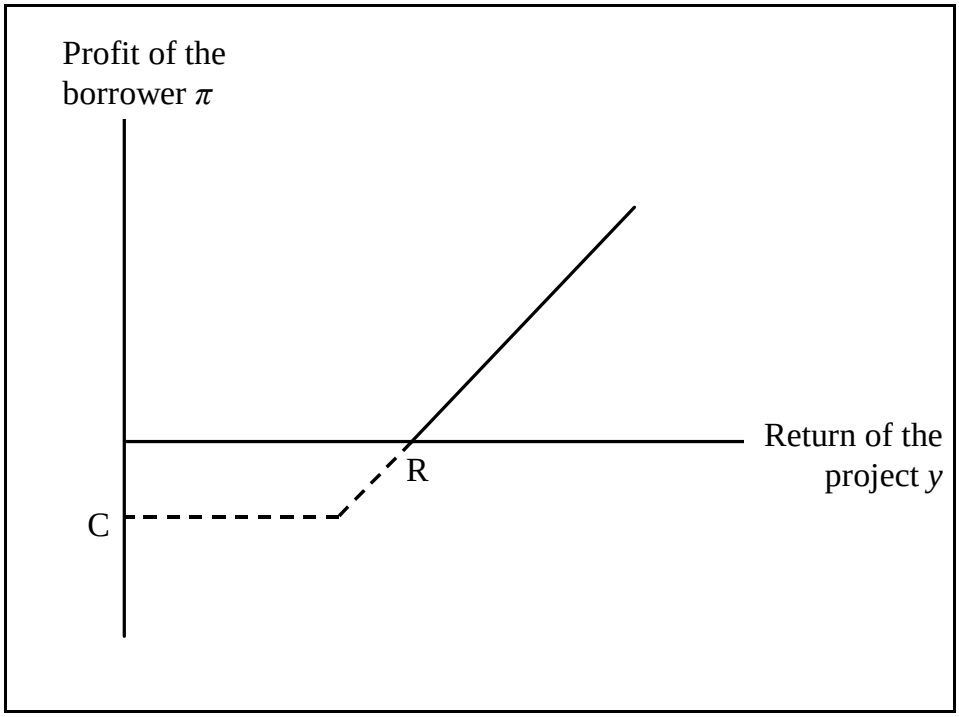
that is the distribution of the riskier project has more weight in the tails.

Borrowers are required to pledge a certain amount of collateral *C*. Since the bank cannot discriminate between borrowers, the bank offers all borrowers the same standard debt contract, in which the borrower either repays a fixed amount *R* (if she can) or her collateral plus cash flow is seized by the bank. The profit of each borrower can thus be written as:

$$\pi(y,R) = \max(-C, y-R). \tag{2-1}$$

Hence, the borrowers' profit is *convex* in *y* (see Figure 2-4).

Figure 2-4: Profit of the borrower as a function of project return

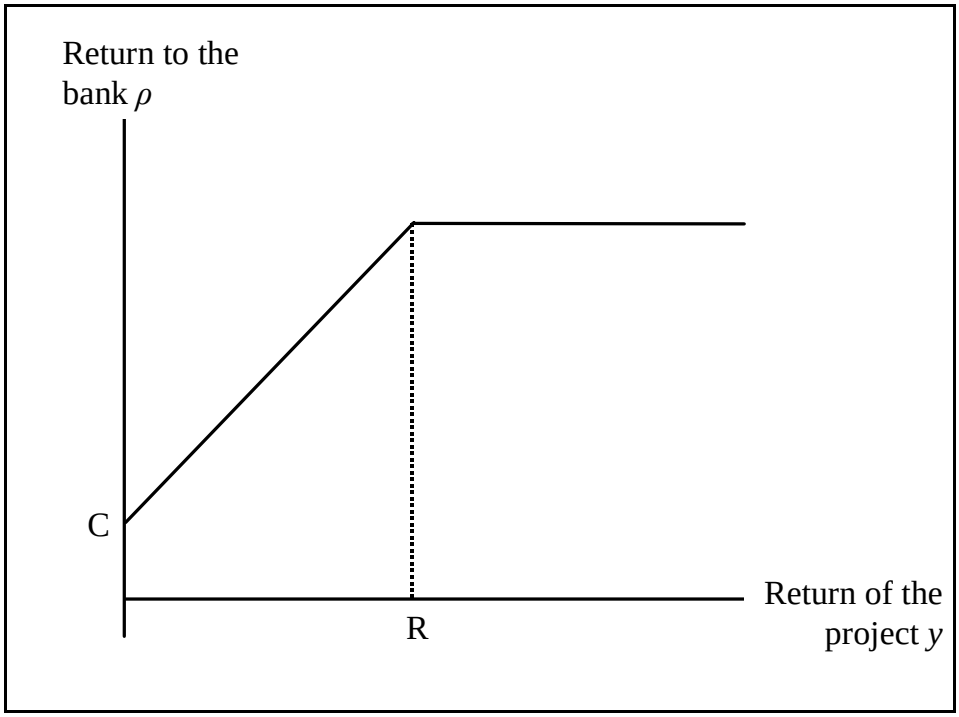


Source: Adapted from STIGLITZ and WEISS (1981, p. 396).

To the contrary, the return to the bank ρ is a *concave* function of y (Figure 2-5):

$$\rho(y, R) = \min(R, C + y)\,. \tag{2-2}$$

Figure 2-5: Return to the bank as a function of project return



Source: Adapted from STIGLITZ and WEISS (1981, p. 396).

Borrower and bank are thus affected *differently* by an increasing riskiness of projects: while borrowers *gain* if the return of the project undergoes a mean preserving spread, the bank *loses*. The downside risk is borne by the bank alone. This is an application of Jensen's inequality, which states that the expected value of a convex (concave) function increases (decreases) as its argument undergoes a mean preserving spread.[29] As a consequence, within the pool of borrowers with the same expected project returns, the more risky borrowers generate the largest profits. However, the projects with the lowest risk generate the highest return for the bank. Since all borrowers are offered the same interest rate, low-risk borrowers implicitly subsidise high-risk borrowers, which is a special form of externality.

Under these circumstances, STIGLITZ and WEISS (1981) establish that the effect of an increase in interest rates on the bank's return is *twofold*. On the one hand, it *increases* the return the bank makes on any individual loan granted to a bor-

[29] Jensen's inequality does not appear in the original paper of STIGLITZ and WEISS (1981). However, it is a useful formalisation of their argument (see LENSINK et al. 2001, p. 17 and appendix B2).

rower with given risk θ. On the other hand, it also *decreases* the return of the bank: a rising interest rate decreases the profits of borrowers, probably below zero (or any reservation level). The crucial fact is that, as explicated above, the projects with the *lowest* risk drop out of the market *first*, since they generate the lowest profits for borrowers. In turn, the pool of borrowers becomes more risky, which decreases the return of the bank. Therefore, an increase in the interest rate *need not necessarily increase the return to the bank*. If the adverse selection effect outweighs the increased return from interest rates, the total return of the bank declines. Whether and when this is the case depends on the distribution of θ. For some of these distributions, the bank's expected return on loans will be single-peaked with a maximum for a repayment R^* (see the simulation in NEYER 2000, pp. 95-100). Under the assumption that the supply of deposits is not fully elastic, this results in a backward bending supply of credit and, therefore, a situation of equilibrium credit rationing as shown in Figure 2-3.

STIGLITZ and WEISS (1981) also consider a case where *moral hazard* induces a backward bending loan supply curve (in section II of their paper). In this instance, each borrower has available *a choice of projects* with different risks. Increasing the interest rate increases the relative attractiveness of the riskier projects, for which the return to the bank is lower. Raising the interest rate may thus lead borrowers to take actions that are contrary to the objectives of the bank. This establishes a similar case to the one above, where the bank may ration credit instead of raising the interest rate.

The results of STIGLITZ and WEISS stand in marked contrast to the conventional perfect market model (see STIGLITZ 1987; HILLIER and IBRAHIMO 1993, pp. 284-288):

1. Equilibrium credit rationing *is inconsistent with the orthodox view that in equilibrium supply equals demand* (the 'law of supply and demand'). STIGLITZ and WEISS (1981, p. 409) conclude their paper by saying that "The usual result of economic theorizing: that prices clear markets, is model specific and is not a general property of markets – unemployment and credit rationing are not phantasms."

2. Conventional *comparative static analysis breaks down* in the presence of asymmetric information. For example, a shift in demand, that is an increase in demand at every interest rate level, would usually be expected to increase both the interest rate and the loan volume traded. If the market is characterised by equilibrium credit rationing, such as with regard to Demand 2 in Figure 2-3, neither of the two effects will occur.

3. Supply and demand are *no longer independent*, if informational asymmetries are important. Suppose that an external shock makes all projects to be financed less likely to be successful. This would affect the demand for funds and also the banks' willingness to supply funds, since both functions partly depend upon the distribution of projects' risk.
4. If there are observationally distinguishable groups of borrowers, particularly risky groups may be denied credit at any rate; a phenomenon known as '*red-lining*'. This may be the case if there is no interest rate at which the bank receives a certain minimum return. Although these borrowers have particularly profitable projects, the market equilibrium fails to allocate credit to them (STIGLITZ and WEISS 1981, pp. 406-407).

Welfare and policy implications will be treated in more detail below (section 2.2.3). I now turn first to the question of how sensitive the previously presented model is to changes in assumptions.

2.2.2 Theoretical robustness of equilibrium credit rationing

This section aims to challenge the assumptions of the model presented in the previous section and to examine how plausible these assumptions are and how critical for the result of equilibrium credit rationing. Without claiming comprehensive coverage of the broad and still ongoing scientific debate spurred by the paper of STIGLITZ and WEISS (1981), I attempt to highlight some key contributions that are of importance for the topic of this thesis.

A first line of criticism concerns the fact that even under the conditions assumed by STIGLITZ and WEISS (1981), the existence of a bank optimal interest rate is only a *possibility*. In a recent study, NEYER (2000) demonstrates that, by assuming normally distributed returns to projects, the existence of a bank optimal interest rate crucially depends on a sufficient heterogeneity of projects (p. 100). A second objection is with regard to the availability of loanable funds. Only if there is some *restriction* of these funds – for example by an upward sloping supply of deposits – will rationing occur (BALTENSPERGER and DEVINNEY 1985, p. 490). Provided that there is a fully elastic supply of deposits at a sufficiently low interest, banks would offer loans at rate R^* until all borrowers desiring such a loan were served. However, the prevailing interest rate would be higher than in the full information case (this is discussed in detail by HILLIER 1997, chapter 2). Of course, both assumptions of a heterogeneous pool of borrowers and an inelastic supply of deposits are not totally unplausible.

It is however striking that, in the model of STIGLITZ and WEISS (1981), the bank has an absolutely blind spot with regard to the riskiness of projects, whereas it perfectly knows the average return of projects. Since emphasis is on the (indirect) screening effect of the interest rate, the possibility to *directly screen* borrowers by other means *is completely ignored* in the model as presented so far. Though all borrowers have to provide collateral, they are all offered the *same* standard debt contract which is exogenously given. However, both the bank and the less risky borrowers will have an interest in some type of sorting mechanism that mitigates the negative effects of asymmetric information (see section 2.1.5 above).

The latter aspect is taken up by BESTER (1985), who shows that no credit rationing will occur if banks use *collateral as a screening device*. This is possible if the bank offers *different contracts* as a self-selection mechanism. Let me examine BESTER's (1985) model in some detail (partly following the exposition in FREIXAS and ROCHET 1997, pp. 144-147).

BESTER maintains the assumption of STIGLITZ and WEISS (1981) that banks cannot discriminate a priori between borrowers who hold projects with identical return but different, only privately observed risks. For simplicity, there are only two values for the risk parameter θ ($\theta \in \{\theta_a, \theta_b\}$), where θ_b is a higher risk than θ_a in the sense of a mean preserving spread. In contrast to STIGLITZ and WEISS, however, the bank offers a *menu of contracts* $\gamma_k = (R_k, C_k)_{k \in \{a,b\}}$ specifying, together with an interest R_k, a collateral requirement C_k which may be different for each contract.

Two problems arise in modelling loans that are backed by collateral: (a) the optimal solution may imply a value of collateral equalling or even exceeding the volume of the loan plus interest, $R \leq C$, so that the loan is perfectly secured, or (b) the value of collateral demanded by the bank may exceed the wealth of the borrower. The second problem will be ignored for the moment, and will be taken up later again. The first problem leads to a situation where imperfect information essentially becomes irrelevant (FREIXAS and ROCHET 1997, p. 156, fn. 6). However, the case that $R < C$ can reasonably be excluded, since then a borrower would never admit to being bankrupt and always prefer to repay R (BESTER 1985, p. 851, fn. 6). The case of $R = C$ can be made undesirable by introducing a *cost of collateral*, which implies that a unit of collateral costs more for the borrower than what the bank will obtain from it.[30]

[30] A recent survey of the literature on collateral is COCO (2000).

BESTER (1985) considers a competitive equilibrium on the loan market. Competition on each of the contracts offered by the banks results in expected zero profit for each of them (abstracting from costs of financial intermediation):

$$\rho_a(\gamma_a) = \rho_b(\gamma_b) = r_o,$$

where ρ_a is the expected return for the bank resulting from *a*'s distribution of projects' returns, and accordingly for ρ_b. r_o is the bank's cost of funds.

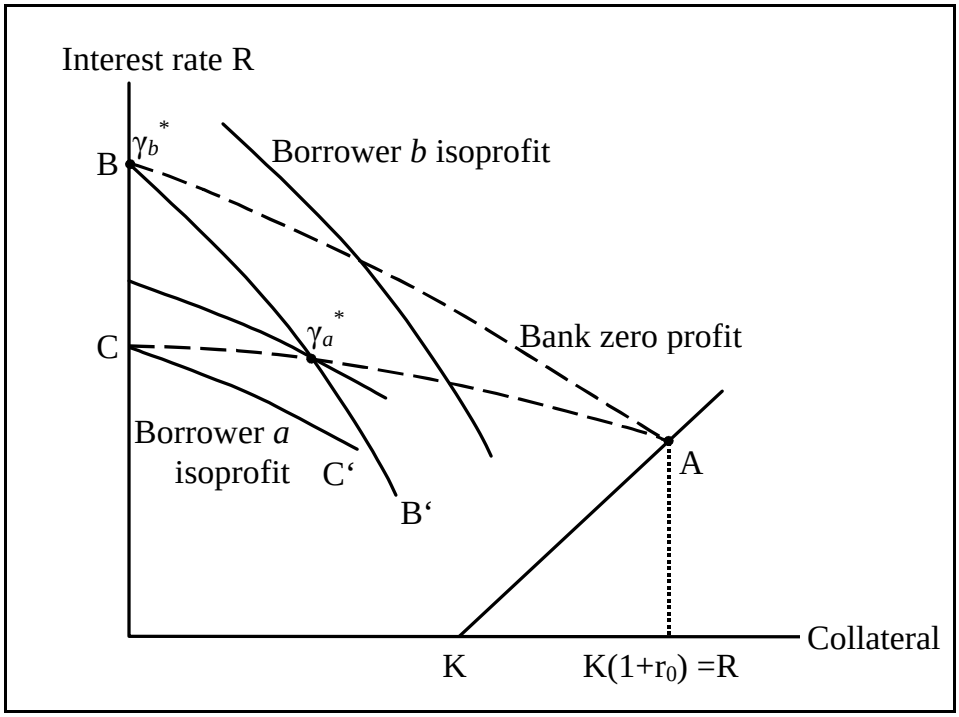
There may be two types of Nash equilibria: a separating equilibrium, where different borrowers choose different types of contracts, and a pooling equilibrium, where both types of borrowers choose the same contract (see the general treatment by VARIAN 1992, chapter 25).

A *separating equilibrium* is defined as a pair of distinct contracts (γ_a^*, γ_b^*) that satisfy the following conditions: (a) γ_a^* is preferred by low-risk firms and γ_b^* is preferred by high-risk firms (these are the self-selection constraints expressing the incentive compatibility of the contract offer); (b) no bank is able to offer another contract on which it obtains an expected return higher than r_o; (c) the expected bank profit for each contract is zero, that is $\rho_a(\gamma_a^*) = \rho_b(\gamma_b^*) = r_o$.

A *pooling equilibrium* is defined as involving a single contract preferred by both types of borrowers $\gamma^* = \gamma_a^* = \gamma_b^*$. Analogue to the separating equilibrium, the expected return to the bank of the single contract γ^*, denoted $\rho_{a+b}(\gamma^*)$ and resulting from the total distribution of projects' returns, may not exceed r_o.

BESTER establishes that the only possible equilibrium entails *no* credit rationing. This can be seen in a diagram that displays possible combinations of interest and collateral (Figure 2-6).

Figure 2-6: Separating equilibrium with no credit rationing



Source: Adapted from FREIXAS and ROCHET (1997, p. 145).

The figure shows two *types* of curves: zero profit curves of the bank (broken lines) and isoprofit curves of borrowers (solid lines). There are two zero profit curves for the bank: line *AB* denotes all contracts that imply zero profit for the bank if they were chosen only by type *b* borrowers, while line *AC* denotes all contracts with zero profit if they were chosen only by type *a* borrowers. Since type *b* borrowers have a higher default risk for the bank, they are charged a higher interest rate than type *a* borrowers. *A* denotes the point of perfect securitisation $K(1+r_0)=R$, with *K* the loan size. At *A* the default risk (and thus the problem of asymmetric information) becomes irrelevant. However, since there is a cost for pledging or seizing the collateral, the isoprofit curves of borrowers are steeper than the zero profit curves of the bank related to their respective risk. *BB’* and parallels denote the isoprofit of type *b* borrowers, while *CC’* and parallels denote the isoprofit of type *a* borrowers. Isoprofit curves of type *b* borrowers are steeper than and for a given profit always above those of type *a* borrowers, since, for a given amount of collateral, the former are riskier and yield a

higher profit (as in the STIGLITZ-WEISS model).[31] Borrowers prefer less collateral and lower interest rates, while the bank prefers more collateral and higher interest rates (see equations (2-1) and (2-2)).

The problem analysed by STIGLITZ and WEISS (1981) would imply to take the amount of collateral as given and to investigate the consequences of raising the interest rate along a parallel of the vertical axis. In fact, this means that, as soon as the isoprofit curve of type *a* borrowers that denotes *zero* profit is passed, all type *a* borrowers withdraw from the market, leaving only type *b* borrowers. However, the less risky borrowers are more profitable for the bank. Hence, even when there is an excess demand for loans, it may not be profitable for a bank to enter the market by raising the interest rate. There may be credit rationing in a competitive equilibrium, as long as the bank offers the *same* contract to all applicants.

To prove that a *pair* of contracts γ_a^* and γ_b^* defines a separating equilibrium with no credit rationing first requires confirming that γ_a^* is preferred by type *a* borrowers and γ_b^* by type *b* borrowers (condition (a) above). Type *a* borrowers strictly prefer γ_a^* given their lower risk. Notice that this implies some welfare loss as compared with the situation of full information and zero collateral, where type *a* borrowers would attain point *C*. Type *b* borrowers are indifferent with regard to the two types of contracts.

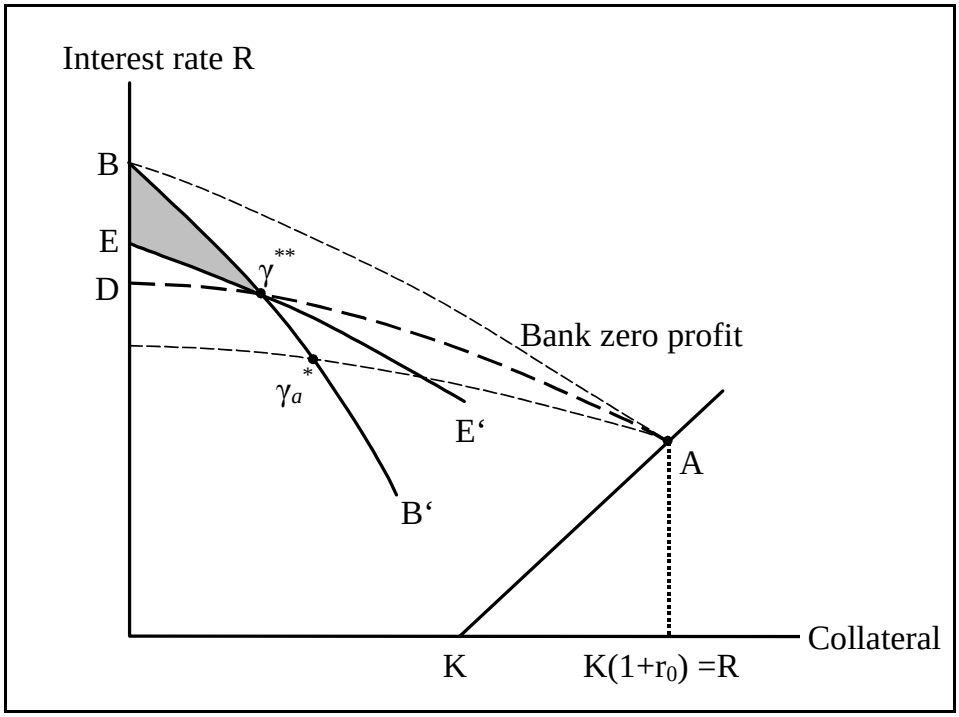
However, to see that the solution cannot be a pooling contract, consider condition (b) and Figure 2-7: a pooling equilibrium, if it were to exist, would lie on the zero profit line *AD* which satisfies $\rho_{a+b}(\gamma^*) = r_0$. For example, it would be γ^{**}. Since the riskier borrowers have steeper isoprofit curves, it is possible for a deviant bank to offer a contract in the shaded area that attracts only borrowers of type *a* and therefore results in a positive profit. This construction can be carried out at any point of the *AD* curve. On the other hand, if the indifference curve for type *a* borrowers that goes through γ^{**} intersects the vertical axis at a point below *D* (such that *E* is below *D*, other than shown in Figure 2-7), then *a* would strictly prefer a contract below *AD*, such as γ_a^*, with the result of a separating equilibrium. Consequently, there is always a preferred alternative to the pooling contract, which is equivalent to saying that *pooling is not viable against competition*.[32]

[31] Isoprofit curves need not to be concave, this is only a possibility (see BESTER 1985, p. 852).

[32] This was first established in an insurance market framework. See ROTHSCHILD and STIGLITZ (1976).

Furthermore, no separating pair of contracts dominates (γ_a^*, γ_b^*) in Figure 2-6. γ_b^* is the contract on the bank's *AB* zero profit curve that type *b* borrowers prefer most. However, for a contract γ_a to be preferred by *a* and make zero profit, it should be on the left of γ_a^* and on the *AC* curve. Therefore it would also attract all type *b* borrowers and the bank would suffer a loss.

Figure 2-7: No pooling equilibrium exists



Source: Author's depiction, based on VARIAN (1992, p. 467).

The argument that there cannot be rationing at (γ_a^*, γ_b^*) is as follows. A type *a* borrower is rationed at γ_a^* only if his loan application is turned down although his project makes a positive profit. However, in such a situation, a competing bank could enter the market and raise R_a^* by a small amount. All borrowers who are denied credit at γ_a^* would apply for this offer. Since it yields higher returns to the lender than γ_a^*, market entry would be profitable, so that an equilibrium cannot entail γ_a^* (contradiction to condition (b)). Therefore, type *a* borrowers are never rationed in equilibrium.

Suppose that a type *b* borrower would be rationed at γ_b^*. In this case, she would certainly apply for γ_a^*, which results in pooling of different borrowers at γ_a^*. However, it was shown above that pooling cannot be an equilibrium.

Any existing equilibrium is thus a separating equilibrium in which type *a* borrowers choose γ_a^* and type *b* borrowers choose γ_b^*. This also satisfies condition

(c) above, since each contract is on the bank's zero profit curve. In this equilibrium, no credit rationing will occur, because collateral is used in order to sort out the different, non-observable types of borrowers:

> In the BESTER (1985) model, the plausible assumption that banks employ *non-price elements* (collateral) in loan contracts to overcome problems of asymmetric information makes credit rationing disappear.

A similar point is made by MILDE and RILEY (1988), who demonstrate that, as soon as the assumption of fixed loan sizes is relaxed, contract menus including different interest rates *and* loan sizes have the same effect of removing credit rationing.

Is it therefore unlikely that credit rationing as an important phenomenon actually exists? This cannot be answered positively either, as further investigations of the problem have shown.

First, both BESANKO and THAKOR (1987) and BESTER (1987) analyse the case in which the collateral demanded by the bank exceeds the wealth of the borrower. In this case, signalling is not feasible for all borrowers. The result is again a pooling of some borrowers, as in the STIGLITZ-WEISS model, which may exhibit rationing.

Second, more generally, JAFFEE and STIGLITZ (1990, p. 867) claim that as long as the dimensionality of the space of borrower characteristics exceeds the dimensionality of the space of contracts, perfect screening of borrowers will be impossible and rationing may therefore occur. As candidates for additional dimensions they suggest the wealth or the risk aversion of borrowers.

Subsequent contributions in the theoretical literature have taken up these suggestions and continued to explore the conditions under which credit rationing will be likely to exist. Indeed, the explicit consideration of varying degrees of *risk aversion* in connection with asymmetric information make rationing equilibria a likely outcome, even if signalling devices are principally available to borrowers. An example is SCHMIDT-MOHR (1997) who demonstrates in a rather general setting with divisible projects that loan-size rationing and self-selection of borrowers may co-exist in equilibrium. On the other hand, no equilibrium involving collateral may exist (p. 1331). The latter point is also made by COCO (1999) who argues that collateral loses its role as a signalling device if more risk-averse borrowers choose safer investment projects but are also more reluctant to pledge collateral. In this case, credit rationing re-appears as an effect of heterogeneous risk preferences of borrowers.

As a supplement to the discussion of collateral, I want to briefly mention a number of theoretical studies that have examined *other types of institutional arrangements* that potentially overcome problems of asymmetric information on loan markets. These may be broadly grouped into three categories, depending on whether they emphasise the role of joint liability, multiperiod effects, or interlinkage of credit with other transactions. Presented references highly selectively focus on primarily theoretical contributions.

The first strand of literature refers to any sort of *joint liability*, also sometimes called 'social collateral'. The basic idea is that the social and economic relationship between the borrower and a third person (which may also be a borrower) is utilised to overcome the abundant incentive problems of giving credit. The third person may simply be an outside *guarantor* as in BESANKO and THAKOR (1987). Alternatively, it may be reasonable to form *groups of borrowers* who are jointly liable and thus have an incentive to monitor each other ('peer monitoring', see STIGLITZ 1990 and VARIAN 1990). This is practised in many developing countries (see the comprehensive treatment by GHATAK and GUINNANE 1999). Moreover, informational advantages of peers rationalise the existence of *credit cooperatives*, which allow a group of otherwise credit-constrained borrowers to raise outside finance (BANERJEE et al. 1994).

Social sanctions available in credit cooperatives may also provide incentives to sustain *long-term* non-opportunistic behaviour of borrowers, which leads to the second category of literature stressing the importance of *multiperiod effects*. The threat of termination of the borrower-lender relationship can be used to encourage borrower behaviour that the lender finds desirable (STIGLITZ and WEISS 1983). Borrowers in turn can develop a *reputation* for being creditworthy over time, which may improve access to funds (DIAMOND 1989).

A third category of studies examines the case where credit exchange is *tied to other types of transactions*, also called 'interlinkage'. The most well-known is the trade-credit interlinkage, or trade credit in short. Giving credit to trade partners makes private information about business activities available to the lender at little costs. Screening and monitoring of potential borrowers may thus be greatly facilitated. Furthermore, enforcement of loan repayment may be easy by simply deducting it from the goods sold to or through the lender. The theory of tied credit has been studied both in the framework of developing (BELL 1988) and of developed countries (see the brief survey in PETERSEN and RAJAN 1997 as well as JAIN 2001).

Before closing this section, a final line of attack against the STIGLITZ-WEISS model needs to be introduced. It concerns the specific distributional assumptions underlying the pool of loan applicants. DE MEZA and WEBB (1987) demonstrate that a slight change of the distributional structure of loan returns suffices to turn the credit rationing plus underinvestment model in a model of *over*investment without rationing. They particularly focus on the welfare and policy implications of credit rationing; their results are therefore presented in more detail in the subsequent section.

Summing up, it can be concluded that the STIGLITZ-WEISS result of equilibrium credit rationing is to a large extent driven by the specific set of assumptions chosen. Due to the high degree of abstraction from reality this is only to be expected. The model of BESTER (1985) yields the important insight that the possibility of signalling and screening in the lender-borrower relationship is crucial to overcome credit rationing. Although there exists a host of mechanisms to reduce information asymmetries, these mechanisms are unlikely to work perfectly in reality, or may not be available at all. The theoretical prediction of later research, namely that *credit rationing is an important phenomenon under a variety of settings*, appears thus quite plausible. How far the robustness of results extends into the domain of welfare and policy implications is the topic of the next section.

2.2.3 Welfare and policy implications

Does credit rationing due to imperfect information provide a theoretical justification for government intervention on credit markets? It was noted above (section 2.1.5) that many authors seem to suggest this, although policy advice based on theoretical reasoning is far from unambiguous. In the subsequent section I want to clarify this point and briefly outline the varying theoretical results in a partial equilibrium framework.

As suggested by the previous discussion in this monograph, the usual benchmark for welfare comparisons is the neoclassical first-best world of perfect information and zero transaction costs (see section 2.1.2 above). The question of whether this is adequate will be ignored for the moment, but be taken up again in chapter 5. In line with a common sense understanding of the term credit rationing as explicated in section 2.1.1, a number of authors assume as a working hypothesis that informational asymmetries on loan markets and the presence of credit rationing necessarily result in *too little investment* as compared with a situation of perfect information (for example GALE 1990, p. 44; HUBBARD 1998, p. 197). Indeed, it can be shown in a slightly modified version of the STIGLITZ-

WEISS model that underinvestment as compared with full information results from their assumptions. The following is based on DE MEZA and WEBB (1987) and HILLIER and IBRAHIMO (1993).[33]

Consider again a bank facing a group of observationally indistinguishable borrowers on a competitive loan market. To obtain a tractable version of the STIGLITZ-WEISS model, I retain the assumption that each project has a common expected return $\bar{y}$. However, for simplicity, the project may either be successful, yielding a project-specific return y_i^s with probability P_i, or fail and yield zero. For all projects the following holds:

$$P_i y_i^s = \bar{y}, \text{ with } P_i \in]0,1]. \tag{2-3}$$

Project *i* is said to be riskier than project *j* if, under the condition of (2-3), $P_i < P_j$. All other assumptions of STIGLITZ and WEISS (1981) as given in section 2.2.1 remain unchanged except that I set the value of collateral to zero. This can be done without altering the results, since, in the STIGLITZ-WEISS framework, collateral is not used to sort out borrowers.

Hence, the expected profit of any borrower *i* is given by:

$$E(\pi_i) = P_i(y_i^s - R), \tag{2-4}$$

where *R* as before is fixed repayment to the bank (including principal and interest). Rationally behaving, risk-neutral borrowers will carry out their project if and only if the expected profit exceeds zero, which is given if $y_i^s > R$. Therefore, only projects with a sufficiently high y_i^s will be made. Since (2-3) holds, this is equivalent to say that only projects with a sufficiently low P_i will be carried out. Consequently, as *R* rises, average P_i in the pool of realised projects will fall, and projects become riskier on average. This establishes the adverse selection effect known from previous sections.

Consider now the expected profit of a risk-neutral bank. The density of projects' success is denoted $g(P_i)$. In a pooling equilibrium with competition, the standard debt contract offered to all borrowers earns an expected return to the bank as follows:

$$E(\rho) = R\int_0^{\tilde{P}} P_i g(P_i) dP_i \,, \tag{2-5}$$

[33] A detailed coverage of the topic with numerical simulations is also provided by NEYER (2000).

where $\tilde{P}$ is the success probability of the marginal project. This is the project on which borrowers make just zero profit if there is no rationing.

Suppose that at the equilibrium interest rate R^* there are borrowers who could make positive profits but are denied loans. A necessary condition for this to be an equilibrium is that $\partial E(\rho)/\partial R = 0$ at R^*. In fact, a rise in R may have two opposite effects. On the one hand, a rising R increases $E(\rho)$ due to higher interest revenues. However, as a result of (2-3) and (2-4), a rising R also induces $\tilde{P}$ to fall, so that the average success probability of projects and hence $E(\rho)$ tend to fall. The sign of $\partial E(\rho)/\partial R$ is therefore ambiguous, depending upon which of the two conflicting effects dominates. A credit rationing equilibrium is possible if in this equilibrium the rate demanded by depositors is such that the supply of deposits is less than loan demand. The latter may well be the case under the STIGLITZ-WEISS assumption that deposit supply is not fully elastic.

It is now possible to compare this outcome with a first-best situation of full information. In a 'socially efficient' world, all projects are financed that yield at least the safe return, to be denoted $\hat{R}$ in the following (see the discussion in section 2.1.2 above). That is, all projects must satisfy:

$$P_i y_i^s \geq \hat{R}. \tag{2-6}$$

In a first-best world, the marginal borrower makes zero profit. Furthermore, banks in a competitive environment would just break even on marginal loans. However, the latter is different in a STIGLITZ-WEISS world with imperfect information as described previously. Due to the inherent asymmetry between banks and borrowers, all intra-marginal borrowers have success probabilities *lower* than $\tilde{P}$ and thus *higher* profits than the marginal borrower (see (2-4) and the discussion in section 2.2.1). Would the bank just break even on the marginal loan, it would definitely expect losses on all intra-marginal loans. In equilibrium, therefore, *investment must be less than the first-best level*. Instead, since competitive banks are assumed to make zero profits in total and the marginal borrower has the highest success probability which, thus, yields the highest profit for the bank, this latter profit from the marginal borrower must be positive. In other words, marginal and near-marginal borrowers subsidise borrowers with low success probabilities to make the banks break even.

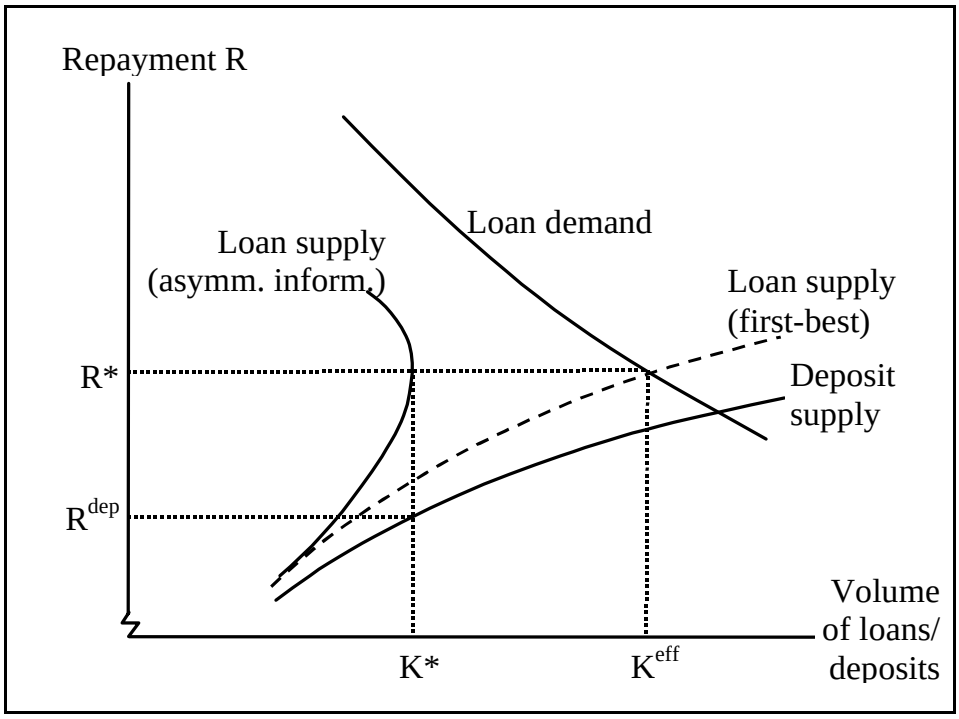
DE MEZA and WEBB (1987) present a straightforward *policy advice* for this situation of underinvestment (p. 288): a *subsidy on deposit interest rates*. Such a subsidy on interest income will reduce the gross rate banks must pay on deposits. Banks can therefore expand the credit volume granted at a given loan rate R^*

ideally up to the socially efficient level, since smaller profits made on the (near-) marginal borrowers will suffice to break even in total.

The question remains whether restoring the first-best situation is in fact a desirable policy goal. DE MEZA and WEBB do not consider the way subsidies are financed, and hence do not carry out a welfare analysis of government intervention on credit markets. Since reality seldom is first-best, it is doubtful a priori whether an artificial, costly re-establishment of the first-best equilibrium is in fact worthwhile. In the following, therefore, an attempt is made to apply the traditional concepts of welfare analysis (see JUST et al. 1982) to the problem of credit rationing.[34]

Figure 2-8 relates capital quantities traded on the loan and deposit market (denoted *K*) to prevailing rates of fixed repayment *R*. Solid lines display supply and demand on the loan market with asymmetric information as well as deposit supply at the safe rate. The broken line denotes the first-best loan supply as explained below.

Figure 2-8: Underinvestment and credit rationing



Source: Author's depiction.

[34] I am indebted to Peter WEINGARTEN for making a number of comments which (hopefully) improved the clarity of the presentation.

The downward sloping demand curve for loans is due to the fact that more and more borrowers drop out of the loan market as R increases (see equation (2-4)). It represents borrowers' willingness to pay for loans, which for each borrower is equal to y_i^s. Note that repayment is conditional on projects' success and therefore *stochastic*.

As in the STIGLITZ-WEISS model, deposit supply at the safe rate is not fully elastic and thus upward sloping. To allow a comparison, I sketched as a broken line the *first-best supply of loans*, which can be derived as follows. With symmetric information on the loan market, suppliers of capital would charge a *borrower-individual risk premium* as part of the repayment R. The size of the risk premium would depend on the project-specific uncertainty of return. At higher R, projects become riskier and average individual risk premia increase. In such a first-best world, all investment projects are financed for which $y_i^s P_i$ exceeds the risk-adjusted deposit rate. This is given at (R^*,K^{eff}), with K^{eff} being the efficient loan (and deposit) volume. In Figure 2-8, the broken line of first-best loan supply can be interpreted as displaying those interest rates required from lending to uncertain projects which on average pay depositors the safe rate. It can be obtained if deposit supply at the safe rate is shifted upwards by the average risk premium required at each level of R. The slope of first-best loan supply thus has two components. It has a *per se* positive slope due to inelastic deposit supply. Furthermore, the slope is additionally increased due to higher risk premia for higher R.

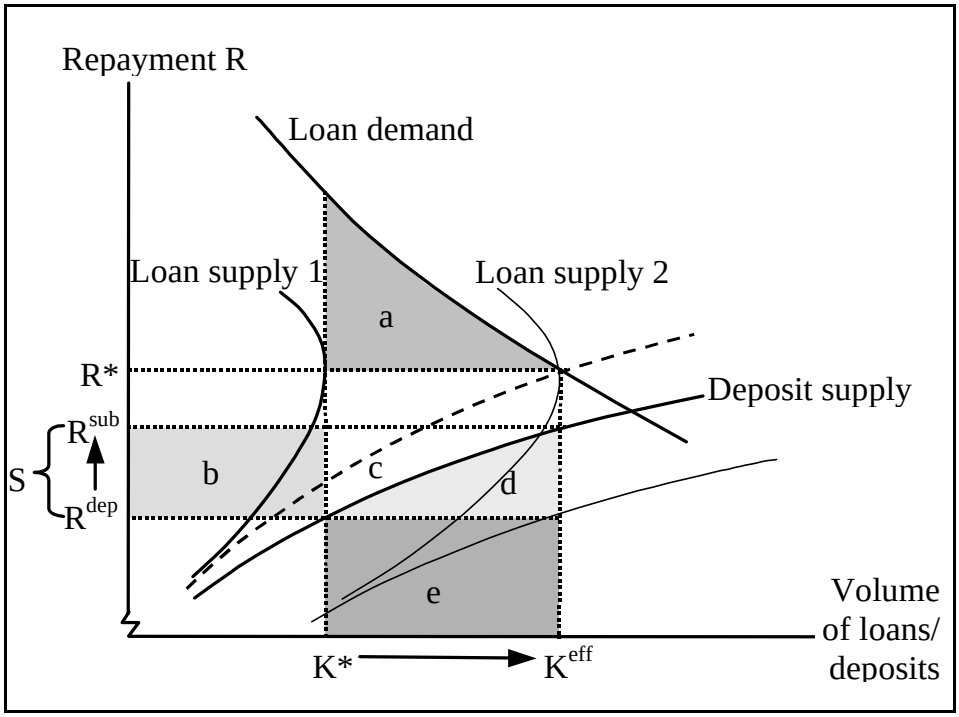
In the presence of imperfect information as described previously, banks act as intermediaries between deposit and loan markets. While depositors demand a safe rate on their capital, exchange on the loan market is subject to the conditions of the standard debt contract (fixed repayment in case of success). Since banks cannot discriminate between heterogeneous borrowers, they are only able to offer a *single, average risk premium* and hence a single interest rate to *all* loan applicants. Additional loans extended at the margin require higher interest revenues to meet the not fully elastic demand of depositors. Fully informed lenders could negotiate loan contract terms on an individual base, so that loan terms of all other borrowers were left unaffected. However, this is not possible under imperfect information, where a rise in interest rates affects *all* borrowers and thus leads to adverse selection. The interest rate required for banks to break even must therefore contain an *extra premium* to compensate for the lower success probability of the entire borrower pool. This explains the increasing gap as R rises between loan supply under asymmetric information and first-best loan supply in Figure 2-8. As discussed above, it may even lead to a backward bend-

ing supply of loans and credit rationing, as shown in the figure, where K^* is the equilibrium loan volume. Since there is an excess demand of loans at R^*, the loan volume K^* has to be distributed to borrowers by non-price means. At the equilibrium rate R^*, depositors obtain only the risk-free rate R^{dep}. As a result, there is underinvestment of the size $K^{eff} - K^*$.

In case that loan supply and demand are intersecting (if loan supply was not backward bending), there would be no perceived rationing. However, interest rates on the loan market would still be above the first-best level and a situation of too little investment would continue to prevail. With reference to the earlier discussion in section 2.1.4, the difference between the actual and the (lower) fist-best interest rate might be regarded as an additional transaction cost component, although the model does not suggest any real activities that could have caused these costs.

Returning to the case of rationing, consider a subsidy on deposit interest rates of size S in Figure 2-9. As a result of this subsidy, the market relevant supply of deposits shifts from the initial position downwards (displayed with a light line). The increased deposit rate R^{sub} induces depositors to supply K^{eff}, the first-best volume of loans, at rate R^{dep} to the banks. Banks in turn offer K^{eff} at rate R^* to borrowers (Loan supply 2), so that the first-best equilibrium is restored and rationing disappears.

Figure 2-9: Underinvestment and the effect of an interest subsidy



Source: Author's depiction.

For this result to obtain, it is irrelevant whether subsidies are paid to depositors per euro supplied or to banks per euro loaned.[35] In the first case, the net costs of attracting deposits for the banks drop, which offers space for credit expansion up to the new zero profit equilibrium. In the second case, the subsidy allows banks to make profits from additional loans as long as the extra subsidy exceeds the extra costs of deposits. However, due to competition, loan supply will be expanded up to the new equilibrium, which implies the equality of total revenues and costs. As long as there is perfect competition, banks will therefore be unable to extract any rents from these subsidies. Instead, rents will flow completely to borrowers and depositors, as the following analysis shows. Government expenditures as a consequence of interest subsidies amount to a volume of areas $b+c+d$. Depositors obtain an additional income on their funds in the size of areas $b+c+d+e$, of which $d+e$ can be interpreted as the opportunity costs of supplying deposits. Net of these opportunity costs, depositors thus obtain a rent of

[35] To the contrary, paying the subsidy to borrowers will change nothing, due to rationing. At (R^*,K^*), their willingness to pay for loans already by large exceeds the market interest rate.

size $b+c$. Borrowers who are now able to carry out the full volume of investment obtain a rent of at least size a in case of success, assuming that borrowers with the highest willingness to pay are served under rationing. If the rationing scheme implies that the total loan volume K^* is distributed randomly among borrowers, the area would be even larger. However, it has to be weighted by the individual success probabilities of the projects undertaken, since in case of project failure the rent for the borrower is zero. The precise magnitude depends on the expected return of the projects in the applicant pool.

The overall welfare effect is thus a fraction of a minus d, which has an ambiguous sign. Depending on the elasticities of loan demand and deposit supply and the success probabilities of the financed projects, there may be a gain in net welfare as a result of government intervention. However, if success probabilities of projects are private information, a welfare analysis ex ante is impossible. Note that $a+b+c$ could be viewed as the welfare loss (the agency costs) between the first-best world and a constrained situation of asymmetric information (following FURUBOTN and RICHTER 1997, pp. 200; 248).[36]

The main results of the previous analysis can be summarised as follows:

> In a competitive equilibrium on the loan market characterised by asymmetric information as described by STIGLITZ and WEISS (1981), investment *falls short* of the first-best level with full information. This equilibrium may or may not entail credit rationing. In either case, subsidising deposit interest rates can restore the first-best level of investment (DE MEZA and WEBB 1987), which may imply a welfare improvement.

[36] A number of cases cannot be analysed in depth due to space constraints. First, a deviation from the situation as depicted in Figure 2-9 may be that the equilibrium interest rate on the loan market under rationing is *above* the first-best interest rate (loan supply is less strongly backward bending). This does not principally alter the result except that expanding deposit supply will lead to a fall in interest rates on the loan market. The additional rent borrowers obtain will thus be comparatively larger. Apart from that, the graphical analysis remains generally the same. Second, the equilibrium interest rate on the loan market under rationing may be *below* the first-best interest rate. Under these circumstances, an interest subsidy can still ensure that the first-best volume of loans is supplied on the loan market, but there is still rationing (an excess demand for loans at the low equilibrium rate). It depends thus on the method of distribution whether all efficient projects are in fact carried out. Finally, deposit supply may be fully elastic. In this case (investigated in much detail by NEYER 2000) there is no rationing, but interest rates on the loan market are higher than at the first-best, so that certain efficient projects are not carried out. A subsidy can again restore first-best efficiency, although it will now completely flow to borrowers.

How robust is this line of argumentation? The main contribution of DE MEZA and WEBB (1987) is the surprising insight that the underinvestment result is *quite sensitive* to the underlying distribution of projects' risk.

DE MEZA and WEBB replace the assumption of mean preserving spreads between projects by the assumption that projects are ordered by first-degree stochastic dominance. All projects are supposed to have the *same* payoff y^s if successful, although they differ in their probability of success P_i, which is privately observed. As before, unsuccessful projects yield zero. Under these circumstances, projects with a higher probability of success have a higher mean expected return than those with a lower success probability. Furthermore, borrowers are assumed to have available a limited amount of wealth *W* either for investment in their project or in a safe asset. If *I* is the total amount to be invested, the borrower has to take a loan of size $K = I - W$ to carry out the project, since *W*<*I*. His expected profit $E(\tilde{\pi}_i)$ under the changed distributional assumptions is thus:

$$E(\tilde{\pi}_i) = P_i\left(y^s - (1+r)(I-W)\right), \tag{2-7}$$

where *r* is the interest rate on loans. It is assumed that $y^s > (1+r)K$. Profit maximising, risk neutral entrepreneurs apply for credit only if $E(\tilde{\pi}_i) \geq (1+\hat{r})W$, where $\hat{r}$ is the rate on safe assets. From (2-7) follows that $\partial E(\tilde{\pi}_i)/\partial P_i > 0$ and $\partial E(\tilde{\pi}_i)/\partial r < 0$. Hence, if *r* rises, to keep a minimum return in the magnitude of the safe rate on *W* requires a higher P_i. Under a rising *r*, borrowers with relatively low P_i will therefore soon prefer the safe asset and drop out of the loan market first. The remaining borrowers are those with high success probabilities, which implies a *favourable selection* process for the bank!

It is intuitively plausible that under these conditions there will be no rationing, since banks gain from a rise in interest rates in a twofold way: revenues are increased by an increasing interest rate, and the default risk of borrowers declines.

In a further step, DE MEZA and WEBB (1987) establish that, under the conditions just presented, investment *exceeds* the first-best level at the competitive equilibrium. In a first-best world, all projects are financed that satisfy the following condition:

$$P_i y^s \geq (1+\hat{r})I\,. \tag{2-8}$$

Again, the bank will just break even on the marginal project. Under favourable selection, however, the bank makes a positive profit on all intra-marginal pro-

jects and thus a positive profit overall. Since in equilibrium all positive profits are competed away, banks will reduce loan rates even below the first-best rate. Banks thus incur losses from marginal and near-marginal projects, which are compensated by profits made from intra-marginal projects. Overinvestment results, because projects are funded which, if weighted with their success probability, yield less than the safe rate. Thus, in contrast to STIGLITZ and WEISS (1981), (near-)marginal projects are those which are implicitly subsidised by intra-marginal projects with high success probabilities. Borrowers will invest in these marginal projects as long as the overall expected return $P_i y^s$ minus repayment to the bank at the below-first-best interest rate still suffices to pay W a return in excess of $\hat{r}$.

In reversed analogy to the case of underinvestment, DE MEZA and WEBB propose a *tax on deposit interest rates* in order to remove overinvestment. This tax would make loanable funds more expensive for the bank, and in the ideal case it were just of such a magnitude that banks' profits were exactly zero at the social optimum.

Whether this tax is in fact welfare improving with reference to an existing world of asymmetric information is again an open question. Due to space constraints, I will not carry out the graphical analysis in this case. In general, in contrast to the case of adverse selection, loan supply curves will be *below* the first-best loan supply, as a result of favourable selection. There may be a potential Pareto-improvement if deposit supply is sufficiently inelastic, and if loan demand is sufficiently elastic and fraught with a high degree of uncertainty in the relevant areas. Inelastic deposit supply ensures relatively high tax revenues, and elastic loan demand or risky projects rather low losses of borrowers' rent. Overall compensation may therefore be feasible.

Looking at the discussion in this section so far, the only certain insight is that asymmetric information leads to efficiency losses as compared with a first-best world of symmetric information. Apart from that, results are far from unequivocal. Strikingly enough, an apparently small change in assumptions turns the policy implications of the whole model upside down. Even worse, this is already the case in a most abstract kind of model, in which characteristics of investment projects are greatly simplified. It is only to be expected that the introduction of more complex differences between observationally indistinguishable borrowers make a clear-cut judgement of the probable effects almost impossible.

In a series of papers, DE MEZA and WEBB have continued to undermine the belief that asymmetric information or credit rationing as such suggest straightforward

policy action. In DE MEZA and WEBB (1988), they show that arguments both for subsidy or tax intervention lose their unambiguity as soon as the possibility of costly screening is introduced into the model. Furthermore, in subsequent contributions, they demonstrate that the observation of credit rationing in the sense that some borrowers cannot get as much credit as they would like to at prevailing interest rates does neither always imply a market failure, nor does it necessarily imply underinvestment.

In their 1992 paper, DE MEZA and WEBB make the case for an efficient form of loan-size rationing when information between market participants is symmetric. The intuition behind this result is as follows. Suppose that borrowers are endowed with an investment exhibiting decreasing returns to scale which either succeeds or fails. The bank obtains the entire return in case of failure. Suppose further that the interest rate charged on a competitive loan market depends on the loan size, which may vary between borrowers. Banks therefore receive the *average* product of the loan in the case of failure, which will be larger than the *marginal* product. Under competition, banks make zero profit, which drives down the marginal interest rate charged from borrowers. However, since borrowers are only concerned with investment return in the success case, their marginal return on credit in the good state exceeds the overall fair, marginal interest rate. Borrowers would thus like to borrow more, although the marginal product of capital in good and bad states weighted by the success probability is equal to the marginal cost of funds, and social efficiency is thus warranted. The upshot of this model is that the mere observation of credit rationing does neither imply a market failure nor makes a case for government intervention.

Finally, DE MEZA and WEBB (2000) establish that a credit rationing equilibrium may even be consistent with overinvestment as compared to a first-best world. They do this by combining moral hazard and favourable selection effects. As in part II of STIGLITZ and WEISS (1981), borrowers are rationed due to moral hazard, although rising the interest rate induces a favourable selection of loan applicants, as in DE MEZA and WEBB (1987). It is intuitively clear that, under these circumstances, government intervention aimed at encouraging lending to credit rationed borrowers makes little sense if efficiency shall be restored.[37]

[37] One may get the impression that *any* policy measure can be rationalised in the presence of asymmetric information, if only the model is appropriately chosen. Two examples in point are the papers by MANKIW (1986) and INNES (1991). MANKIW, by using a simple credit market model, argues that the government should secure loans to private borrowers in order to increase overall efficiency. To the contrary, INNES, with a model that allows separat-

On theoretical grounds, the fact that borrowers have only randomised access to credit or cannot borrow as much as desired at the going interest rate does neither necessarily imply too little investment, nor does it create a prima facie case for government intervention of any certain type. Generally, asymmetric information on loan markets *is not sufficient for underinvestment*, nor does it readily suggest a certain policy measure.

A key message of this section is thus that credit rationing on the one hand and too little investment on the other need not go hand in hand and have to be treated separately from each other. Market failure in the presence of asymmetric information is likely to be too complex for straightforward policy advice.

The theoretical analysis therefore leaves the pragmatic policy advisor with apparently little substantial help. This is even more so if the limitations of the approach chosen above are considered. Formalisation necessarily leads to an abstraction from many relevant problems. These include the efficiency of the financial intermediary itself, that is the real costs of intermediation as well as the quality and outreach of financial services; and the many administrative issues of potential government intervention on rural credit markets. For instance, even if one had identified a credit market equilibrium involving rationing, one major impediment to implement an efficiency-restoring interest subsidy would be that capital volume and interest rate of the first-best equilibrium are in fact unknown. Furthermore, it remains unclear how this subsidy shall be financed and whether it induces any general equilibrium effects. Other aspects of government activity such as prudential regulation or adequate supervision of the banking sector have not been mentioned at all (see STIGLITZ 1994). Some of these issues will be taken up again in the discussion of chapter 5.

2.2.4 Summary and conclusions for further research

In the course of this subchapter, a formal model of credit rationing as a consequence of adverse selection was presented. Apart from rationalising a situation of absent market clearing, this model was also shown to undermine a number of other properties usually attributed to conventional, neoclassical markets, such as analytical independence of supply and demand or the impossibility of redlining. However, the credit rationing result was seen to be crucially dependent on the

ing loan contracts, arrives at the conclusion that subsidising debt contracts may be welfare improving because it fosters self-selection of borrowers, while a public loan guarantee is regarded as inefficient (p. 371).

ability of market participants to overcome asymmetric information by screening and signalling activities, for example by the use of collateral.

A probably surprising insight of the subsequent, formal welfare analysis was that credit rationing is not a *per se* undesirable situation in terms of social efficiency. Moreover, asymmetric information may create a market equilibrium with either too little or too much investment, both possible with or without credit rationing. Accordingly, policy implications are fundamentally different depending on which state of affairs is present. Unfortunately, however, the predictions of the models are not based on something that can be measured with precision, but rather on theoretical assumptions regarding the distributions of uncertain investment outcomes (BESLEY 1994). In short, *credit rationing does not necessarily imply underinvestment*, and *it generally does not create a case for straightforward government policy*. It seems therefore reasonable to *analytically decouple* the analysis of credit rationing as a privately perceived excess demand and underinvestment as a socially undesirable situation.

Luckily, the fact that the fundamental research questions posed in subchapter 1.3 cannot be answered satisfactorily by theory alone does not make theoretical reasoning superfluous. Building on the considerations presented in section 2.1.6, the following can be concluded from the analysis in this subchapter:

1. *Asymmetric information* between market participants can be an essential cause of privately and socially undesirable outcomes on credit markets. However, the precise way in which asymmetric information affects these outcomes cannot be judged a priori.

2. The theoretical analysis suggests that *credit rationing as private excess demand is a likely outcome* on markets with asymmetric information. Even so, theory does not provide unambiguous propositions regarding the welfare assessment of credit rationing. An alternative could be to base the ultimate decision concerning the presence of underinvestment on *empirical grounds*. In the ideal case, an empirical analysis will not only have to detect any constraints in the access to credit, but also whether these constraints lead to over- or to underinvestment.

3. However, to use any observable market interest rate as a *benchmark for comparison* will require much care. Apart from distortions due to government intervention or explicit transaction costs, there may be additional biases as a consequence of asymmetric information. The more these distortions are relevant in a given situation, the less likely is it that private excess demand coin-

cides with socially undesirable underinvestment. Whereas an assessment of credit rationing in the perspective of a single borrower can take the interest rate as exogenously given, this is much more difficult with regard to an evaluation of underinvestment.

4. The extent to which asymmetric information has harmful effects on investment outcomes depends on the availability of *counteracting instruments or arrangements*, such as collateral, joint liability, or reputation of borrowers. These elements should be included in any empirical analysis.
5. Policy advice must consider the *conditions and causes* that are responsible for any undesirable market outcome, in case that this has been successfully identified. The way in which governments can improve on the instruments and arrangements mentioned in the previous paragraph (4.) and section 2.2.2 will play a vital role in these considerations.

The further analysis in this monograph will primarily aim at the investigation of credit rationing. The extent to which underinvestment can be empirically detected at all and what can be said about the situation in Poland will be a topic in chapter 5.

In line with these thoughts, the next subchapter will go a further step in the direction of empirical analysis by theoretically modelling a credit-rationed farm household. These models will allow the further formalisation of the research problem and thus guide the econometric analysis of later chapters.

2.3 Credit rationing in intertemporal farm household models

In this subchapter, I want to examine the effects of credit rationing on production and investment decisions of farm households. I will take up again and develop further the model of intertemporal choice already introduced in section 2.1.2 of this monograph. A key modification concerns the explicit consideration of restricted access to credit. It will be seen that this results in similar complications as the introduction of positive transaction costs.

In a first step, I formalise the two-period case which leads to the decision alternatives of production versus consumption (section 2.3.1). In a second step, I allow for an infinite planning horizon and investment activities (section 2.3.2). Since informational asymmetries as causes of credit rationing are not explicitly modelled in this subchapter, the credit constraint is taken as exogenously given in the first section. However, in the second section, this will be relaxed by allow-

ing the decision maker to influence his access to credit via the accumulation of equity.[38]

2.3.1 Credit rationing in a two-period farm household model

In this section, I discuss the effects a credit constraint has on optimal resource allocation in a neoclassical producer-consumer model. Particular attention will be paid not only to the separate impact on consumption and production decisions, but also on their interdependencies if access to credit is limited. A farm household that both produces and consumes agricultural goods is probably the classical prototype for such a model. Accordingly, there exists a broad literature on *agricultural household modelling* on which I could draw (see e.g. SADOULET and DE JANVRY 1995; SINGH et al. 1986; WITZKE 1993).

The starting point for the analysis is the formal model of a rational decision maker acting in a neoclassical environment of exogenous prices as outlined in section 2.1.2. Since the temporal dimension is important for the analysis, the decision maker is supposed to maximise consumption in periods 0 and 1 as expressed by an intertemporally additive utility function. The utility function is assumed to be twice differentiable and quasi-concave, and defined over consumption in period 0, c_0, and in period 1, c_1, so that $u = (c_0, c_1; z^h)$. z^h parameterises the utility function and summarises exogenous household characteristics such as number of people in each sex or age category.

Agricultural production requires upfront financing such that expenses on x are due in period 0, while harvest occurs in period 1. To meet liquidity requirements for input purchases, the farmer can take a working capital loan of size K in period 0, which has to be repaid in period 1. The production opportunities of the household are depicted by a twice differentiable, quasi-concave production function $y = f(x^k, x^{nk}; z^y)$. There are two types of variable inputs. x^k represents a variable input that requires upfront financing (e.g. seed or fertiliser) and is thus subject to a liquidity constraint; x^{nk} is an aggregate of all other types of variable inputs. z^y stands for fixed and exogenous inputs, such as land and machinery.[39]

[38] The following exposition emphasises the household's desire to finance current production and consumption expenses as well as physical investment activities as the central motivation for borrowing. Aspects of consumption smoothing and liquidity insurance are widely neglected; the reader interested in these issues is referred to BESLEY (1995) and DEATON (1992) and (1997, chapter 6).

[39] To avoid unnecessary clutter, I abstain from explicit vector notation.

The household faces a budget constraint in each period and a credit constraint in period 0. The budget in period 0 consists of initial endowment with liquid funds, *E*, an amount of credit taken, *K*, and exogenous public transfers $T(z^h)$, assumed to be obtained only in period 0. In equilibrium, the sum of these is equal to the expenses for the variable input which requires upfront financing plus consumption. $p^{xk}x^k$ is expenses on the variable input, with p^{xk} the price of the input, and $p^c c_0$ expenses on consumption in period 0, with p^c the (nominally constant) price of the consumption bundle. The budget in period 1 entails revenues from production $p^y y$, with p^y the price of the output. In equilibrium, this is equal to repayment of credit taken in period 0, consumption in period 1, and expenses on variable inputs not subject to upfront financing. $K(1+r)$ is repayment of credit, with *r* the interest rate, $p^c c_1$ expenses on consumption, and $p^{xnk}x^{nk}$ expenses on inputs, with p^{xnk} the price of the input not subject to upfront financing.

Note that all prices may be understood to include a transaction cost component which adds to the nominal market price. For the decision maker, many of these costs are quite real, for example travelling or time expenses, although they may be difficult to quantify in order to obtain an objective measure of market efficiency (see the discussion in subchapter 2.1). In particular, opportunity costs will have to be evaluated pragmatically (see section 4.2.2 below).

It was demonstrated in previous sections that borrowers may be denied credit even on a competitive loan market. A simple way to introduce this into the farm household model is by considering an upper bound of credit $\overline{K}(z^h, z^y)$ the household can obtain. The availability of devices to overcome credit rationing is dependent on household and production characteristics z^h and z^y, for example collateral or borrowers' reputation as discussed in section 2.2.2.

The farmer's problem can thus be formally summarised as follows:

$$\max u(c_0, c_1; z^h) \text{ with respect to } c_0, c_1, x^k, x^{nk}, K \text{, all} > 0$$

subject to

$$E + K + T(z^h) - p^c c_0 - p^{xk}x^k = 0 \tag{2-9}$$

the budget constraint in period 0,

$$p^y f(x^k, x^{nk}; z^y) - p^c c_1 - p^{xnk}x^{nk} - (1+r)K = 0 \tag{2-10}$$

the budget constraint in period 1, and

$$\overline{K}(z^h, z^y) - K \geq 0 \tag{2-11}$$

the credit constraint in period 0. The credit constraint may or may not be binding.

To solve this optimisation problem, I form the Lagrangean as follows:

$$L = u(c_0, c_1; z^h) + \eta(E + K + T(z^h) - p^c c_0 - p^{xk} x^k) + \lambda(p^y f(x^k, x^{nk}; z^y)$$
$$- p^c c_1 - p^{xnk} x^{nk} - (1+r)K) + \mu(\overline{K}(z^h, z^y) - K) \tag{2-12}$$

The first-order conditions of the optimal solution are represented by the first derivatives of the Lagrangean with respect to all decision variables and the Lagrangean multipliers. Since (2-11) is an inequality, I use the Kuhn-Tucker conditions for this constraint (see CHIANG 1984, pp. 722-730).

$$\frac{\partial L}{\partial c_0} = \frac{\partial u(.)}{\partial c_0} - \eta p^c = 0 \tag{2-13}$$

$$\frac{\partial L}{\partial c_1} = \frac{\partial u(.)}{\partial c_1} - \lambda p^c = 0 \tag{2-14}$$

$$\frac{\partial L}{\partial x^k} = -\eta p^{xk} + \lambda p^y \frac{\partial f(.)}{\partial x^k} = 0 \tag{2-15}$$

$$\frac{\partial L}{\partial x^{nk}} = \lambda\left(p^y \frac{\partial f(.)}{\partial x^{nk}} - p^{xnk} \right) = 0 \tag{2-16}$$

$$\frac{\partial L}{\partial K} = \eta - \lambda(1+r) - \mu = 0 \tag{2-17}$$

$$\frac{\partial L}{\partial \eta} = E + K + T(z^h) - p^c c_0 - p^{xk} x^k = 0 \tag{2-9}$$

$$\frac{\partial L}{\partial \lambda} = p^y f(.) - p^c c_1 - p^{xnk} x^{nk} - (1+r)K = 0 \tag{2-10}$$

$$\frac{\partial L}{\partial \mu} = \overline{K}(z^h, z^y) - K \geq 0,\ \mu \geq 0,\ \mu \frac{\partial L}{\partial \mu} = 0 \tag{2-18}$$

Equations (2-13) and (2-14) characterise optimal consumption, equations (2-15) and (2-16) optimal production, (2-17) optimal credit demand, and (2-9), (2-10), and (2-18) are the side conditions that have to be satisfied by an optimal solution. Taken together, these equations constitute the *structural form* of the model (see SADOULET and DE JANVRY 1995, pp. 378-383). η, λ, and μ are the Lagrangean multipliers which denote the marginal value of the constraint in terms

of the objective function. In the present model, they are hence a measure of the marginal utility of the two budget constraints and the credit constraint, respectively. The Kuhn-Tucker conditions (2-18) are to be interpreted as follows. Either the credit constraint is binding, in which case (2-11) holds with equality and $\mu > 0$. In the other case, *K* does not exhaust the credit limit, so that (2-11) holds with inequality and $\mu = 0$. If all three conditions of (2-18) are satisfied simultaneously, always one of the two cases applies.

I first examine optimal consumption and production if the credit constraint is *not binding*, that is $\mu = 0$. Equations (2-13) and (2-14) state that in both periods, the respective Lagrangean multiplier equates the marginal utility of the consumption good divided by its price, which is usually referred to as the marginal utility of money. This result is formally analogous to the standard two-good single-period consumption choice problem (see e.g. LAYARD and WALTERS 1978, p. 134). The only exception is that in the two-period model, there is a single nominal price of the consumption good but two different budget constraints. These are, however, connected by the credit variable, so that substitution of (2-17) into (2-13) and (2-14) yields the following condition for optimal consumption over time if the credit constraint is not binding:

$$\frac{\partial u(.)/\partial c_0}{\partial u(.)/\partial c_1} = (1+r) \qquad (2\text{-}19)$$

This is simply the conventional optimality condition of intertemporal choice which implicitly emerged already from the analysis in section 2.1.2 (see also BRANDES et al. 1997, pp. 253-257; LAYARD and WALTERS 1978, pp. 327-335). The left hand of the equation is the marginal rate of utility substitution between consumption in periods 0 and 1, which is sometimes expressed also as the derivative dc_1/dc_0. In equilibrium, this equals one plus the market interest rate, or the inverse of the real price relationship between c_1 and c_0 (p^c in period 1 is discounted by (1+*r*)). (2-19) also restates the separation result of section 2.1.2: optimal consumption solely depends on the utility function and the interest rate, given the household budget. In which *relation* the budget should be allocated to consumption in period 0 versus period 1 is thus independent of the production decisions of the farm household, and can be chosen separately from them. Production decisions only determine the *overall volume* of the budget.

Equation (2-16) gives an immediate rule how inputs that require no upfront financing should be allocated. The decision is not affected by the intertemporal nature of the household model, so that λ can safely be dropped. Due to the concave production function, the result is the standard condition that marginal reve-

nue should equate marginal cost of input use (see LAYARD and WALTERS 1978, pp. 208-212):

$$p^y \frac{\partial f(.)}{\partial x^{nk}} = p^{xnk} \tag{2-20}$$

With regard to input x^k which requires pre-harvest liquidity, a procedure similar to the consumption analysis can be applied. Again, I substitute (2-17) into the first-order condition (2-15), which yields the following if $\mu = 0$:

$$\frac{p^y}{1+r} \frac{\partial f(.)}{\partial x^k} = p^{xk} \tag{2-21}$$

This is identical to (2-20) except that the output price has to be discounted by the interest rate, since expenses are due in an earlier period than revenues. If the input price is normalised to one by division through p^{xk} in (2-21) and the equation is multiplied through by 1+*r*, the same rule which underlies Figure 2-1 in section 2.1.2 obtains, namely that in equilibrium the marginal return on productive investment equals the market interest rate. (2-20) and (2-21) are independent of the utility function or any household characteristics, which again demonstrates separability of production and consumption choices as long as the credit constraint is not binding.

The solution or *reduced form* of the model is a set of demand, supply and factor demand functions (SADOULET and DE JANVRY 1995, p. 379). I define *M* as the overall budget constraint:

$$M \equiv E + T(z^h) + \frac{p^y}{1+r} y - p^{xk} x^k - \frac{p^{xnk}}{1+r} x^{nk} \tag{2-22}$$

The reduced-form equations are then given as follows:

$$c_0 = c_0(r, p^c, M, z^h) \tag{2-23}$$

$$c_1 = c_1(r, p^c, M, z^h) \tag{2-24}$$

$$y = y(r, p^y, p^{xk}, p^{xnk}, z^y) \tag{2-25}$$

$$x^k = x^k(r, p^y, p^{xk}, p^{xnk}, z^y) \tag{2-26}$$

$$x^{nk} = x^{nk}(r, p^y, p^{xk}, p^{xnk}, z^y) \tag{2-27}$$

$$K = K(r, p^c, p^y, p^{xk}, p^{xnk}, z^h, z^y) \tag{2-28}$$

By definition, all of the explanatory variables of reduced-form equations are exogenous, that is not under the control of the household. With regard to the demand functions (2-23) and (2-24) this is only true if household demand is treated separately from the production side and *M* hence taken as exogenous, as in the standard consumer choice model. However, in the complete household system, *M* is determined by production decisions, and thus should be replaced by the exogenous variables of the production subsystem (prices and fixed factors) in order to obtain a fully reduced form of the demand functions. Due to the fact that production behaviour affects consumption (but not vice versa) the household model without a binding credit constraint is also called *recursive* (SINGH et al. 1986a, p. 20).

I now turn to the case where optimal credit demand is effectively restricted by the credit limit. The implication is that (2-11) holds with equality and the *credit constraint is binding*. From (2-18), it has the immediate consequence that $\mu > 0$. The link between the budget constraints in both periods and the credit constraint is again given by equation (2-17), which now takes the following form:

$$(1+r) = \frac{\eta - \mu}{\lambda} \tag{2-29}$$

With regard to consumption choice, substituting (2-13) and (2-14) into (2-29) and rearrangement yields the following optimality condition under the binding credit constraint:

$$\frac{\partial u(.)/\partial c_0}{\partial u(.)/\partial c_1} = (1+r) + \frac{\mu}{\lambda} \tag{2-30}$$

The previous equation defines a *shadow interest rate* under the binding credit constraint, which I denote r^*. It is a measure of the household internal value of liquidity. Since μ and λ are both strictly positive, the following holds:

$$r^* = r + \frac{\mu}{\lambda} > r \tag{2-31}$$

Under a binding credit constraint, the increased scarcity of liquid funds is thus reflected by a rise in the interest rate relevant for decision making. The optimality condition for intertemporal consumption choice under the credit constraint can thus be equally written as:

$$\frac{\partial u(.)/\partial c_0}{\partial u(.)/\partial c_1} = (1+r^*) \tag{2-32}$$

Hence, consumption in period 0 becomes more expensive. The same relationship between r and r^* can be derived on the production side. Solving (2-17) for η and substitution into (2-15) yields after some rearrangement:

$$p^y \frac{\partial f(.)}{\partial x^k} = \left((1+r) + \frac{\mu}{\lambda} \right) p^{xk}$$

Under consideration of the above definition of the shadow interest rate (2-31), this results in the following expression:

$$\frac{p^y}{1+r^*} \frac{\partial f(.)}{\partial x^k} = p^{xk} \tag{2-33}$$

As a consequence, the condition for an optimal allocation of the liquidity-requiring input formally remains the same under the binding credit constraint except that the marked-up shadow interest rate must be used. Since the production function is concave in variable inputs, a reduced output price in (2-33) results in a reduction of x^k in order to increase the value of the marginal product. The binding credit constraint has therefore the consequence that input use and hence *output is reduced*.

For later reference, I solve for r^*:

$$\frac{p^y}{p^{xk}} \frac{\partial f(.)}{\partial x^k} - 1 = r^* \tag{2-34}$$

The condition for the input *not* under upfront financing is in so far affected by the shadow rate that the marginal product of x^{nk} will drop as x^k is reduced (analogous to WITZKE 1993, p. 119). x^{nk} will therefore also be reduced.

As a result, a new set of consumption as well as input demand and output supply equations under the binding credit constraint is created, which is linked by the discounted value of the household's full income under the binding credit constraint M^* as follows:

$$M^* \equiv E + T(z^h) + \frac{p^y}{1+r^*} y - p^{xk} x^k - \frac{p^{xnk}}{1+r^*} x^{nk} = p^c c_0 + \frac{p^c}{1+r^*} c_1 \tag{2-35}$$

Note that an increasing r^* will usually unambiguously reduce M^*. As can be seen from the left-hand (production) side of the equality (2-35), a change in r^* affects the relative prices of the output and the two types of inputs and hence profit. While a rise in r^* reduces the relative price of the output by increasing the discount factor, it also reduces the price of the input not under upfront financing. This is equivalent to a relative rise in the price of the input under the credit constraint. Since profits are nonincreasing in input prices (see VARIAN 1992, p. 41), M^* will usually decrease if r^* increases, or at best remain con-

stant.[40] Hence, the binding credit constraint not only reduces farm output but also *the household's income*.

It may be worth emphasising the effects of an increase in exogenous r or $\overline{K}$, for example as a result of government policy or improvements in lending technology. Both effects act in opposite directions by (2-31). A rise in r means an additional upward shift of r^*, with the same results as before (M^* drops). To the contrary, if $\overline{K}$ increases, its shadow price μ and eventually r^* is reduced, M^* therefore increases.

A particular implication of the binding credit constraint is that it *breaks the separability* of consumption and production decisions. As a result, input allocation depends on household preferences and consumption choices depend on the production technology, both via the shadow rate of interest. This property of the interdependent household model can be used for an empirical test of market imperfections, as will be discussed in chapter 3. To demonstrate it formally, I analyse the effect that household characteristics z^h have on r^* (the following parallels the exposition in D. BENJAMIN 1992, pp. 292-295).

The demand function for consumption in period 0 is defined by (2-32) as follows:

$$c_0 = c_0(r^*, M^*; p^c, z^h) \tag{2-36}$$

The demand for the variable input under the liquidity constraint is determined by (2-33):

$$x^k = x^k(r^*; p^y, p^{xk}, p^{xnk}, z^y) \tag{2-37}$$

Taken together, the latter two equations form a liquidity equilibrium that implicitly defines the shadow interest rate as follows:

$$\begin{aligned} &E + \overline{K}(z^h, z^y) + T(z^h) - p^c c_0(r^*, M^*; p^c, z^h) \\ &\quad = p^{xk} x^k(r^*; p^y, p^{xk}, p^{xnk}, z^y) \end{aligned} \tag{2-38}$$

The left-hand side of this equation is household supply of liquid funds, and the right-hand side is farm demand for funds. Both are equated at the shadow interest rate r^*. Differentiation by the implicit-function theorem (see CHIANG 1984,

[40] A (rather unrealistic) case where M^* remains constant is when x^k and x^{nk} are perfect substitutes.

pp. 204-214) and holding all other variables constant yields the following relationship:

$$\frac{dr^*}{dz^h} = \frac{-\frac{d\overline{K}(.)}{dz^h} - \frac{dT(z^h)}{dz^h} + p^c \frac{dc_0(.)}{dz^h}}{-p^c \left.\frac{dc_0(.)}{dr^*}\right|_{u=const} - p^{xk} \frac{dx^k}{dr^*}} \tag{2-39}$$

The denominator consists of the negative compensated interest rate effect on consumption in period 0 times the price of the consumption good minus the interest rate effect on input demand times the input price.[41] Both are negative: consumption of c_0 falls if by an increase of r^* its real price increases relative to that of c_1 (see (2-19)). The real price of the input likewise increases, which reduces input demand. Taken together, the denominator is unambiguously positive. The sign of the numerator depends on the total effect of a change in household characteristics on the availability of credit, on the reception on transfers, and on consumption of c_0. Transfers affect the numerator directly via liquidity creation and indirectly via expansion of M^*. The overall effect of z^h on r^* is thus ambiguous. For example, the shadow interest rate rises if the net increase in consumption in period 0 as the result of an increase in family members outweighs a potentially improved access to credit and transfers.

Implicit differentiation of (2-38) may also be used to illustrate a potential *liquidity effect* of an increase in public transfers:

$$\frac{dr^*}{dT} = \frac{-1 + p^c \frac{dc_0}{dT}}{-p^c \left.\frac{dc_0}{dr^*}\right|_{u=const} - p^{xk} \frac{dx^k}{dr^*}} \tag{2-40}$$

The denominator is the same as before; the numerator consists of the direct effect of increased transfers plus the household's marginal propensity to consume (mpc) in period 0. The latter is ≤ 1 by definition, so that the numerator is always

[41] The compensated interest rate effect can be obtained by taking the total derivative of (2-36) as follows (see CHIANG 1984, pp. 198-200): $\frac{dc_0}{dr^*} = \frac{\partial c_0}{\partial M^*}\frac{dM^*}{dr^*} + \frac{\partial c_0}{\partial r^*}$. The total effect on c_0 of a change in r^* consists of the indirect effect via M^* and the direct effect as given by the partial derivative. Since dM^*/dr^* can be interpreted as the amount necessary to compensate the change in M^* as the result of a change in r^*, the total derivative is a Slutsky equation for the intertemporal choice problem (see LAYARD and WALTERS 1978, p. 138). In this equation, dc_0/dr^* is the interest effect with utility held constant.

nonpositive. Usual values of the mpc will be smaller than 1, so that the numerator is strictly negative. Hence, improved access to public funding reduces the shadow interest rate by relaxing the liquidity constraint. A smaller r^* will reinforce the use of inputs that require upfront financing and may result in an expansion of agricultural output. This is in contrast to the textbook case of an allocatively neutral effect of government transfers (see HENRICHSMEYER and WITZKE 1994, p. 190).

It became clear that household characteristics play a central role in the determination of r^* and hence in the optimal allocation of production inputs. As a consequence, the household model is not separable any more. The binding credit ration leads thus to a similar effect as the direct incorporation of positive transaction costs into the model of intertemporal choice as presented in subchapter 2.1. Under non-separation, all reduced-form equations of the model ultimately depend on all exogenous variables of *both* the consumption and the production side (see SADOULET and DE JANVRY 1995, p. 160; I drop subscripts of consumption goods and superscripts of inputs):

$$c = c(r, p^c, p^x, p^y, E, \overline{K}, z^h, z^y) \tag{2-41}$$

$$y = y(r, p^c, p^x, p^y, E, \overline{K}, z^h, z^y) \tag{2-42}$$

$$x = x(r, p^c, p^x, p^y, E, \overline{K}, z^h, z^y) \tag{2-43}$$

With respect to the further empirical analysis, it seems instructive to emphasise the difference between *structural* and *reduced-form* equations of the model (see BEHRMAN and OLIVER 2000). Structural equations include only right-side variables that have *direct* effects on the outcome. For example, the basic structural equation of the current model is the production function, which depicts the direct relation between inputs and output. Right-side variables of structural equations are often *endogenous* to the model, which means that they are themselves determined as a part of the decision making process in response to other, exogenous variables. They therefore give rise to particular problems of econometric estimation (see section 3.2.2 below). In contrast, the reduced-form equations provide the total (*direct* plus *indirect*) effects of *exogenous* explanatory variables on the demand or supply outcome. However, they cannot disentangle the exact pathways by which the household's objective function and the production function influence behavioural outcomes (BEHRMAN and OLIVER 2000, p. 377). For example, the reduced-form output supply equation (2-42) displays the total effect of credit $\overline{K}$ on output supply. Even so, it cannot reveal separately how

much credit affects output directly by financing fertiliser, as expressed by the production function, and how much credit affects output indirectly by providing liquidity for financing consumption expenditures which in turn make family labour more (or less) productive. Credit may also be simply used for non-productive purposes, so that there is no indirect effect on output apart from the mere diversion of funds. In line with these thoughts, the reduced-form output supply equation (2-42) has been a focus of interest in the empirical literature on credit rationing of farm households (see FEDER et al. 1990; SIAL and CARTER 1996).

It is therefore useful to derive a further magnitude which is closely related to the shadow interest rate. I call it the *credit-rationed household's marginal willingness to pay for credit*, ρ^*. This magnitude is measuring the ability of the household to pay for credit in period 1 given the possibility that some credit was used for consumption purposes in period 0. The shadow interest rate correctly measures the marginal value of the last unit of liquidity *provided it is used for purchasing inputs*. To the contrary, the marginal willingness to pay for credit addresses the question: what interest is the farm household able to pay at the margin, given its preferred use of credit for *both* production or consumption? If some credit is used for consumptive uses, the shadow interest rate may overestimate the actual payment abilities of the household in period 1. To understand this idea, consider the utility maximising liquidity surplus of the household in period 1 under credit rationing, denoted Λ:

$$\begin{aligned}\Lambda &\equiv p^y f\left(x^k(.), x^{nk}(.); z^y\right) - (1+r)\left(p^{xk}x^k + p^c c_0 - E - T\right) - p^{xnk}x^{nk} \\ &= p^y y(.) - (1+r)\overline{K} - p^{xnk}x^{nk} \qquad (2\text{-}44)\end{aligned}$$

The liquidity surplus in the repayment period 1 is the revenue of the household in period 1, given as the value of the optimal production volume, minus credit repayment and interest and minus input purchases not under the credit constraint. Credit is equal to the gap between the value of input purchases and consumption in period 0 on the one hand and available endowment plus transfers on the other.

The partial derivative of the liquidity surplus with regard to credit indicates what the household is marginally able to pay in excess of the market interest rate. For the moment it is assumed that there are no effects of an increased $\overline{K}$ on the *not* credit-financed input x^{nk}, that is $p^{xnk}\,\partial x^{nk}/\partial\overline{K} = 0$. The partial derivative can then be stated as follows:

$$\frac{\partial \Lambda}{\partial \overline{K}} = p^y \frac{\partial f(.)}{\partial x^k} \frac{\partial x^k}{\partial \overline{K}} - (1+r) = p^y \frac{\partial y(.)}{\partial \overline{K}} - (1+r). \tag{2-45}$$

To enable a direct comparison with the market interest rate, I define the household's marginal willingness to pay for credit under rationing, ρ^*, as follows:

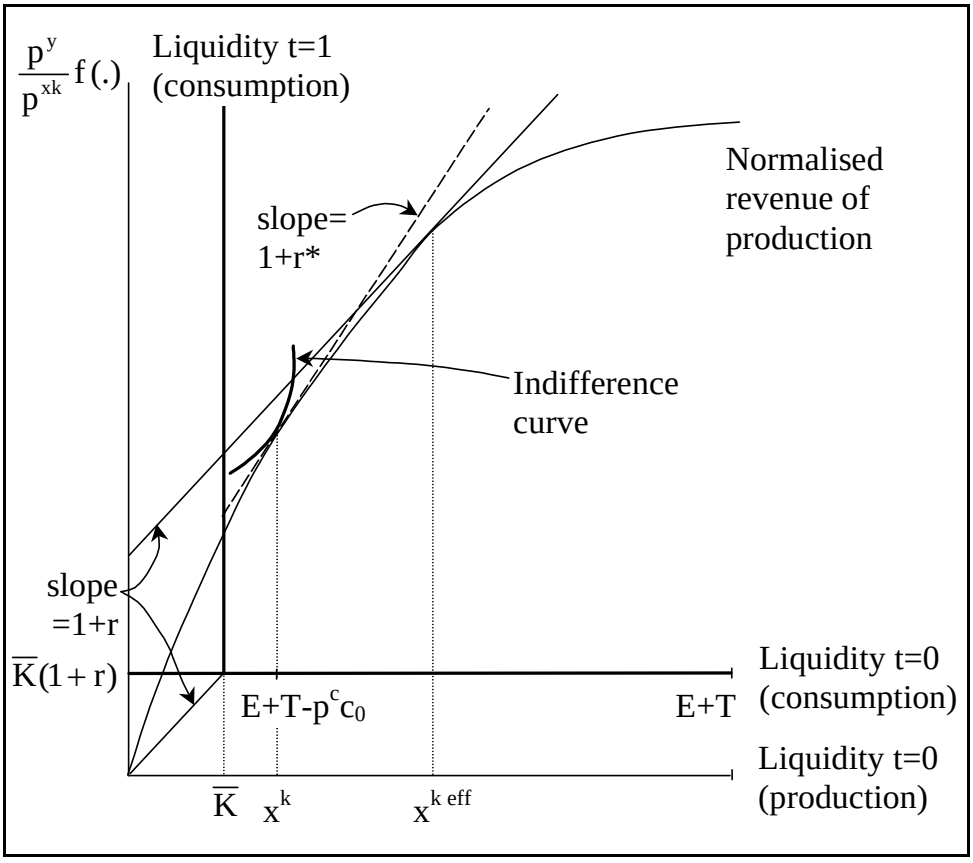
$$\rho^* \equiv r + \frac{\partial \Lambda}{\partial \overline{K}} = p^y \frac{\partial f(.)}{\partial x^k} \frac{\partial x^k}{\partial \overline{K}} - 1 = p^y \frac{\partial y}{\partial \overline{K}} - 1. \tag{2-46}$$

A comparison with (2-34) reveals that ρ^* is a measure of the actual interest payment ability which takes into account the possible use of credit for consumptive purposes. Under the restrictive assumption that credit is fully used for purchasing inputs, that is $p^{xk}\, \partial x^k / \partial \overline{K} = 1$, it follows that $\rho^* = r^*$. However, if some credit is used for consumption in period 0, it follows from $p^{xk}\, \partial x^k / \partial \overline{K} < 1$ that $\rho^* < r^*$. If there is no rationing, the marginal willingness to pay for credit is equal to the market interest rate *r*. In an extreme case of diversion, ρ^* might even become smaller than *r*, so that the household cannot fully pay the interest of the debt.

Note that in case of $p^{xnk}\, \partial x^{nk} / \partial \overline{K} > 0$, (2-46) overestimates the actual payment abilities of the household in period 1. Whether such an indirect effect of credit on the not credit-financed input can be borne out empirically will be addressed in the econometric analysis below, section 4.2.1, pp. 172 et seq.

Since consumption of credit funds is both likely to be relevant in reality (see Section 1.2) and has important consequences for the actual repayment capacity of households, the empirical approach in this study focuses on estimating ρ^* rather than r^* (see the further discussion in sections 3.1.3 and 3.3.4, pp. 149 et seq.).

Figure 2-10: Liquidity allocation in the farm household with credit rationing



Source: Author's depiction based on D. BENJAMIN (1992, p. 296).

The allocation decisions within the farm household can be depicted graphically as shown in Figure 2-10. The bold axes in the figure measure the budget (the volume of liquidity) in the two periods available for household consumption. The light axes depict production opportunities, given by a revenue curve that relates the value of input supplied to revenue from farm production, with exogenous input and output prices. The output price has been normalised by the price of the input under the credit constraint. This input yields a given revenue in period 1 and has thus a price of one, so that the value of input is simply denoted by *x* on the light horizontal axis. The household has preferences for consumption in period 0 and 1 as shown by the indifference curve. Note that consumption in period 0 is measured from the right to the left on the bold horizontal axis, while in period 1 it is measured from bottom to top on the bold vertical axis.

The farm household has available a limited amount of credit $\overline{K}$ in period 0 which must be repaid in period 1 including the market interest *r*. Credit has two effects that are illustrated in the figure by the inward position of the bold con-

sumption axes relative to the production axes. First, it increases the liquidity potentially available in period 0 beyond endowment *E* plus transfers *T*, which is why both horizontal lines of the consumption and the production budget are shifted to the right. Second, while credit expands the production opportunities, consumption in period 1 is now subject to loan repayment. Therefore, the consumption axes are shifted upwards by the volume of repayment $\overline{K}(1+r)$, whereas production revenues in period 1 are used for credit repayment. Costs of other inputs not under the credit constraint are neglected in the figure, for reasons of simplicity.

Optimal consumption and production decisions of the utility maximising household are finally determined by the slope of the interest rate line. With variable credit access, the optimal volume of input $x^{k\,eff}$ would be given by the point where the interest line touches the revenue curve, regardless of initial endowment *E* and transfers *T*. The point of optimal consumption could be determined without knowledge of the input allocation decision; it would lie somewhere on the solid interest rate line. The only effect of production on consumption would be via the budget available in period 1.

If the credit constraint is binding, the interest rate relevant for the household-internal allocation decisions increases, as was shown above. Therefore, the slope of the interest line increases as well, which is illustrated by the broken line in Figure 2-10. It is now optimal for the household to *reduce* the use of the input which is subject to upfront financing to x^k. Since the budget in period 0 is fixed by the sum of $\overline{K}$, *E*, and *T*, optimal consumption is now *simultaneously determined*. Optimal consumption bundles are given by the point where the indifference curve touches the broken line denoting the shadow interest rate, as shown in the figure.

This section will be an important background for the empirical approach to be discussed in chapter 3. It has picked up a number of earlier results and may be summarised as follows:

> In the two-period producer-consumer model, a binding credit constraint results in a household-internal *shadow interest rate* which is above the market interest rate of a first-best situation. Therefore, input use is reduced, which implies an *output reduction* as compared with a first-best situation. Furthermore, *household income* will usually decline as well. Production and consumption decisions are *no longer analytically separable* from each other. As a consequence, an increase in public transfers the household receives may result in *liquidity effects* which increase agricultural output. The credit-rationed

household's *marginal willingness to pay for credit* measures its interest payment abilities in the repayment period.

2.3.2 Credit rationing in a multi-period farm household model

In this section, the step from a two-period to an infinite-period planning horizon will be taken, whereas the formal framework of a producer-consumer model remains the same. This step will be used to extend the results of the previous section in a number of directions. First, I want to re-examine the interdependence between intertemporal consumption and investment decisions by introducing an explicit link between these decisions and access to credit. Although, due to the intertemporal nature of the problem, input allocation as portrayed in section 2.3.1 might be interpreted as investment activity, it seems useful to make the investment problem more visible by expanding the number of periods. Furthermore, it will be possible to establish a relationship between financial variables of the farm and its investment demand, which stands in marked contrast to the Modigliani-Miller Theorem mentioned in section 2.1.2. In addition, the type of model presented below will rationalise the slow adjustment of productive capital stocks observed in the real world, which is difficult to explain within the standard neoclassical theory of the firm.[42] Finally, this section will provide a theoretical underpinning for the empirical implementation of an investment equation in chapter 3.

Investment analysis has been a long standing issue in economics, and the related literature is immense. Therefore, I confine myself to sketching a few lines of thought, whereas the interested reader is referred to recent surveys.[43] An early and quite general approach was to condition the optimal capital stock of a firm on the observed level of output, which results in a (static) *accelerator* model. Investment hence depends on output growth (see KRELLE 1978). To improve the flexibility of this model, the relation was later made time-dependent by introducing a *distributed lag*, according to which current investment is determined by

[42] The discrepancy in this respect between the neoclassical model world and reality is best illustrated by the following quotation: "Thus a restaurateur from this particular world who had more customers on weekends as opposed to weekdays would be observed to buy a small restaurant for weekdays but would sell it on Friday nights and purchase a large restaurant for the weekend, reselling it on Monday mornings" (NICKELL 1978, p. 9, cited in WITZKE 1993, p. 190).

[43] These include from a general point of view CABALLERO (1999); CHIRINKO (1993); COEN and EISNER (1991); KRELLE (1978); LENSINK et al. (2001); and from an agricultural economics perspective MUNDLAK (2001); WITZKE (1993).

current *and* previous levels of output (on distributed lags see KRELLE 1978, pp. 276-278). The latter type of model was called the *flexible accelerator*. Written in a general form, the flexible accelerator relates investment $I(t)$ to the difference between the desired and the actual capital stock at the beginning of the period, denoted Z^* and $Z(t)$, respectively:

$$I(t) = B\left[Z^* - Z(t)\right] \tag{2-47}$$

with B an adjustment coefficient (KRELLE 1978, p. 283). A crucial question is how the desired capital stock should be operationalised. Inspired by the neoclassical theory of the firm, JORGENSON (1963) deviated from the earlier approach to proxy desired capital by output and made the optimal capital stock being determined by *prices* of outputs and inputs, and, in particular, the *user cost of capital*. The latter is the cost per period of holding and maintaining one unit of capital.

Despite some empirical success, a problem with the flexible accelerator models is their weak theoretical foundation (CABALLERO 1999). A finite demand for investment is obtained in a rather ad hoc way by imposing a largely arbitrary distributed lag structure. The major challenge of explaining any *lagged* adjustment of capital stocks cannot be solved by neoclassical production theory since it is inherently static. However, competing theories until the late 1970's had been devoid of fundamental explanatory power as well (CABALLERO 1999, p. 817). This situation naturally stimulated the emergence of new theories of investment over the previous two decades, which I want to group according to their main explanatory element: (a) adjustment costs, (b) financial constraints, and (c) uncertainty.

The basic tenet of the *adjustment costs* literature is that firms forego a certain amount of output by diverting resources from production to investment activities (see MACCINI 1991 for an overview). For example, resources may be necessary for planning and installation of investment. Hence, the conventional neoclassical production model is augmented by a strictly convex adjustment cost function. A crucial and controversially discussed assumption is that adjustment costs are *marginally increasing* with the level of investment to obtain the result of lagged adjustment; otherwise the firm will close immediately any gap between desired and actual capital stocks. It may be possible to interpret adjustment costs as a sort of transaction costs stemming from the search for adequate financing of investment as discussed in section 2.1.4, an interpretation that is however not explicit in this literature. Furthermore, particularly search and information costs

are much more likely to be concave rather than convex, since they usually entail a fixed cost component.

An approach that avoids this problem and provides the link to the context of this monograph is the *financial constraints* model advanced by E. HOCHMAN et al. (1973) and STEIGUM (1983). This model explicitly considers credit rationing in a dynamic optimisation framework and will be presented below in more detail. Though not explicated by these authors, it is easy to see the connection between the theoretical developments in the credit market literature as discussed in subchapter 2.1 and the incorporation of financial constraints in the investment literature.

A third important field of theoretical progress has recently evolved around the problem of *uncertainty* in investment (for an overview see LENSINK et al. 2001, part two). This group falls in a more traditional branch that considers adjustment costs and the risk attitude of the investor, and a more recent branch that is also called the *real option approach* to investment. An earlier result of the first branch is that investment may be negatively affected if the decision maker is risk averse (NICKELL 1978). Later research went into the direction of dynamic optimisation models under uncertainty, which could also incorporate elements of the adjustment cost approach (for example ABEL 1983, see also section 3.1.3 below). The second branch emphasises the value of waiting if investment is (partly) irreversible and can be delayed in order to obtain additional information about the future (DIXIT and PINDYCK 1994). In a world of uncertainty, it pays the decision maker to wait for the optimal time to exercise his (real) investment option.

All three approaches partially had stimulating effects on each other and continue to develop, but in some respects also appear to be mutually incompatible. For example, the contingent claim analysis of the DIXIT-PINDYCK model is implicitly based on perfect financial markets (LENSINK et al. 2001, pp. 115-6), and thus in conflict with the assumption of limited credit access made by the financial constraints model. I will go on to elaborate on the latter since it illuminates a number of effects credit rationing has on the dynamic allocation decisions of households. Furthermore, it provides an intuitive extension of the model described in the previous section.

There are four major changes to the two-period model presented in section 2.3.1. First, due to the multi-period planning horizon, the objective function of the decision maker has to be modified in order to account for the utility derived from future consumption in many periods. If the additive specification is maintained,

an analytically convenient and thus frequently applied objective function is defined as the integral of instantaneous utility discounted by a positive, subjective time preference rate, δ, over an infinite planning horizon (see WITZKE 1993, p. 252). The infinite planning horizon avoids the arbitrary choice of a terminal state and can be regarded as including the utility of future generations. Since the decision now has to be made about consumption *paths* and no longer about discrete consumption *bundles*, one speaks of an objective *functional* instead of an objective function (CHIANG 1992, p. 7).

A second key modification concerns the endogenisation of the capital stock Z in order to make investment a decision variable of the farmer. Investment is the *change* of capital over time, $\dot{Z} = I$, where the dot denotes marginal change over time. As in the previous section, the financial constraint restricts the adjustment of the capital stock to its long-term optimal level.

Third, the farmer is now able to *influence* his access to credit as the available credit ration is made dependent on the farm's equity, E. This is motivated by the screening and/or signalling function equity as a general form of collateral may have on imperfect loan markets (see the discussion in subchapters 2.1 and 2.2). Equity in turn is determined by the consumption choices of the farm household. Principally, there are several possible ways in which credit access can be made dependent on equity. STEIGUM (1983) introduces an interdependency between the *interest rate* and equity by conditioning interest on the debt-equity ratio $r = r(K/E)$. However, this formulation rules out credit rationing as a *quantity* restriction as it is understood in this monograph so far. I therefore choose a specification in which the credit ration is a *direct* function of equity, as in CHAMBERS and LOPEZ (1984). This version stresses the quantity aspect of credit rationing and assumes an exogenous, fixed interest rate. Under the assumption of a binding credit constraint, the choice of equity in a given period simultaneously determines (short-run) optimal capital and hence investment (CHAMBERS and LOPEZ 1984, p. 150). I introduce an *access to credit function* $K(E)$, which is assumed to be concave in E, hence $K'(E) > 0$ and $K''(E) < 0$. The implication is that more credit is dependent on the availability of equity, whereas the marginal credit increment decreases with increasing equity.

Finally, since the financing problem is now related to investment activities, variable inputs are neglected. Furthermore, household characteristics are for the moment assumed to be condensed in the time preference and are not otherwise considered explicitly. Since it plays no distinctive role in the analysis, the price of the consumption bundle is also dropped and assumed to be normalised to one.

The resulting model can be formalised as follows:[44]

$$\max \int_0^\infty u(c(t))e^{-\delta t}dt \text{ with respect to } c \text{ and } Z, \text{ both} > 0,$$

subject to

$$\dot{E} = M(E, p) + T - c \tag{2-48}$$

the budget constraint in each period, and $E_0 = \overline{E}$, the initial level of equity. T denotes public transfers, c is consumption in time period t, p denotes the output price, and $M(.)$ is farm income. The latter is defined as follows:

$$M(E, p) = pf(Z) - rK(E) \tag{2-49}$$

$f(Z)$ is the production function which is monotonous and concave in capital. For reasons of simplicity, depreciation and the price of capital goods are ignored. According to (2-48), each period's total income is hence allocated to either consumption, c, or savings (equity formation), $\dot{E}$. The credit constraint is expressed by the following equation:

$$Z - K(E) - E \leq 0 \tag{2-50}$$

The maximum level of capital is thus constrained by the sum of equity plus credit. All variables take on different values through time, however, again for reasons of simplicity, I neglect time subscript notation in the sequel.

The previous optimisation problem does *not* suggest that the household formulates an optimal plan in the base year and follows that plan in perpetuity (CHAMBERS and LOPEZ 1987, p. 370). A more appropriate interpretation is that the initial plan reflects the information available at that time, which is continuously updated and thus leads to a reformulation of the optimal plan. Apart from that, there is no explicit account taken of uncertainty, that is expectations are assumed to be static (for a discussion of this assumption see e.g. CHAMBERS and LOPEZ 1984, pp. 152-3).

The above model can be solved by methods of *optimal control theory* (KAMIEN and SCHWARTZ 1991; CHIANG 1992). By the maximum principle, a solution maximises the so-called Hamiltonian function, H, with regard to the control variables c and Z, for which optimal paths are sought. These control or decision

[44] I gratefully acknowledge the helpful comments Heinz Peter WITZKE made on an earlier version of the formal model.

variables influence the state variable *E*, whose motion is determined by the constraint (2-48). Similar to the Lagrangean multiplier in the static optimisation procedure applied in section 2.3.1, a costate variable λ is introduced which denotes the shadow price of the associated state variable. Other than the conventional static Lagrangean multiplier, in the current dynamic model, λ may take on different values in different periods.

In order to solve the above model I make one further assumption. I only consider cases in which the credit constraint is *exactly binding*, so that (2-50) becomes an equality (see CHAMBERS and LOPEZ 1984, p. 150). This allows to substitute (2-50) into the income function, which considerably simplifies the solution. As a consequence, *Z* is effectively *fixed* in the short run and can only be influenced by dynamic changes in *E*. The only remaining control variable is consumption *c*.

I employ the *current-value Hamiltonian* (CHIANG 1992, pp. 210-214) which is devoid of the discount factor and can be written as follows:

$$H = u(c) + \lambda(M(E, p) + T - c) \tag{2-51}$$

A solution if it exists must obey the first-order condition for a maximum, the equations of motion of the state and the costate variable, and the initial condition $E_0 = \overline{E}$:

$$\frac{\partial L}{\partial c} = \frac{\partial u}{\partial c} - \lambda = 0 \tag{2-52}$$

$$\dot{E} = M(E, p) + T - c \tag{2-48}$$

$$\dot{\lambda} = \lambda\left(\delta - \frac{\partial M}{\partial E}\right) \tag{2-53}$$

The intuition behind the structure of the model can be explained as follows. The dynamic problem is to choose between consumption now versus saving for consumption in future periods. This is visible in the current-value Hamiltonian, which is the sum of the utility from current consumption and the value of equity formation in terms of utility units evaluated at the shadow price λ. Equation (2-52) implies that in the optimum, the marginal rate of substitution between equity formation and consumption equals one.

Maximised income plus transfers in connection with current consumption choice in each period yield a *path of equity accumulation* via (2-48) and (2-53). While (2-48) simply restates the budget constraint according to which equity formation is the residual of income minus consumption, the motion of λ determines how

the dynamic decision problem is balanced over time. As long as the opportunity costs of foregoing consumption (or equity formation) as expressed by the time preference rate δ exceed the marginal income from equity $\partial M / \partial E$, λ will grow and vice versa. Hence, equity will be accumulated (reduced) until a *steady state equilibrium* is eventually reached, in which $\dot{E} = \dot{\lambda} = 0$. In the long run, the farmer chooses an equity level that maximises the difference between current utility from consumption plus future utility from equity formation on the one hand and the opportunity costs (in terms of utility) of acquiring that equity on the other (CHAMBERS and LOPEZ 1987, p. 372).[45]

Of particular interest here is the effect of the credit constraint on the household's investment behaviour. In case of a perfect capital market, the farmer could hire any amount of capital at the constant rate *r* and there were no restriction on *Z*. This would result in an optimality condition for *Z* identical to that for a variable input in the two-period model as discussed in the previous section. Under these conditions, no equity formation would be necessary, and current consumption would be entirely determined by farm income and public transfers.

I examine the case where credit access is marginally dependent on equity. (2-50) as an equality defines the relation between equity and capital, *Z*(*E*). The derivative of the latter is:

$$Z'(E) = K'(E) + 1 > 0 \tag{2-54}$$

Z(*E*) is thus increasing in *E* and investment has the following relation to equity formation (differentiate $Z = Z(E)$ with regard to *t*, application of chain rule):

$$\dot{Z} = Z'(E)\dot{E} \tag{2-55}$$

If the farmer is a net borrower, that is $\dot{Z} > \dot{E}$, (2-55) also determines the change in debt as $\dot{K} = \dot{Z} - \dot{E}$, which might be positive or negative. $\dot{Z}, \dot{K}$ and $\dot{E}$ all move in the same direction. STEIGUM (1983, p. 643) has shown in a slightly different framework that (2-55) can be approximated by a flexible accelerator (see (2-47)), with a speed of adjustment coefficient *B* determined by the parameters of the utility function and the income generation opportunities:

[45] If analysed in a two-variable phase diagram, the presented dynamic problem yields a *saddle point equilibrium* (CHIANG 1984, p. 633). The problem is a simplified version of models discussed in CHAMBERS and LOPEZ (1987) and WITZKE (1993, pp. 250-267). Both references provide a detailed graphical analysis; the latter also covers extensive formal comparative statics.

$$\dot{Z}(t) = B[Z^* - Z(t)] \tag{2-56}$$

In this equation, Z^* is the long-term, steady state capital stock. As STEIGUM (1983) notes, this results in an algebraically quite complex expression for *B*. It is however clear that the optimal capital stock is reached only after several periods of equity accumulation. The presence of financial constraints (or credit rationing in previous terminology) thus *hampers investment* and provides an explanation for slow capital adjustment.

Any effects of changes in parameters of the above model will induce the farmer to *gradually approach* the new steady state equilibrium over several periods, according to (2-53). This can be seen as follows. Substitution of the credit constraint into the income function results in the following:

$$M(E, p) = pf(K(E) + E) - rK(E) \tag{2-57}$$

Differentiating (2-57) with regard to *E* yields:

$$\frac{\partial M}{\partial E} = pf'*(K'+1) - rK' \tag{2-58}$$

For this expression holds that $\partial M / \partial E > 0$ and $\partial^2 M / \partial E^2 < 0$, since due to the credit constraint $pf' > r$.

Parameter changes can hence be analysed as follows. In a long-term or steady state equilibrium, the marginal income from equity equals the time preference rate, $\partial M / \partial E = \delta$, see (2-53). Parameter changes affect the marginal income from equity, via (2-58), which now differs from δ. The household hence adjusts its consumption choices in such a way that the resulting equity formation brings $\partial M / \partial E$ back into equilibrium with δ. Since the latter is exogenous, steady state capital and equity stocks are only affected by changes in those variables which influence short-run production. With regard to other variables (for example public transfers), there exists a type of long-term separability, although the capital market is imperfect (WITZKE 1993, p. 262).

It is now possible to analyse several effects of parameter changes in the model. I confine myself to verbal exposition, formal treatments of similar models are given by STEIGUM (1983), CHAMBERS and LOPEZ (1987), and WITZKE (1993, pp. 260-66). I assume that the system is in steady state equilibrium initially. In the framework of static price expectations, a change in *output price* acts like a shift in *farm technology*. The effect is intuitively as follows: an increase in the output price (an improvement of farm technology) immediately increases the marginal product of capital. $\partial M / \partial E$ therefore moves up. To achieve again equality with

the given time preference, it is optimal for the household to *gradually increase* the equity stock in the long run. Resources are hence diverted away from current consumption towards equity formation. This in turn relaxes the credit constraint, which leads to positive investment until the new steady state equilibrium is reached. The effect of an output price increase on investment is thus *positive*.

Next I consider an *improvement in access to credit* in the sense that the same equity level implies a larger credit ration. In a graph, $K(E)$ would hence be shifted upwards. Initially, this leads to a (mechanistic) expansion of the capital stock by debt financing. Since the credit constraint is assumed to be permanently binding, more capital is always desirable. In contrast to the previous paragraph, however, the effect on equity formation is negative. The reason is as follows. Positive investment results in a lower marginal product of capital. $\partial M / \partial E$ therefore drops. This tends to *reduce* equity formation in the long run, according to (2-53). The credit constraint hence tightens, and Z is reduced again. Improvements in access to credit have therefore *conflicting short- and long-term effects* on investment. This result is due to the fact that investment activities are only carried out to secure consumption in the future, they are no end in itself. If a larger share of funds comes from the debt market, equity is reduced accordingly. The net effect of an improved credit access on investment is ambiguous, depending on the magnitude of the credit shift and the precise shape of the production function.

An increase in *government transfers T* similarly has conflicting short- and long-term effects on investment. A discrete rise in T immediately provides additional equity for the household, which instantaneously reduces λ. According to (2-52), the additional funds are allocated to consumption and equity formation.[46] Increased equity makes capital less expensive and thus induces investment. However, a rise in equity also reduces $\partial M / \partial E$. As a consequence, by virtue of the long-term equilibrium condition (2-53), λ rises again. Equity is thus diverted away from the production sphere, which also reduces investment. By the condition that (2-53) equals zero, the additional transfer income is completely used up for consumption in the long run, and E again attains its initial level. Hence, as in the two-period model of section 2.3.1, *short-term liquidity effects* of an increase

[46] An increase in equity formation is the more plausible reaction which, in an analogous discussion of the effects of a consumption tax, is assumed to hold in general by CHAMBERS and LOPEZ (1987, p. 374). WITZKE (1993, p. 263), however, shows that the immediate effect of an increase in T on equity formation is undetermined a priori. This is due to the theoretical possibility that the direct expansion of the budget constraint (2-48) is overcompensated by an overshooting consumption effect triggered by the instantaneous drop in λ.

in public transfers are likely, but these effects are counteracted by a *contraction of output in later periods*. Since the increase in public transfers reduces the need for on-farm income generation, the new steady state shadow price of equity will be lower than before.

The main points of this section may be summarised as follows:

> In the dynamic financial constraints model, credit rationing causes *a lagged adjustment* of capital stocks to the steady state equilibrium. Optimal investment is *dependent on equity formation* of the household in terms of profit retention or savings. Investment is thus *neither separable from consumption decisions nor independent of the equity position* of the farm. Improvements in *access to credit* have ambiguous short- and long-term effects on investment. *Output price increases* unambiguously *stimulate farm investment*. Possible short-term liquidity effects of *government transfers* are counteracted by a subsequent *contractive* adjustment of farm output.

2.3.3 Summary and conclusions for further research

In this subchapter, I investigated how credit rationing affects production, investment, and consumption decisions in the framework of a two- and a multi-period farm household model, respectively. Furthermore, the effects of changed parameters on the optimal plan were studied. In contrast to the previous subchapter, the ultimate reasons for and mechanisms of credit rationing were disregarded and were taken as exogenously given. Only in the multi-period model, the farmer was able to influence his access to credit by means of equity (savings) formation.

In the two-period model, the introduction of a binding credit constraint led to similar problems as already outlined in subchapter 2.1 in the context of transaction costs. The market interest rate loses its relevance for household internal allocation of funds and is replaced by an endogenous, unobservable *shadow interest rate*. Compared with a first-best world without credit rationing, the household will *reduce output*, which implies a *loss of income*. An increase in *government transfers* relaxes the liquidity constraint and thus has *positive effects on farm output*.

In the multi-period model, credit rationing results in a positive *shadow price of equity*, since equity (for example as collateral) has a value for financing production in the future. *Investment cannot immediately attain its optimal level* due to credit rationing. The household thus *reduces current consumption* in favour of equity formation, which would be superfluous in the presence of a perfect capi-

tal market. Since the ultimate goal of the household is current and future consumption, possible *liquidity effects* on production as a result of increased public transfers are *only of a short-term nature*. Additional funds are likely to be consumed in the long run.

The presence of a perfect capital market allows the convenient separation of production or investment decisions on the one hand and consumption decisions on the other. Both models suggest that this *cannot be maintained* under a binding credit constraint, which has two important consequences. First, there is *no objective criterion anymore* which allows to assess the (private) efficiency of input use or investment activities. Both decision complexes can only be made *simultaneously* with the household's consumption plan and are thus affected by the household's preferences. Second, any *empirical production or investment analysis* has to *take these interdependencies into account*. Household preferences have to be made amenable to measurement and must not be neglected in the analysis.

Generally, the models presented in this subchapter provide a number of starting points for the further empirical analysis. These include *household demand* and *supply functions* as well as *production functions* which can be quantified by econometric methods. Furthermore, the postulated interdependencies between the consumption and the production/investment sphere of the household can be subjected to *empirical tests*. Both strategies are aimed at a quantification of credit rationing effects on the sector level and will be explained in the following chapter.

3 EMPIRICAL RESEARCH METHODOLOGY

The goal of the present chapter is to explain the methodological approach of the empirical investigation conducted in this research. The chapter is guided by the aim to make the theoretical considerations of the previous chapter fruitful for the analysis of the real world problems outlined in the introduction to this monograph. This requires the discussion of a number of methodological issues involved in the empirical analysis of credit rationing. I proceed as follows. First, in subchapter 3.1, I will clarify the objectives of the empirical investigation and provide some methodological background information. This will inter alia make clear that any empirical methodology is intimately linked to the availability and quality of the data it draws on. Data issues are therefore considered next, in subchapter 3.2. The latter paves the way for subchapter 3.3 in which the approach chosen in this research is presented and discussed.

3.1 Research objectives and methodological background

In this subchapter I want to specify the objectives of the empirical investigation and explain the background of the chosen research strategy. The latter will include a brief discussion of major approaches found in the literature.

3.1.1 Objectives of the empirical investigation

The empirical analysis of this research aims at addressing the issues raised in the introduction by a theoretically and methodologically informed examination of real world observations. Apart from the initial research questions posed in subchapter 1.3, p. 11, the theoretical findings as summarised in sections 2.1.6, 2.2.4, and 2.3.3 are of particular relevance in this respect. The objectives of the empirical research can be restated as follows:

1. A first fundamental objective of the empirical analysis is to detect *whether there is* any credit rationing of Polish farm households at all. From a methodological point of view this requires to develop an *operational definition* of credit rationing and a *strategy how this definition can be made useful* for an empirical analysis of credit rationing.
2. A second objective concerns the investigation of the *causes* of credit rationing if its presence has been successfully detected. These causes will be of decisive relevance for any *policy advice* with regard to future government action.

3. Finally, based on a theoretical understanding of how credit access affects economic decisions of farmers, the empirical analysis shall quantify the *effects* of credit rationing on production and investment outcomes of Polish farm households. At the same time, this should allow an *assessment of the current policy environment* on rural credit markets in Poland with regard to the performance of farms.

The methodological implications of these objectives will be discussed in the following sections of this chapter. To ease the understanding of these implications, I continue with some comments on the location of my approach in the wider field of social science methodology.

3.1.2 On the methodological foundations of (agricultural) economics

In 1776, Adam SMITH published his thoughts on how individual behaviour of economic agents steers the resource allocation of society in the classical text 'The Wealth of Nations' (see section 2.1.2, p. 24). This is commonly regarded as the birthday of modern economic science and happened at a time where successful research in the natural sciences begun to provide the basis for the industrial revolution and thus had a large influence on daily life. Not by chance, the practice to discover physical laws – of which the axioms of Newtonian physics are a prominent example – by experimental research had a lasting effect on the young profession of economics. There was a widely held view among the classical economists that the social and economic system of society should obey general laws similar to those found in the natural sciences (ALBERT 1979, pp. 52-53). The research methodology of the natural sciences thus soon became a blueprint for economics as a scientific enterprise.[47]

According to this methodology, for example as formalised in the famous scheme due to HEMPEL and OPPENHEIM, the process of scientific explanation involves the logical deduction of a statement about some real world event from a description of a set of initial conditions plus a *universal law* (see BLAUG 1992, pp. 4-5).[48] This methodological view holds that any scientific explanation at the same

[47] RICHTER (1994, p. 592), in a retrospective on the methodological views held among economists in Germany in the 1960's, reports the following: "We were marked by the desire to apply the analytical style of the natural sciences [...] to our subject area, so as in that way to emulate the great successes of the natural sciences".

[48] For example, the universal law may take the form: "in all cases where event A occurs, event B also occurs." The initial condition may be: "event A occurs". Taken together, by way of deductive logic, it is possible to *explain* the occurrence of an observed event B by referring to the initial condition and the universal law.

time allows the *prediction* of future events, as soon as the initial conditions and the universal law are known. As a consequence, a first crucial question is under what circumstances a postulated law may claim to be universally true. An influential view in the philosophy of science maintained by representatives of a positivist tradition is that there is only *one* criterion decisive for the truth content of a proposition: the *empirical evidence*. Only statements that are backed by empirical observation or experiment may claim to be universal laws and thus deserve to be called 'scientific'. This implies a second important question: how can the required empirical evidence be furnished? Again, there is a widely acknowledged position laid down in Karl POPPER's 'Logic of Scientific Discovery' ('Logik der Forschung' in German, (1994 [1934])) and known under the labels of 'falsificationism' or 'critical rationalism', which will be outlined briefly.

The key to POPPER's methodology is his assertion that the empirical content of theories can only be tested by attempting to *falsify* them, since conclusive *verification* is logically impossible (see BLAUG 1992, pp. 12-26). A theory is the more corroborated and hence scientific the more empirical tests it has resisted without refutation. Although (or because) there are no 'crucial experiments' which once and for all refute theoretical propositions (the so-called Duhem-Quine thesis), POPPER recommends to be as precise about the circumstances (empirical events) under which a theory can be regarded as falsified. In a Popperanian view, it is thus good scientific practice to maximise the empirical testability of scientific statements. On the other hand, such auxiliary hypotheses are to be avoided which reduce the applicability or testability of the theory, for example in the form of unspecified ceteris paribus clauses or ad hoc modifications.

A cursory glance at the major economics journals today (and probably also at several previous sections of this monograph) leaves the impression that the precision of mathematically formulated, universal laws is what indeed characterises the research process in economics. Furthermore, the branch of *econometrics* apparently offers the promising opportunity to subject any theoretical reasoning in economics to a rigorous empirical test. Probably for one or both of these reasons, the majority of economists seems to implicitly or explicitly accept POPPER's critical rationalism as the relevant research methodology.[49]

[49] This might be exemplified by a look at an arbitrary selection of widely used economic textbooks. In the third edition of their 'Structure of Economics', SILBERBERG and SUEN (2000) assert that (p. 6, italics by myself): "[E]conomics is that discipline within social science that seeks *refutable* explanations of changes in human events on the basis of changes in observable constraints, utilizing *universal postulates* of behavior and technology, and the

But *do* economists in fact *practice* what they preach? And *can* they? There is an ongoing debate concerning both questions, and the alternative methodological positions are more or less fundamentally different from the mainstream, depending on whether only the first or both questions are answered negatively. I will briefly present a number of positions in the following.

BLAUG (1992) is one of the most articulate contributors in favour of a stronger commitment to falsificationism in economics.[50] Though he obviously believes that economists *can* practice falsificationsim (p. xv), he complains that they

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simplifying assumption that the unmeasured variables ('tastes') remain constant." LIPSEY and CHRYSTAL (1995), in the eighth edition of 'Positive Economics', write (p. xii): "Economic theory is meant to be about the real world. Economists seek, by the use of theory, to explain, understand, and predict real-world phenomena, and theory must therefore be related to, and tested by, empirical observations." PINDYCK and RUBINFELD (1995), in the third edition of their 'Microeconomics', note that (pp. 4-5; italics in the original): "Like any science, economics is concerned with the *explanation* and *prediction* of observed phenomena. [...] The usefulness and validity of a theory depend on whether it succeeds in explaining and predicting the set of phenomena that it is intended to explain and predict. Consistent with this goal, theories are continually tested against observation. As a result of this testing, theories are often modified or refined or even discarded. The process of testing and refining theories is central to the development of economics as a science." German textbooks are even more explicit. WOLL (1993), in the eleventh edition of 'Allgemeine Volkswirtschaftslehre', ascertains (p. 13): "Unsere Kenntnis von der Realität wird vor allem dadurch gefördert, daß an die Stelle bisher unsicherer Theorien neue, empirisch hinreichend bestätigte Aussagensysteme treten. Dazu ist es nötig, die vorhandenen Theorien ständigen Falsifizierungsversuchen zu unterwerfen. (Our knowledge of reality is particularly improved by replacing previously uncertain theories by new, empirically sufficiently corroborated systems of statements. To achieve this goal, existing theories must be continuosly subjected to falsification attempts (translation by myself).)" He continues on p. 27: "Die empirische Überprüfung ökonomischer Hypothesen [...] fällt in das Aufgabengebiet der Ökonometrie. (the empirical testing of hypotheses [...] falls in the domain of econometrics)." Finally, KOESTER (1992), in the second edition of 'Grundzüge der landwirtschaftlichen Marktlehre' spends more than six pages (pp. 5-11) on explaining how POPPER's methodological positions define the empirical approach of agricultural economics. He opens his considerations with the statement (p. 5; italics in the original): "Nach den grundlegenden Ausführungen von *Popper* wird heute allgemein mit Hilfe der deduktiven Methode gearbeitet und das im folgenden dargestellte Vorgehen akzeptiert. (following the fundamental considerations of Popper today's scientists commonly work with the deductive method and accept the approach presented in the sequel (translation by myself).)"

[50] In Germany, a methodologically similar position is held by BRINKMANN (1997). FOX and KIVANDA (1994) support a falsificationist view with regard to production analysis in agriculture. See also the comment by CLARK and COYLE (1994).

don't (p. 111). After rigorously examining the methodological background of many important fields of economics in the sequel, he sums up his criticism in the form of two major conclusions (p. 238): (a) economic theories are not formulated in such a way that they yield empirically refutable implications, and (b) there generally is too little empirical testing of economic theories. BLAUG's position may be illustrated by the following passage on general equilibrium (GE) theory, which was already mentioned in section 2.1.2 as a presumed landmark of economic thought (BLAUG 1992, p. 169):

> "Enormous intellectual resources have been invested in its [GE theory, M.P.] endless refinements, none of which has even provided a fruitful starting point from which to approach a substantive explanation of the workings of an economic system. Its leading characteristic has been the endless formalization of purely logical problems without the slightest regard for the production of falsifiable theorems about actual economic behaviour, which, we insist, remains the fundamental task of economics. The widespread belief that every economic theory must be fitted into the GE mold if it is to qualify as rigorous science has perhaps been more responsible than any other intellectual force for the purely abstract and nonempirical character of so much of modern economic reasoning."

In contrast, *agricultural* economists were supposed to have always maintained a close relationship to the research field they were studying; probably more than economists of other branches. This was made almost proverbial by the assessment of LEONTIEF (1971, p. 5), according to whom agricultural economists, "[w]hen they speak of crop rotation, fertilizers, or alternative harvesting techniques, they usually know, sometimes from personal experience, what they are talking about."[51] Agricultural economists hence can hardly be accused of being entirely abstract and non-empirical. Despite this commendatory assertion, there is a growing scepticism in this applied tradition with regard to the value of economic theory for the understanding and prediction of real world phenomena. A prominent example in the German context is BRANDES (1985; 1989).

A major aim of BRANDES is to point to the limitations of what he calls 'armchair economics' ('Schreibtisch-Ökonomie' in German). By taking the agricultural sector as example, he demonstrates that current economic theories of farmers' behaviour are not capable of accurately predicting individual response to changing environments (BRANDES 1985, pp. 60-62; 1989, p. 334). On the sectoral or aggregate level, the reliability of forecasting may improve, however, also the danger of mutually compensating errors in the analysis increases (1985, p. 110).

[51] In a recent comment on the broadening of research fields agricultural economists deal with, this favourable assessment was however called into question by HANF (1997, p. 573).

In his considerations on scientific methodology, BRANDES' initial position seems to be basically Popperian since he emphasises the search for an empirically grounded, scientific explanation of economic behaviour (1985, pp. 114-120; 144). At the same time, he is fully aware of the fact that it is fraught with problems to follow this path in economics. I list three major groups of arguments why it is so difficult to make economics a 'hard science' (an expression used by MAYER 1980), since they are of relevance for the further discussion (I refer to BRANDES 1985, pp. 76-81; 123-130; 156-159): (a) it is usually regarded as being impossible to devise controlled experiments in economics, it is hence quite difficult to test a given hypothesis in isolation from the surrounding auxiliary assumptions; (b) in economics, there are no constant numerical relationships as in physics, and any 'laws' are only of a stochastic nature; (c) there is a wide range of possibilities to manipulate empirical models in order to obtain a desired result, a practice also called 'data mining'. The latter means the arbitrary and intransparent choice of the researcher to publish his favourable result out of a pool of estimates with possibly largely diverging implications.

All three points in some respect concern the role *econometric analysis* plays in the methodological approach of economics. As a supplement to the assessment by BRANDES, I want to highlight a number of reasons why it must be seriously doubted that econometrics can play the empirical judge for economic theories (see SCHOR 1991, pp. 54-56; 151-152):

1. The first step of econometric analysis concerns the operationalisation of the theory to allow its connection with observable data. Often the data employed in the empirical model corresponds *only crudely* to the concepts in the theory, or relevant and reliable data may *not be available* at all. Several frequently used concepts have *no measurable counterpart*, for example risk aversion or technical progress. Astonishingly, the various *sources of error in data collection* are often neglected even by applied economists (BRINKMANN 1997, pp. 176-189; a comprehensive description of these errors is GROVES 1989).

2. In a second step, the econometric model to be tested is specified, that is the precise qualitative structure of the relationship between right- and left-hand variables is determined. A premise for this specification is the *assumption* that *one knows* the true qualitative nature of the underlying structure. However, this is usually not the case. Correlation is not causation (DEATON 1997, p. 65), and a given theory may be represented by a variety of models or functional forms. There is a substantial danger that relevant exogenous variables are omitted or that irrelevant ones are included, which compromises any re-

gression analysis due to *specification error*. LEAMER (1978) has criticised the intransparent search for the 'best' fit (the one that confirms the theory – or falsifies it?) as 'ad hoc inference' without any clearly articulated procedure. If there is no criterion determining which of the models is correct, it is impossible to conclusively reject any theory based on the obtained estimates.

3. Next, the parameters of the empirical model are quantified by employing an appropriate estimator. The estimation may often be impossible without various *auxiliary assumptions* or simplifications. An example is the *identification problem* if systems of equations are underidentified, which necessarily requires additional theoretical assumptions (HSIAO 1983). It is clear that the validity of a theory cannot be tested if it is the constituting assumption of the test. Identification may also be increasingly difficult if, as a measure to improve model precision, formerly exogenous variables are endogenised and hence explained by other exogenous variables.

4. A final remark concerns the use (or abuse) of significance tests in econometrics. It must be stressed that there is *no objective criterion* that allows to maintain or reject a certain hypothesis. If probabilistic relationships are examined, there is a clear trade-off between the risk of committing a type I error (reject a correct hypothesis) and a type II error (accept a false hypothesis). *Both are relevant*, though the latter is usually neglected (see MAYER 1993, pp. 132-151). The commonly used levels of statistical significance are only based on *convention*, and thus a completely arbitrary choice. MCCLOSKEY (1985), by asking the question 'how large is large?' (p. 142), stresses that whether or not a coefficient is significant is not a statistical problem (p. 163). Instead, he emphasises the importance to evaluate the *benefits or costs for society* if a certain hypothesis is rejected or accepted, for example by specifying a loss function (p. 158). This, in turn, will clearly involve several normative judgements. As a consequence, there is no 'objective' line between science and non-science left.

The purpose of this is of course not to banish econometrics from the toolbox of the economist. Econometric analysis remains a powerful instrument to confront economic theories with empirical facts. What should be acknowledged, however, is the following:

> It seems expected far too much of econometrics to be the fundamental benchmark for the falsification of theories. Because econometrics is regarded as the only convincing tool to potentially falsify theories (BLAUG 1992, p. 245), the methodological standpoint of critical rationalism becomes *unten-*

able for economics. Furthermore, even if the demand on econometric analysis is more modest, a good deal of openness and honesty is required to make any results credible.

At this point of the examination, it appears useful to refer to the *conclusions* BRANDES arrives at, which are in my view as follows:

1. It is necessary to overcome the existing *theoretical deficit* by developing theories that are more capable of explaining economic behaviour in the real world (BRANDES 1985, p. 167). At the same time, economists should become more humble with respect to the performance of their profession (1985, p. 216).
2. More attention should be paid to *empirical work*. This includes on the one hand more transparency and openness in the publication of conventional approaches, particularly in econometrics (1985, pp. 183-188). On the other hand, it also implies to increase efforts to directly investigate economic behaviour, for example by field studies or experiments (1985, pp. 168-172; 188-200).
3. The aim of economics to be a *hard science* that produces objective knowledge must be questioned (1989, p. 336) because it is regarded as impossible to follow the strict rules of falsificationism (1985, p. 124). The belief in a universally accepted, 'scientific method' should thus be openly replaced by a more subjectivistic and pragmatic attitude (1985, pp. 130-136; 162-164).

It would be a rewarding task to analyse the development of the past fifteen years since BRANDES' (1985) publication in the light of his previously summarised critique. However, from the perspective of my own work, I confine myself to the following remarks.

With regard to theory, I have already stressed the increasing willingness of economists to adapt their models to the 'irritating observations of the real world' (WITZKE 1993, p. 53), see section 2.1.3, p. 30. Of particular importance for this monograph is the rapidly growing field of the 'New Institutional Economics' (NIE), of which a selection of results was discussed in the previous chapter. Whether the deviation from the neoclassical benchmark is merely gradual or principal is a second question (see BRANDES et al. 1997, p. 320); currently there exist efforts to push the frontier of knowledge in both directions (see section 5.2.2, pp. 201 et seq. below).

Unfortunately, the hope that the closer proximity to real world phenomena improves the testability of theoretical approaches of the NIE seems unjustified. As

TERBERGER (1994, pp. 143-151) argues, the empirical testability of NIE concepts may even have decreased in comparison to that of the orthodox neoclassical tradition: (a) unobservable factors play an even larger role in NIE, for example the general assumption of utility instead of profit maximisation, the informational status of agents, or the possibility of bounded rationality; (b) as a result of these modifications, even less observable events can be excluded by theoretical arguments (see the diverging effects of various forms of information asymmetry on credit market outcomes in section 2.2.3, pp. 63 et seq.); (c) concepts that appear to be simple to operationalise at first sight turn out to be rather vague after a second thought (see the reflections on 'transaction costs' at the end of section 2.1.5 above). In addition, several reservations concerning econometric analysis as expressed above apply even more for models derived from NIE theories. This particularly concerns the risk of specification errors, since postulated relationships may be highly non-linear, and even less might be known about functional forms in institutional economics than it is, for example, in applied production analysis. The further discussion in this chapter will illustrate these points.

On the other hand, it seems fair to say that contemporary econometricians care a lot more about the sources of error outlined above than it was the case a few decades ago (see MAYER 1993, p. 145). It is now an emerging standard in introductory econometric textbooks to refer to the danger of data mining and to acquaint the reader with available testing procedures (see for example JOHNSTON and DINARDO 1997, chapter 4, particularly pp. 109; 112). At the same time, expectations with regard to the power of causal interference in econometrics have become more modest, and increasing attention is paid to the procedures of survey design and data collection. This is particularly true for researchers who deal with large sets of micro-data. A case in point are the huge amounts of data collected by the World Bank in the framework of the Living Standards Measurement Study. DEATON (1997, pp. 65-66), in his textbook on survey data analysis, comments on the problems involved by citing FREEDMAN (1991): "'[...] statistical technique can seldom be an adequate substitute for good design, relevant data, and testing predictions against reality in a variety of settings.' " DEATON continues his introduction to econometric methods as follows:

> "One of my aims [...] is to clarify the often rather limited conditions under which the various econometric techniques work, and to indicate some more realistic alternatives, even if they promise less. A good starting point for all econometric work is the (obvious) realization that it is not always possible to make the desired inferences with the data to hand. Nevertheless, even if we must sometimes give up on causal inference, much can be learned from careful inspection and description of data [...]."

Again, this is not to say that causal interference in econometrics is an undesirable goal. Much of what follows in this monograph is still committed to this kind of analysis. However, it again demonstrates the possible limitations of empirical analysis in economics.[52]

This brings me to the last point in this section, which concerns the adequate methodological standpoint in economics. If critical rationalism cannot be the benchmark for economists, the natural question arises what will take its part. I will not review the entire and rather dispersed field of current thinking about economic methodology (the interested reader is referred to surveys such as BLAUG 1992 or CALDWELL 1994).[53] However, I want to point the reader to an influential strand of thought introduced by MCCLOSKEY (1983) as 'rhetoric of economics' and developed further towards a methodological position of 'pragmatic instrumentalism' by SCHOR (1991).

MCCLOSKEY (1983, 1985) shares most of the critique of traditional methodology in spirit of the natural sciences as outlined above; a methodology he calls 'modernist'. He insists that the 'modernist' rules of scientific reasoning are not cogent, are counterproductive to any scientific progress in economics, and, in particular, are not followed by economists (1983, pp. 484-493). The problem he sees is that economists *do not recognise* the fact that the prescriptions of traditional methodology "are apparently not the grounds for their scientific conviction" (p. 482). What economists in fact practise, MCCLOSKEY argues, is *persuading their auditorium* by a *specific rhetoric of economics*. Following BOOTH, he understands rhetoric as " 'the art of probing what men believe they ought to believe, rather than proving what is true according to abstract methods.' " In his view, this 'unofficial methodology' is neither sufficiently acknowledged nor examined more closely by the profession, although it should. A central claim of MCCLOSKEY is that economists should become aware of the rhetoric they are using, which to a substantial extent consists of metaphors, even if the language of mathematics is used. He takes the production function as an example (1983, pp. 505-506):

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[52] It should be noted that conducting *laboratory experiments* has become a quite widespread methodological approach in economics which clearly has left the stage of infancy (for an overview see KAGEL and ROTH 1995). Vernon L. SMITH as a major proponent was awarded the Nobel prize in 2002. However, in my opinion, an important problem not yet solved in a satisfying way is how results gained in the laboratory can be generalised to be valid in given real world situations (the problem of external validity, see FRIEDMAN and SUNDER 1994, pp. 15-16).

[53] A brief and up-to-date overview is HANDS (2001).

> "Consider [...] the theory of production functions. Its vocabulary is intrinsically metaphorical. 'Aggregate capital' involves an analogy of 'capital' (itself analogical) with something – sand, bricks, shmoos – that can be 'added' in a meaningful way; so does 'aggregate labour,' with the additional peculiarity that the thing added is no thing, but hours of conscientious attentiveness; the very idea of a 'production function' involves an astonishing analogy to the subject, the fabrication of things, about which it is appropriate to think in terms of ingenuity, discipline, and planning, with the modifier, a mathematical function, about it is appropriate to think in terms of height, shape, and single valuedness."

If metaphors are essential to economic thinking, MCCLOSKEY continues, these metaphors should be openly recognised and examined, but not be banished. For him the consequence to draw from a better understanding of economists' rhetoric is to avoid any discrimination of allegedly 'non-scientific' arguments, and to open economics "to a wider range of discourse" (p. 493). What counts in the end is the persuasiveness of argument: "There are some subjective, soft, vague propositions that are more persuasive than some objective, hard, precise propositions" (p. 511). MCCLOSKEY concludes that the recognition of this fact will, due to more transparency and honesty, also contribute to a better quality of research and teaching (pp. 512-515).

SCHOR (1991) takes these rather provocative claims as a starting point for the development of a more fully articulated, methodological position of what he calls 'pragmatic instrumentalism' (pp. 103-140). According to its very name, the key characteristics of this position are (a) a close *proximity to the object of investigation* (in opposition to an abstract 'scientific rule' of positivist methodology), and (b) the recognition of scientific reasoning as an *instrument of argumentation* within the scientific community (rather than a universally valid explanation of the real world). A major stepping stone in SCHOR's argumentation is the so-called 'linguistic turn' in the philosophy of science, according to which there is no real world existing independently of a system of language, and the relationship between language and real world cannot be examined without referring to the context in which a speech product originated (SCHOR 1991, p. 106).[54] It is hence regarded as impossible to assess an abstract theory without reference to the individuals by whom it is constructed and employed. The purpose of theories is no longer to formalise truth claims, but, more modestly, to structure and

[54] Since my exposition at this point has more the form of a digression, it must necessarily be crude and simplifying. The reader interested in the broader background of the philosophy of social science is referred to the recent introductory survey by BENTON and CRAIB (2001).

communicate relevant problems identified by the scientist *in a way that others find plausible or persuasive*.

A question largely left unanswered so far is *what makes* an argument plausible. If producing plausible statements about some real phenomena is the purpose of economic reasoning, it is natural to ask what kind of benchmark distinguishes plausible from less plausible statements. SCHOR (1991, pp. 119-124) claims that a theory is plausible if its user *recognises the correspondence between the theory and his subjective knowledge or understanding of the real world*. Subjective knowledge consists both of individual perception (for example based on intuition or introspection) *and* empirical facts (for example based on experimental measurement or observation). A plausible theory connects its content with the user's subjective knowledge by means of analogy or metaphors. There are no formal or objective criteria determining whether an analogy is valid, this is decided upon by the subjective perception of the auditorium alone. However, according to SCHOR, a theory is to be preferred among others with otherwise the same properties if it has a *larger target area* for *questioning its premises and implications* (p. 134). A good theory hence *promotes the interaction process* between its content and the auditorium, for example by the use of well chosen metaphors.[55]

Against this background, the 'traditional' methods of economic reasoning are relieved from the burden of being imperfect tools for a positivist methodology. However, in the view of pragmatic instrumentalism, their specific strengths is now ascribed a new quality (SCHOR 1991, pp. 162-176). The widespread use of *mathematical models* in economics, for example, may be regarded as an obvious hint for the reader that this is no description of reality but a fiction, an idealising metaphor of real world events. By formulating a theory in mathematical terms, the degree of unambiguity and consistency is clearly raised, which in turn increases the target area for questioning and probing. Furthermore, mathematical language has the advantage of being easily communicated and widely understood. All this is desirable for a methodology of pragmatic instrumentalism. Similarly, *econometric modelling* is now assessed with regard to its persuasiveness and plausibility, but no longer seen as the fundamental judge for the falsifi-

[55] To elaborate on the philosophical debate about the interconnection between social reality and language is beyond the scope of this monograph. Inter alia, SCHOR (1991) draws on work by HABERMAS who, roughly speaking, takes language as a model for democracy. The properties of language can be used to derive an 'ideal speech situation', which creates a standard for assessing real world communication processes (BENTON and CRAIB 2001, p. 115). See also HABERMAS (1999).

cation of theories. The assumption that one knows the real structure of an econometric model simply serves as a means of argumentation, but does no longer claim any universal validity or truth. However, econometricians should be aware of the rhetoric they are using, which implies to make transparent the limitations of the employed statistical techniques.

I would like to conclude this section with a more personal statement. When I started the empirical work for this thesis, I was fascinated by the Popperian view of critical rationalism and its methodological rules of putting theories to the empirical test, and I still am. However, when writing these lines, I am convinced of the following two points: neither does this research pursue a falsificationist approach, nor can falsificationism be regarded as the mainstream method that is practised by the majority of economists. It is presumably much closer to the truth that this research (even more so as a doctoral thesis) does what contemporary agricultural economists *find plausible*, and thus follows a much more pragmatic and instrumentalist track.[56]

3.1.3 A survey of methods[57]

After the digression of the former subchapter I now return to the more narrow objectives of the thesis. In this section, I want to fit the research into the framework of empirical economic analysis constituting the background of this study. I therefore review the available literature on the topic. In the following section, I will explain the choice of the empirical approach for my own research, which will be further developed in subchapter 3.3, pp. 144 et seq.

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[56] In how far this entire debate has been acknowledged by agricultural economists in Germany is an open question. HANF (1996, pp. 47-48) suspects that the critical writings of MCCLOSKEY and others have contributed to the decision of a number of (European) researchers to leave the conventional formulation of the neoclassical theory of the firm in favour of a more comprehensive household modelling approach. Among others, HANF mentions the work of HENNING (1994) and WITZKE (1993). This conjecture might be doubted on two grounds. First, the household modelling framework can safely be regarded as one of the most modest modifications of traditional theory (see section 2.1.3 above and the following discussion in this monograph). Accordingly, WITZKE (1993, p. 17) sees the modifications he discusses primarily as *extensions of* (and not alternatives to) standard microeconomic theory, so that HANF's examples lend no support to his claim. Second, HENNING (1994, p. 21) himself openly declares his commitment to critical rationalism at the outset of his thesis. Although the consequences of this commitment are not particularly visible in the thesis, this is clearly a position opposite to MCCLOSKEY.

[57] This section is based on PETRICK (2004b). It benefited from helpful comments by Stephan BROSIG and Laure LATRUFFE.

Before examining the recent literature, it seems useful to develop a number of criteria on which to base the choice of method. In line with the research objectives stated in section 3.1.1, p. 102, and the theoretical consideration of the previous chapter, I establish the following standards:

1. Based on an operational definition, the approach should allow the empirical measurement (quantification) of credit rationing of farm households.
2. The approach should somehow address the problem of defining an appropriate efficiency concept of financial intermediation on rural credit markets.
3. It must take into account the (non-)availability of data on Polish farm households.
4. It should lend itself to plausible methods of data analysis that allow the examination of causes and effects of credit rationing and how credit rationing is itself influenced by the structural and policy environment of farm households.

In my opinion, the recent literature on the topic allows to distinguish six approaches to the empirical investigation of credit rationing:

1. A direct method based on measurement of loan transaction costs,
2. a direct method based on qualitative information collected in interviews,
3. a direct method based on the credit limit concept,
4. a direct method based on spill-over effects,
5. an indirect method based on econometric household modelling,
6. an indirect method based on an econometric analysis of dynamic investment decisions.

Direct methods are characterised by the fact that they immediately utilise observations made in the field, while *indirect* methods analyse the consequences of credit rationing by means of econometric modelling. However, there are a number of interdependencies between both types, because the two indirect methods usually are dependent on additional information provided by direct methods. I briefly explain the six approaches in the following. I will focus on applications to *rural* credit markets and refer to the general literature only where it seems appropriate. How far the previously used methods comply with the above criteria will be examined as a part of the subsequent discussion, which will in particular show that the definitions of credit rationing vary between approaches. Some of

the econometric methods mentioned in the sequel are explained in more detail in subchapters 3.2 and 3.3.

Approach 1: Direct measurement of loan transaction costs

This method prescribes to directly collect information about additional, loan specific transaction costs borrowers face apart from nominal interest rates, such as costs of information collection, loan application, insurance of collateral, etc. The approach was already introduced in section 2.1.4 above, pp. 32 et seq., together with a number of applications mainly in developing countries. Observed transaction costs may well make investment unprofitable and thus lead to exclusion of borrowers who might have been in a position to repay nominal interest rates. The explicit reason for credit rationing in this approach is thus that the price a borrower faces is effectively too high for him to pay.[58] In case that these non-interest transaction costs are not 'naturally' associated with financial intermediation (ADAMS 1993, p. 4), they may be taken as an *indicator for the efficiency of credit markets* (as proposed by R.L. MEYER and CUEVAS 1992, p. 310). Which transaction costs are necessary is of course difficult to distinguish; ADAMS (1993) argues that costs associated with regulation or loan targeting do *not* fall under this category.

CUEVAS and GRAHAM (1986) provide an analysis of *determinants* of transaction costs of a sample of farms in Honduras, based on a generalised power function. Their results indicate that transaction costs as percentage of loan amount decrease with loan size, decline with increases in the interest rate, and are higher for private bank loans than development bank loans (p. 685).

SAITO and VILLANUEVA (1981) in their examination of the Philippine credit market take a slightly different approach in that they analyse capital and transaction costs of small farm lending that are *internal to the bank*. They conclude that

[58] Initially, high transaction costs have appeared as an argument for credit rationing in environments where there are governmentally imposed interest rate ceilings (see section 2.1.4 and LADMAN 1984, p. 107). Later contributions use this argument in a more general context of financial intermediation that seems to be independent of certain interest policies (e.g. CUEVAS and GRAHAM 1986; R.L. MEYER and CUEVAS 1992). The following quote documents that the literature on the current approach is imprecise with regard to the question of whether credit rationing works through a quantity or a price mechanism: "In this paper we investigate the role of transaction costs of borrowing as a rationing mechanism in the agricultural credit markets of five less-developed countries. We show that borrowing transaction costs become an effective *non-price* rationing device in these markets" (CUEVAS and GRAHAM 1986, p. 680; italics added).

these costs are much higher than for large-scale industry lending, which should be reflected in nominal interest rates.

A crucial question in assessing the value of this method for measuring credit rationing is thus how far transaction costs are included into the nominal interest rate, and how far these costs are inevitable. More liberal government policies may imply that transaction costs *are* in fact included in nominal interest rates, which says little about whether they are inevitable or not (see BESLEY 1994, 1995). If they are included, an efficiency analysis has to start with the financial intermediaries themselves (see KHITARISHVILI 2000 for such a study on Polish co-operative banking).

The method is assessed as follows:

- The method requires collection of specific information in field surveys. Non-interest transaction costs should be included in the calculation of the effective costs of each borrower to obtain a relevant price variable. Their collection is therefore highly recommendable. At the same time, this procedure is less satisfactorily on theoretical grounds, since opportunity costs are almost impossible to measure (see section 2.1.5 above, pp. 38 et seq.). A pragmatic operationalisation is thus necessary.
- Furthermore, the validity of the share of transaction costs in total lending costs as an indicator of market efficiency depends highly on the pricing policy of the respective bank (that is which costs are effectively passed on as part of the nominal interest rate and which accrue in addition to that). Since this is likely to be different for different banks, comparisons cannot necessarily be made and the indicator is thus of limited value.
- The absolute value of effective interest rates is also a difficult measure since it might be impossible to distinguish which costs reflect real expenses necessary for loan appraisal, monitoring, etc., and which are simply slack in the intermediation process. The theoretical discussion in chapter 2 suggests that there is no agreement in the literature how far certain costs are in fact avoidable.

As a conclusion, this approach rightly stresses the importance of transaction costs in rural credit markets. However, in my opinion, it provides no adequate method to measure credit rationing. Due to its conceptual difficulties, it is regarded as inappropriate to analyse the determinants of credit rationing in terms of a cause-effect relationship.

Approach 2: Analysis of qualitative information collected in interviews

The idea of this method is to directly ask borrowers whether they would have liked to borrow more at the prevailing interest rate. In case of a positive answer, respondents are classified as 'credit-constrained'. The same applies to non-borrowers who respond that they could not get credit although they liked to. This method to my knowledge was first applied by FEDER et al. (1989 and 1990) and, presumably independently, by JAPPELLI (1990). FEDER et al. (1989) provide empirical evidence that this indicator is a reliable measure of liquidity shortages in their sample of 600 Chinese farm households, where liquidity is defined as the sum of savings, cash, and fungible credit.

While the paper of FEDER et al. (1989) is at last driven by the desire to support policy formulation that stimulates *production*, JAPPELLI (1990) has a theoretically differently motivated point of departure. His aim is to analyse the characteristics of credit-constrained households in the U.S. economy in order to challenge the life-cycle model of *consumption*. The life-cycle model in its simple form claims that current consumption is independent of current income – an independence that breaks down in the presence of binding borrowing constraints. Theoretically, an appropriate strategy would be to estimate a reduced form function for the demand for loans *in excess* of the binding borrowing constraint. This excess demand is supposed to depend on both demand and supply variables. Since excess credit demand (as the difference between optimal consumption[59] and debt ceiling) is unobservable, JAPPELLI exploits the specific qualitative information contained in the 1983 U.S. Survey of Consumer Finances on whether a respondent is credit-constrained or not. This information was obtained in a similar fashion as in the study by FEDER et al. (1989). As a result, JAPPELLI estimates a Logit equation with the probability of being credit-constrained as dependent variable. He finds that income, wealth, and age are the most important determinants of being credit-constrained.[60]

The approach of directly asking respondents about their rationing status was further refined by BAYDAS et al. (1994) and ZELLER (1994). BAYDAS et al. analyse a sample of micro-entrepreneurs in Ecuador, in which they further divided the

[59] In the standard version of the life-cycle model, current consumption only depends on life-cycle characteristics such as age or household composition (but not on current income, see DEATON 1997, pp. 359-60).

[60] WINKER (1996) applies a similar approach to German firm panel data, where financial constraints based on 'ifo-Innovationstest'-data are used as dependent variable of a Probit model.

group of constrained borrowers in those who are (a) *completely rejected*, i.e. who applied for a loan without success, or (b) *unsatisfied*, i.e. who applied but obtained a smaller loan than demanded. Together with the (c) *satisfied* borrowers who obtained as much as applied for and the (d) *non-applicants*, BAYDAS et al. identify four groups of respondents. Based on this distinction, they perform a multinomial Logit model to quantify *determinants* and *probabilities* for respondents to be in one of the four distinct groups.[61] ZELLER (1994) employs a similar approach of four categories to analyse formal and informal borrowing in Madagascar. Theoretically, he structures credit rationing as a *sequential process* where first potential borrowers decide whether to apply, and second lenders decide whether to grant a loan.[62] As a consequence, he uses this grouping to estimate a two-stage Probit model.

The above categorisation into four groups of potential borrowers was further developed by MUSHINSKI (1999), who divides non-applicants into (d1) *preemptively rationed* and (d2) *not interested* respondents. He argues that households of group (d1) may well have some *notional demand* for credit, although in effect they do not apply because – according to statements made in interviews – they fear rejection or high transaction costs of loan application. As a consequence, in an analysis of Guatemalan credit unions, the author estimates *notional demand offer probabilities* by means of a Probit model which identifies the probability that a household with positive notional demand for credit receives a loan offer. In a first-best world, this probability is supposed to be one, and a smaller value thus can be interpreted as an indicator of credit rationing. This claim seems however not to be warranted, as long as no information on returns on credit use is provided.

The results suggest that demand offer probabilities of credit unions are generally higher than those of banks, and that credit unions' lending decisions are not as much dependent on easily collateralisable wealth as those of banks.[63] Further-

[61] BARHAM et al. (1996) use principally the same categorisation to investigate the ability of Guatemalan credit unions to relax credit constraints of small-scale producers. However, they condense groups (c) and (d) into one group of *unconstrained* borrowers.

[62] This two-stage structure was also used by HEIDHUES et al. (1998, p. 364) in their analysis of the Romanian credit market.

[63] In order to circumvent the problem of modelling the interdependent decision process resulting in the choice of the lender (credit union or bank), MUSHINSKI focuses only on the lender offer decision, which he assumes to be independent from the households' choice of lenders. He thus understands the credit market outcome as a sequential process of first application and second acceptance or rejection, similar to ZELLER (1994).

more, the econometric analysis shows that ignoring notional credit demand may lead to implausible coefficients of the demand offer equations.

In contrast to all authors using the qualitative information approach desribed previously, KOCHAR (1997) uses survey data of rationing outcomes on segmented credit markets in rural India to analyse these outcomes as *jointly determined* by borrower and lender behaviour. This involves the application of jointly distributed bi- and trivariate Probit models with partial observability (see MADDALA 1983, p. 279).[64] A major result of KOCHAR's analysis is that, conditional on the households' demand for credit, the degree of effective rationing is rather low. A disadvantage is that information on loan contract terms such as interest rate and loan size is discarded.

In light of the criteria established above, the analysis of qualitative information collected in interviews can be assessed as follows:

- Qualitative information on loan rationing in rural credit markets directly corresponds with the casual observation of credit-constrained farmers, that is farmers who complain about lack of access to credit.
- The categorisation of a certain respondent exclusively relies on his own subjective assessment of his situation. The validity of this statement may be questioned, although there are no plausible arguments why it should be less valid than any other information collected in field surveys.
- In any case, the qualitative information allows the consistent differentiation of respondents into those for whom liquidity is exogenous (i.e. not under the control of the respondent) and those for whom it is not.
- However, it is not necessarily a consistent measure of credit market efficiency, since no disequilibrium in terms of resource allocation is explicitly tracked down. Furthermore, it does not allow a quantification of the *severity* of credit rationing.
- Although it requires specific questions to be included in survey questionnaires, it is relatively easy to collect but still lends itself to multivariate methods of analysis. The causal determinants of the qualitative choice variable can principally be identified.

[64] In the approaches described so far there are single decisions among several alternatives, or sequences of single decisions. Opposed to that, in the KOCHAR model there are two (three) interdependent decisions, each between two alternatives, which involves the estimation of a system of equations with correlated disturbances. See GREENE (2000, pp. 849; 857).

– A general problem is the theoretical structuring of the decision-making process on segmented credit markets where more than one source of credit is relevant. There may be good arguments to assert that choice between several sources is an interdependent process and even the decision of the lender to grant the loan may be involved in this. If this assertion holds, estimations based on sequential and independent decision processes might be inappropriate.

In summary, qualitative information on credit access has the advantage that it is relatively easily collected and interpreted. In addition, it may support an important assumption for econometric modelling, namely that credit is exogenously determined for credit-constrained households.

Approach 3: Analysis of quantitative information collected in interviews by using the credit limit concept

In an attempt to overcome the qualitative nature of the indicator described previously, researchers at the International Food Policy Research Institute (IFPRI) developed the credit limit concept as a novel approach to measure rationing (DIAGNE 1999; DIAGNE et al. 2000). The idea is to ask a given respondent about *the maximum amount a lender is willing to lend him*, which is the credit limit of the respondent with regard to this lender (DIAGNE et al. 2000, p. 10).[65] The credit limit thus measures the borrower's *current access to credit*, which may be different for different loan sources. However, a given credit limit does not necessarily imply a binding credit constraint. Departing from the life-cycle model of intertemporal consumption, the authors define a borrower as being credit-constrained if "the optimal amount borrowed when borrowing under a credit constraint is strictly less than the optimal amount that would be borrowed if the credit constraint did not exist" (p. 17). In other words, the borrower is credit-constrained only if his optimal loan size is *effectively restricted* by his credit *limit*. Furthermore, a distinction is made between *access* to credit and *participation* in credit markets. Households may choose not to participate in credit markets, although they have access to credit (i.e. a positive credit limit). Together with information about the optimal loan demand (or simply loan amount applied for), a metric quantification of the extent of credit rationing is possible.

[65] In the survey the respondents were asked "the maximum amount they *could* [subjunctive, M.P.] borrow during the recall period from both informal and formal sources of credit" (DIAGNE et al. 2000, p. 29, italics in the original).

The appealing feature of the credit limit concept is that it allows a metric quantification of credit access, which in turn may be used in econometric analyses. Furthermore, it principally allows to measure the success of a given credit expansion policy by its impact on perceived credit limits of the target group, and the effect this expanded credit limit has on other variables of household welfare.

In an application to Bangladesh and Malawi, DIAGNE et al. (2000) find that microfinance institutions promoted in the study area had a positive effect on borrowers' credit limits.

DIAGNE (1999) uses the credit limit variable to evaluate decisions to participate in credit programmes and access to credit by rural households in Malawi. His formal model has a two-stage structure, according to the choice-based sampling procedure of the survey which was stratified along programme membership status. The first stage consists of a four-alternative, two-level nested multinomial Logit model (see GREENE 2000, pp. 857-874) which depicts participation decisions as population conditional choice probabilities. In the second stage, these probabilities are used to estimate a reduced form recursive system of simultaneous equations of credit limits and amount borrowed as dependent variables. The results of the analysis show that participation decisions in certain credit programmes are highly driven by programme attributes other than the interest rate. Furthermore, the diversification of assets is more relevant for formal credit access than its total value. Increasing credit limits are only partially exploited by borrowers, which – according to the author – underlines the importance of access to credit as an insurance mechanism that is only utilised in case of emergency. Finally, informal credit is regarded as only a weak substitute of formal credit, since, in contrast to the latter, the former is mainly used for consumption purposes.

The characteristics of the credit limit concept are as follows:

- It requires specific questions to be included in survey questionnaires. In particular cases, it may be difficult to make respondents understand what is exactly meant by the question on credit limits (DIAGNE et al. 2000, p. 30), or some respondents may be ignorant about their credit limit.
- Compared to the qualitative indicator it provides a metric measure of credit rationing, which allows the application of more sophisticated methods of analysis.
- As the qualitative indicator, it is also not necessarily a consistent measure of credit market efficiency.

Since the experience with this method is limited so far, it probably makes sense to use it as a complement to other methods.

Approach 4: Analysis of spill-over effects with regard to secondary credit sources

The central theoretical assumption of this method is that credit sources other than bank credit are more expensive than bank loans. If a borrower makes use of these secondary sources, he is assumed to be unable to satisfy his financial needs from the primary source, though he has sufficient repayment capacity to serve the secondary source. He can therefore be treated as credit-rationed with regard to the primary source. It might be possible, however, that there is also rationing on the side of the secondary source. Use of the secondary source due to unsatisfied demand with regard to the primary source is sometimes called 'spill-over' (BELL et al. 1997).

Trade credit in developed countries and *informal credit (moneylender)* in developing countries are the two secondary segments of credit markets usually referred to. Both are regarded as comparatively more expensive than formal bank loans, although lenders in these secondary segments usually are in a more advantageous position with regard to information asymmetries as compared with banks (see the discussion on trade credit in JAFFEE and STIGLITZ 1990, p. 879 and on informal credit in ALEEM 1993, and section 2.2.2 above, pp. 55 et seq.).

As a metric indicator of credit rationing, PETERSEN and RAJAN (1995) and HARHOFF and KÖRTING (1998) use the criterion of fast payment discounts actually taken by a firm, in percent of fast payment discounts offered to it. If firms often do not make use of the advantageous fast payment discount, they are regarded as rationed with regard to their primary lender (bank). The full amount which is to be paid afterwards can hence be regarded as a form of trade credit, which costs usually by far exceed lending rates offered by banks (PETERSEN and RAJAN (1995, p. 426). However, these studies solely concentrate on the formal loan markets in the U.S. and Germany, respectively, and the effects lending relationships have on the access to credit.

BELL et al. (1997) estimate demand and supply functions under relatively restrictive assumptions of an unobserved regime switching model for segmented credit markets in rural Punjab.[66] Their analysis based on a cross sectional sample of farmers shows that the formal market is responsible for most rationing, de-

[66] This study hence provides a link to approach 5. I mention it here due to its emphasis on segmentation and spill-over.

mand is rather inelastic with regard to interest rates, and tying credit to output marketing made informal lenders willing to advance much bigger loans.

The method is assessed as follows:

- It requires detailed information on various loan sources used by respondents. For the more demanding analyses, panel data might be desirable.
- In case that the assumptions implicitly made are correct (secondary sources more expensive than primary, profit maximisation of borrower), this method provides a valid measure to quantitatively analyse rationing phenomena in segmented credit markets. Cause-effect modelling is principally possible.
- It is only relevant where segmented credit markets are important.
- It may be regarded as a shortcoming that the measurement of spill-over effects implies an underestimation of credit rationing if some rationed households do not turn to the secondary source of credit, but simply accept the constraints on the formal market instead.

Approach 5: Econometric analysis in the framework of a static, microeconomic household model

This method seeks to analyse the effects of credit rationing under implicit or explicit consideration of a farm household model and hence can take advantage of its theoretical results. It was demonstrated in subchapter 2.3 that market imperfections such as credit rationing lead to important interactions between the production and the consumption sphere of the household. *Observable consequences* of these interactions are taken as a starting point for the econometric analysis of rationing phenomena in this approach. Since methodologically similar approaches have also been used for the analysis of labour markets, I refer also to selected studies on the latter.

As shown in section 2.3.1 (pp. 77 et seq.), a binding constraint on the credit market leads to the presence of a marked-up shadow interest rate in the first-order conditions for profit maximisation (equation (2-33), p. 83). A similarly modified shadow wage would obtain in the case of labour market restrictions (for example due to limited off-farm employment opportunities for the family labour force or rationing of hired labour in the peak season; see D. BENJAMIN 1992, pp. 292-298). As a consequence, marginal revenues of factor use should be *significantly different* from observable, exogenous factor costs (interest rates or market wages). Furthermore, in the case of rationing, production and consumption decisions are *mutually dependent*. The econometric household model-

ling approach attempts to empirically detect both the household internal shadow price and the mutual dependency of consumption and production.

In the credit market case, the presence of *credit rationing* is hence defined by its consequences for allocation decisions within the farm household. In addition, the credit market is understood to be *efficient* if the first-order condition for optimal credit allocation is met, namely that values of marginal productivity equal exogenous interest rates (see in particular CARTER and WIEBE 1990, pp. 1147-1148; SIAL and CARTER 1996, pp. 771-772; 777-779). Referring to the considerations in subchapter 2.2, this efficiency means the absence of credit rationing (no private excess demand), although social efficiency in a first-best sense is not warranted if the interest rate is affected by agency problems.

Table 3-1: Econometric analyses of credit and labour market imperfections using a household modelling framework

Study	*Estimated function(s)*	*Estimation method*	*Data*	*Imperfection detected*	
	type (form)			*shadow price*	*interdependency*
Credit market					
IQBAL (1986)	FD (linear)	2SLS	India 1970-71	n.a.	+[a]
CARTER (1989)	Prof (Q), Prod (Q), FD (CD)	OLS, 2S-SC	Nicaragua 1981	–	n.a.
CARTER and WIEBE (1990)	Prod (CD)	OLS	Kenya ?	+	n.a.
FEDER et al. (1990)	OS (CD)	2S-SC	China 1987	–	+
SIAL and CARTER (1996)	FD (Tobit), OS (mixed)[b]	2S-SC	Pakistan 1987-88	+	n.a.
KOCHAR (1997a)	FD (mixed)[b]	2S-SC	India 1981-82	n.a.	–
Labour market					
LOPEZ (1984; 1986)	System[c]	FIML	Canada 1970	n.a.[d]	+
THIJSSEN (1988)	Prod (Q), D (AIDS)[e]	OLS	The Netherlands 1970-82	+	n.a.[e]
D. BENJAMIN (1992)	FD (CD, TL)	OLS, 2SLS	Indonesia 1980	n.a.	–
JACOBY (1993)	Prod (CD, TL), FS (mixed)[b]	OLS, 2SLS, 2S-SC	Peru 1985-86	+	n.a.
SKOUFIAS (1994)	Prod (CD), FS (mixed)[b]	OLS-FE	India 1975-79	+	n.a.
SONODA and MARUYAMA (1999)	Prod (CD), D (linear)	3SLS	Japan 1982-91	+	n.a.

Notes: [a] endogenous interest rate and significant life cycle variables; [b] equation entails both logarithmic and linear or quadratic terms; [c] simultaneous equation system consisting of demand, ouput supply, and factor demand functions; [d] assumption of constant returns to scale in labour; [e] demand for leisure based on a first-stage income estimation. Abbreviations: Estimation method: OLS = ordinary least squares, 2SLS = two-stage least squares, 3SLS three-stage least square, 2S-SC = two-stage with selectivity correction, FIML = full information maximum likelihood, FE = fixed effects; Function: type: Prof = profit function, Prod = production function, D = demand, FS = factor supply, OS = output supply, FD = factor demand; form: Q = quadratic; CD = Cobb-Douglas, TL = translog, AIDS = Almost Ideal Demand System; n.a. = not analysed.

Source: Author's compilation.

Table 3-1 lists a number of studies that basically follow this approach. With the exception of FEDER et al. (1990), all studies either concentrate on the shadow price of the factor *or* on the detection of interdependencies between production and consumption spheres of the household. Investigations of the shadow price either estimate a structural production function (CARTER, CARTER and WIEBE, THIJSSEN, JACOBY, SKOUFIAS, SONODA and MARUYAMA) or a reduced-form output supply equation in connection with a selectivity correction (FEDER et al., SIAL and CARTER).[67] The selectivity correction may require additional qualitative information. Both approaches are capable of yielding a – slightly different – estimate of the relevant internal return on credit (see the further discussion in section 3.3.4, p. 149). The estimates are then often employed in a factor demand or supply function in order to analyse the shadow price elasticity. Studies that examine household interdependencies usually take factor demand functions directly as their starting points. The table illustrates that a variety of functional forms is used, with the Cobb-Douglas still being the most popular. Particularly since many studies had to rely on cross-sectional data, instrumental variable estimators (two-stage least squares) play an important role in dealing with simultaneity problems in structural equations (see section 3.2.2, p. 140, below).

The results are not uniform and differ by country. While CARTER (1989) finds that credit has even a negative effect on farm output in his Nicaraguan sample, CARTER and WIEBE (1990) and SIAL and CARTER (1996) report shadow prices of up to 300 and 78 percent net of repayment in Kenya and Pakistan, respectively. A notable result is that of FEDER et al. (1990), who find that the marginal product of credit is low although demographic characteristics of the household have significant influence on production decisions. They conclude that farms are in fact credit-rationed but funds are diverted away to non-productive activities or used to finance long-term investment (p. 1156). KOCHAR (1997a) investigates how formal sector loans affect outcomes on the land lease market in India. He finds no significant relationship between both. The study of IQBAL (1986) is a bit separate from the others since he motivates the inclusion of household characteristics into his borrowing function by considerations of life-cycle behaviour and not by the attempt to explicitly detect interdependencies between production and consumption (p. 196). The coefficients of these variables partly turned out to be significant. Furthermore, he allows for an endogenous interest rate that dif-

[67] The methodology of FEDER et al. (1990) is applied to trace *income* and *nutrition* effects of credit based on rural household data from Madagascar by ZELLER (1995) and on data from Cameroon by SCHRIEDER (1996).

fers across farms. Most of the labour market studies find evidence for significant restrictions on rural labour markets, usually in the sense that on-farm return to labour is lower than the off-farm wage. An exception is D. BENJAMIN (1992), who is unable to trace any dependency between farm labour allocation and household structure.[68]

A related study not mentioned in the table due to its different approach is LEE and CHAMBERS (1986), who take a dual producer model as a starting point. They test for the significance of expenditure constraints in U.S. agriculture. The intuition behind the test rests on the homogeneity condition for the profit function. If profit is homogenous in all prices, this supports the absence of any constraint, if it is homogenous only in output prices, this supports the constrained model (p. 861). LEE and CHAMBERS find evidence for the latter in the time-series data set used in their investigation.[69]

I assess the household modelling approach as follows:

- Adopting the household modelling framework has the major advantage of yielding a theoretically consistent definition of credit rationing and a rather straightforward interpretation of credit market efficiency. Econometric modelling offers a wide range of quantitative analysis including causal inference. The quantitative nature of results enhances comparability and interpretation.
- Econometric modelling is more data demanding than some of the qualitative methods described previously. However, it is not necessary to have available a time-series or panel data set, as the large number of cross-sectional studies demonstrate.

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[68] A household model incorporating labour market imperfections is estimated by GLAUBEN (2000) for the Polish farm sector. GLAUBEN analyses the effects of different tax regimes on the allocation decisions of farm households based on a four-year panel data set. In contrast to the other labour market studies mentioned in Table 3-1, he does not focus on the household-internal wage but on off-farm labour income and costs of hired labour. These are assumed to be marginally decreasing and increasing, respectively. However, instead of *testing* for labour market imperfections, he simply fits a univariate Cobb-Douglas function to his observed income and cost data with labour volume as the sole regressor (p. 144). In my opinion, it is questionable whether this constitutes an appropriately specified regression model of off-farm income or hired labour costs.

[69] By means of an indirect production function, BHATTACHARYYA and KUMBHAKAR (1997) compare the ratio of unobserved shadow prices of inputs to market prices in order to analyse market imperfections for a sample of Indian farms. Their emphasis is on the effects of various distortions on output, therefore they do not provide direct evidence for credit market failure and their study is not further investigated here.

– Estimating an econometric model is methodologically more ambitious than previous approaches and hence to a larger extent subject to criticism, for example as outlined in section 3.1.2, pp. 103 et seq. Crucial error sources are the non-experimental nature of the data (see section 3.2.2 below, pp. 140 et seq.) as well as the exact specification of the functions (for example with regard to functional form and choice of regressors).

The household modelling approach hence offers a promising way to combine theoretical reasoning with quantitative analysis, while the data demands remain manageable.

Approach 6: Detecting violations of perfect market implications in an econometric analysis of dynamic investment decisions

As the previous one, this approach attempts to track down credit rationing by empirically detecting violations of implications of a theoretical decision making model. It thus also has an explicit theoretical foundation in which credit rationing is interpreted, at least in the more recent studies. A central implication of the neoclassical assumption of perfect and complete capital markets is that investment decisions can be made independently of the financial structure of an enterprise (Fisher Separation and Modigliani-Miller Theorem, see the general discussion in chapter 2).[70] If in reality investment is observed to depend on financial structure, this is interpreted as evidence for imperfect capital markets. It hence provides a first test for the presence of credit rationing (called a 'financial sensitivity test' in the sequel, following HAYASHI 1987, p. 101).[71]

[70] There is a similar implication in the consumption literature, namely that consumption decisions can be made independently of current income (which is known as the permanent-income or life-cycle thesis). See HAYASHI (1987).

[71] HAYASHI (1987) uses the notion of an 'excess sensitivity test' for a well-specified problem in the consumption literature. I take 'financial sensitivity' as simply indicating the significance of financial variables for investment outcomes.

Table 3-2: Econometric analyses of credit market imperfections using farm investment equations

Study	*Financial variable(s)*	*Estimation method*	*Data*	*Imperfection detected*	
				financial sensitivity	*orthogonality*
Traditional approaches					
DE HAEN (1976)	increase in net debt; income – consumption	2SLS	Germany 1952-74	+[a]	n.a.
GROLIG (1980)	weighted profit of previous periods	OLS	Germany 1968-77	+	n.a.
KLAIBER (1988)	weighted profit; depreciation; liquidity[b]; equity; public transfers; consumption	OLS	Germany 1985-86	+	n.a.
WEERSINK and TAUER (1989)	farm income; change in external debt	GLS	U.S. 1974-83	+[c]	n.a.
FEDER et al. (1992)	formal credit; informal credit	OLS; Tobit	China 1987-88	+[d]	n.a.
KUIPER and THIJSSEN (1996)	equity to equity plus debt	VAR	The Netherlands 1949-91	+	n.a.
Stochastic investment models					
HUBBARD and KASHYAP (1992)	net worth	GMM	U.S. 1914-87	+	+
C. BENJAMIN and PHIMISTER (1997)	profits/capital; long-term loans/capital	GMM	France 1989-93	–	+[e]
BIERLEN and FEATHERSTONE (1998)	cash-flow	VAR	U.S. 1976-92	+	n.a.

Notes: [a] income – consumption had a negative effect on investment; [b] different liquidity specifications including contributions and withdrawals of the farm household; [c] negative sign for income; [d] formal (informal) credit significant for crop-related investment in one (zero) of four provinces under investigation; formal (informal) credit significant for housing investment in one (four) of four provinces; [e] formulation that allows for transaction costs not rejected. Abbreviations: Estimation method: OLS = ordinary least squares, 2SLS = two-stage least squares, GLS = Generalised Least Squares, VAR = vector autoregression, GMM = Generalised Method of Moments; n.a. = not analysed.

Source: Author's compilation.

The literature related to this approach can be grouped into a more traditional and a more recent branch (see Table 3-2). The theoretical foundation of the more traditional studies is often rather pragmatic (if there is one at all) and generally does not allow for uncertainty in the decision model. In contrast, more recent models explicitly base their research on stochastic investment models, which was probably eased by the development of corresponding econometric tools for time series analysis.

The older and theoretically more pragmatic approach is to simply add a liquidity or financial variable to the existing investment function (comprising output or capital as explanatory variables) or explain investment by a liquidity variable alone (see J.R. MEYER and KUH 1957 on business investment). Later research is based on the flexible accelerator models as outlined in the first part of section 2.3.2, pp. 91 et seq., augmented by a financial variable. Examples with reference to German agriculture include DE HAEN (1976), GROLIG (1980), and KLAIBER (1988), see Table 3-2.[72] DE HAEN investigates the consumption and investment decisions of farm households in Lower Saxony by estimating a simultaneous system of behavioural equations. He finds that an increase in net debt has a significantly negative effect on investment; however, increasing liquidity reserves surprisingly act in the same direction as additional debt. In GROLIG's analysis of German farm accountancy network data, a weighted mean of profit levels of previous periods was taken to reflect profit expectations. In various farm subgroups, these had a positive effect on investment, which might be interpreted as a liquidity effect (see WITZKE 1993, p. 248). KLAIBER uses a host of liquidity-related variables to explain investment behaviour of farms in Baden-Württemberg, most of which turned out to be significant. A drawback of his analysis may be that he did not check endogeneity of regressors, which is likely to be a problem in the cross-sectional data set used for the estimations (see section 3.2.2, p. 140). In the development economics literature, FEDER et al. (1992) found a significant effect of credit on crop-related capital and housing investment in at least some of the investigated Chinese provinces. As KLAIBER (1988), FEDER et al. (1992) based their study on cross-sectional data only.

WEERSINK and TAUER (1989) explicitly compare the explanatory power of different investment specifications by embedding various theoretical views in a single equation. This also includes cash farm income and increase in external debt. Based on their sample of New York dairy farms, the authors find that both are significant determinants of investment, although income has a negative sign.

[72] Further studies are briefly discussed by WITZKE (1993, pp. 247-249).

KUIPER and THIJSSEN (1996) also postulate a general investment equation which integrates several theoretical standpoints. Accordingly, they do not pretend to estimate a structural model provided by theory but rely on an Error-Correction Model known from macroeconomics. This is based on a vector autoregression (VAR) procedure, and hence provides a methodological link to the paper by BIERLEN and FEATHERSTONE (1992) presented below. They find that increasing equity to equity plus debt plays a significant role in determining investment of Dutch farms.

In all these studies, liquidity variables hence turned out to have a significant influence on investment, which is evidence for the thesis of credit rationing.[73] However, in most of the mentioned papers the theoretical framework is rather ad hoc. Often the analysis directly starts with a postulated investment function, which is usually different for the studies in the lower part of Table 3-2.

More recent and methodologically sophisticated research extends the previous approach 5 by explicitly founding the analysis on a *dynamic, stochastic* optimisation problem. An example of such a problem was outlined in section 2.3.2, pp. 91 et seq., a general description can be found in CHOW (1997, pp. 22-23). The model may be regarded as using a modified maximum principle employed earlier in this monograph which is generalised for the case of uncertainty (CHOW 1997, p. 5). This type of extended model can be solved by dynamic programming or the Lagrange method. Since the methodology is quite complex and will not be utilised in the present study, I confine myself to presenting very roughly its basic characteristics and some selected results which are related to credit rationing in agriculture.

Similar to the static model, the absence of financial constraints prescribes that firm behaviour obeys the first-order condition of the dynamic optimisation problem (so-called stochastic Euler-equation, see BOND and MEGHIR 1994, pp. 199-200). In principle, the condition postulates that in each period the expected marginal profit from investment equates its dynamic shadow value. If this condition is empirically rejected, the perfect market model is dismissed and financial constraints are assumed to be relevant.

To avoid specification error, the usual procedure is to split the sample based on a-priori information into a constrained and an unconstrained subgroup. Qualitative information on credit rationing may therefore be desirable. For the con-

[73] A related study that uses financial variables to explain the qualitative decision whether to invest at all is ELHORST (1993).

strained group a modified investment equation including financial variables is then estimated. There are two broad approaches pursued in the literature (see BOND and MEGHIR 1994, p. 200): (a) using a VAR forecasting procedure in order to estimate the marginal profit from investment, which allows an excess sensitivity test, or (b) estimate the investment function as an empirical Euler equation by employing the Generalised Method of Moments (GMM; see JOHNSTON and DINARDO 1997, pp. 327-345). The latter allows an empirical rejection of the Euler-equation. Due to its utilisation of the orthogonality condition in the framework of a GMM estimation, this rejection has been called 'orthogonality test' by HAYASHI (1987). In both cases, time series or panel data is a necessary prerequisite. There are analogous applications in the consumption literature, following HALL and MISHKIN (1982).

Frequent results are that firms classified a-priori as constrained display a higher sensitivity to financial variables than unconstrained ones, and the perfect market Euler equation is rejected by the constrained subsample. A recent survey of the literature is HUBBARD (1998). For illustrative purposes, I briefly summarise three studies dealing with the agricultural sectors in the U.S. and France, respectively.

HUBBARD and KASHYAP (1992) use a large panel of aggregate U.S. farm data to estimate investment functions based on Euler-equations. They test two variants of the Euler-equation against the data, one that implies perfect capital markets, and one including financial variables due to an additional borrowing constraint. The financial variable they use is the farms' net worth, which is supposed to influence investment decisions as a measure of borrowing capacity. In adjacent periods with high net worth (that is without constraints), the assumption of perfect capital markets (and thus the first Euler-equation) should hold, while borrowing constraints should be significant in periods with low net worth. Farm net worth is thus the implicit criterion to distinguish constrained and unconstrained observations to avoid misspecification of the model. The results of their estimations suggest that (a) the model implying perfect capital markets was rejected by the data, (b) including financial variables as explanatories substantially improved the fit of the model, and (c) the effect of changes in net worth was significantly more important in times of a deteriorating economic environment for farming. Overall, the importance of capital market imperfections could thus be proven, with farms' net worth as a significant determinant.

A comparable model is estimated by C. BENJAMIN and PHIMISTER (1997) for French farm panel data. Two main differences to HUBBARD and KASHYAP

(1992) are that BENJAMIN and PHIMISTER (a) use a different selection criterion to distinguish constrained and unconstrained periods, and that (b), in addition to variables of financial structure, they also explicitly include positive transaction costs of borrowing in their extended Euler-equation. Their data set has the advantage that it allows the identification of adjacent periods in which farms' borrowed additional funds. For these periods, credit constraints are assumed to be absent, and the Euler-equation reflecting perfect capital markets should apply. In periods for which borrowing constraints are assumed to be present, an extended Euler-equation that allows for transaction costs of borrowing should hold. Both cases are estimated with or without additional financial variables by a GMM estimator. The results also reject the perfect capital market model. The extended Euler-equation which allows for transaction costs and uses the selection criterion, however, was not rejected. In both cases, inclusion of financial variables could *not* improve the fit of the model. A general result is thus that different investment behaviour under credit constraints could be detected empirically, although the role of financial variables could not further be enlightened.

BIERLEN and FEATHERSTONE (1998) base their study on a panel of individual U.S. farm data.[74] The authors distinguish periods with or without credit rationing as well as subgroups of farms that are more or less likely to be constrained. Their selection criteria are farm individual level of assets, debt-to-asset ratio, age of operator, and certain business cycles. They estimate investment equations for the different subgroups by a VAR forecasting method. Cash-flow as an additional explanatory variable proved to be significant (a) in 'bust' periods and (b) for high-debt and younger-operator farms, according to expectations of relevant credit constraints. Farm debt level was identified as being the most important determinant of rationing.

For the purposes of this monograph, the following evaluation can be given:

- By preserving a theoretical foundation, the more recent studies provide a major extension of the previous static household modelling approach since they explicitly incorporate time and uncertainty.
- Although less theoretically elaborate, also the earlier contributions are capable of detecting an effect of financial variables on investment.
- A major disadvantage of the method is its enormous data requirements, at least for the more sophisticated approaches. In the absence of sufficiently large panel data it might not yield satisfying results.

[74] The theoretical basis of their study is GILCHRIST and HIMMELBERG (1995).

– Most advantages and drawbacks of econometric modelling mentioned earlier also apply here.

3.1.4 Conclusions for further research

The previous methodological survey has shown that there is a large body of literature dealing with the problem of measuring and analysing credit rationing. The approaches differ with regard to their theoretical assumptions and plausibility, data requirements, and amenability to econometric analysis. My choice of method is based on the criteria stated in the outset of the previous section. The general principle was to achieve far-reaching plausibility coupled with theoretical consistency, analytical rigour and empirical tractability, given the limited availability of data. Furthermore, my subjective preferences certainly had some influence.

In my opinion, plausibility and intuition are good reasons to include a qualitative indicator in the analysis, such as outlined in approach 2. Using the individual assessment of farmers has the advantage of corresponding closely with the initial problem statement that motivated this research (see chapter 1 and section 2.1.1, p. 23). Furthermore, the studies mentioned above demonstrate that this does not mean to make sacrifices with regard to econometric analysis, and qualitative indicators also may be incorporated into a theoretically more rigorous analysis. Qualitative survey data will therefore play a role in the following analysis.

I stated earlier that the theoretical foundation of this research can be described as an appropriately modified neoclassical approach (see section 2.1.3, p. 30). It was hence a natural consequence to focus attention on a neoclassical household model (subchapter 2.3). As already indicated, I will also take this model as the framework for the *empirical* analysis and interpretation of credit rationing phenomena in rural Poland. I hence will draw heavily on the literature of approach 5. At the same time I am aware of the theoretical caveats following from the drop of several assumptions of the standard neoclassical environment (see in particular section 2.2.4, p. 74). As far as the data allows, I will therefore utilise the insights to be gained from an explicit consideration of loan transaction costs as stressed in the transaction cost measurement tradition (approach 1).

So far, little has been said about the availability of data. At the time when the current research was initiated, there was no appropriate micro data of Polish farm households available at all. It was therefore decided to carry out a farm survey in order to form a cross sectional data base (see next subchapter). This had the advantage that specific data requirements could find their way into the

design of the questionnaire. However, it was obviously impossible to collect panel or time-series data over a longer time period. This in turn precludes the implementation of a number of data demanding methods as presented in approach 6.

The approaches that use the credit limit variable and spill-over effects both could be employed given the survey data. Since trade and informal credit sources turned out to be of less relevance for the survey respondents, the analysis of spill-over effects was not of primary interest and awaits further investigation. The same holds for an implementation of the rather new credit limit approach, which was simply beyond the given research capacity.

The following subchapter will describe the data used in this study and deal with some issues of econometric methodology. Subchapter 3.3 will elaborate further on the approach used in the empirical investigation.

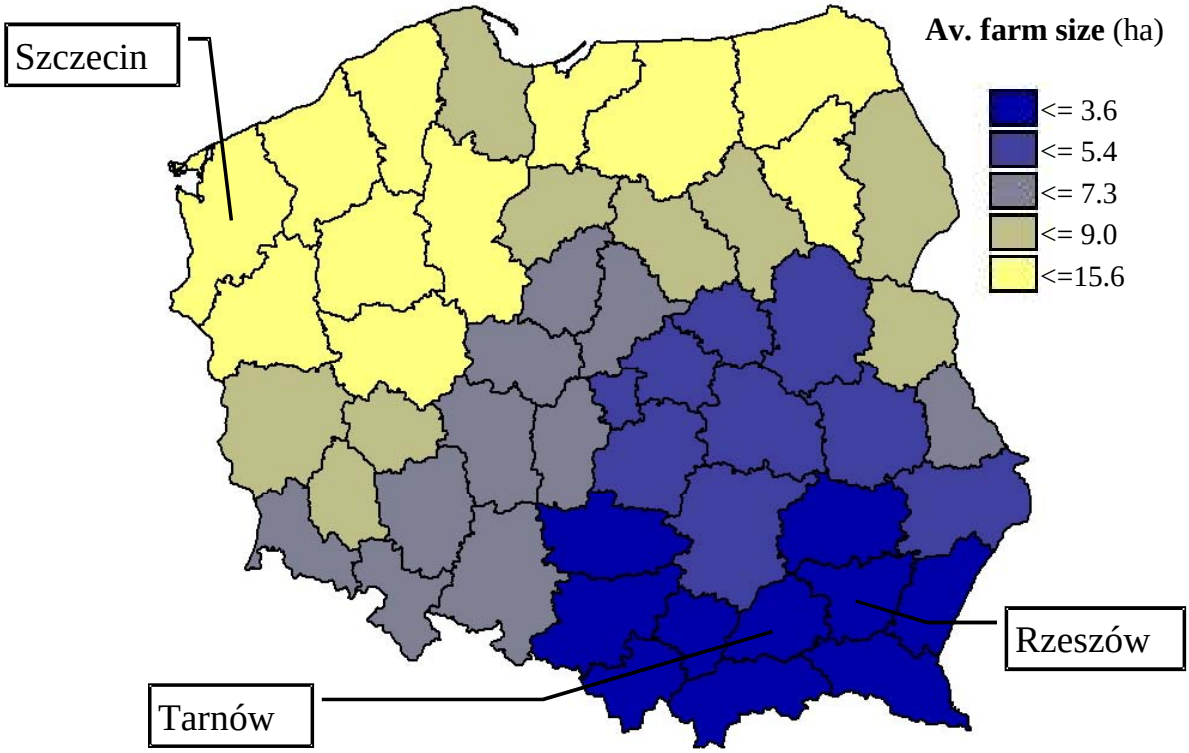
3.2 Data issues

The goal of this subchapter is to describe the data set used in this research. Furthermore, a number of methodological issues will be raised which inter alia result from the non-experimental nature of the data. This will ease the understanding of the empirical approach to be presented subsequently and may serve for further reference throughout the monograph.

3.2.1 Data base

The major data source for the analyses in this monograph is the IAMO Poland farm survey 2000 (see PETRICK 2001, on which this section is based). It is a cross-sectional farm survey conducted in the boundaries of the former Szczecin, Tarnów, and Rzeszów voivodships existing prior to the administrative reform of 1. January 1999. The survey was carried out in 2000 and contains mainly data related to the economic outcomes of the year 1999. As Figure 3-1 shows, Szczecin has very contrary characteristics in terms of farm sizes in comparison to Tarnów and Rzeszów.

Figure 3-1: Survey regions and average farm sizes in Polish voivodships in 1996



Source: Author's depiction based on GUS (1998a).

Mainly due to historical reasons, the organisation and structure of agricultural production in Poland is in fact highly region-specific (this is discussed e.g. in GÓRZ and KUREK 1998; JAKSCH et al. 1997). In the southern and eastern parts of the country, a very small-structured peasant agriculture predominates, with more than 75% of all farms cultivating less than 5 ha of land (see GUS 2002). In contrast to this, the north and north-west of Poland is characterised by a more diverse farm structure with a higher share of large-scale farms, which is a reflection of the previous importance of state enterprises in agriculture (Państwowe Gospodarstwa Rolne, PGR). Accordingly, the average farm size decreases from the north-west to the south-east of Poland. As a peculiarity for Central and Eastern Europe, under the socialist regime, agriculture in Poland never was completely collectivised. State farms in the north had been mainly established as a result of the re-organisation of former German estates after World War II and administrative land allotment in subsequent years (for detailed analyses see BARCZYK 1962, PETRICK and TYRAN 2002, and PHILIPP 1983). However, after transition to a market economy, these state farms were liquidated or turned into the property of the Agricultural Property Agency of the State

Treasury (Agencja Własności Rolnej Skarbu Państwa, AWRSP). This agency in turn sells or leases out the land (for an analysis see e.g. MILCZAREK 2000 and ZIETARA 1995).

As a result of these restructuring processes, the share of agricultural land cultivated by *state-managed farms* in Poland had fallen to less than 8% in 1997 (GUS 1999, p. 9; 1997 is the latest year for which information is available) and its share has presumably further dropped since then. In addition, more than half of the land belonging to state-managed farms was not under cultivation in 1997 (GUS 1999, p. 19), probably mostly due to the apparent dissolution of management structures on these farms or severe economic difficulties. The state-sector thus has completely lost its importance. Within the *private sector*, besides the individual farms (indyvidualne gospodarstwa rolne) a number of other forms of farm organisations are considered in the official statistics (GUS 1998a, pp. 166-7). These are 'co-operative farms' (spółdzielnie produkcji rolniczej), 'private companies in home property' (spółki krajowe prywatne), 'other private entities in home property' (pozostałe jednostki własności prywatnej krajowej), 'private entities in foreign ownership' (własność zagraniczna), and 'private entities in mixed ownership' (własność mieszana). These other legal forms are potentially important in terms of absolute numbers only for the North-western regions, where they partly emerged from restructured state farms. However, their exact delimitation from each other is unclear and is further confused by the ongoing changes of ownership status during the past decade. An examination of their internal management structure has shown that it is quite heterogeneous (FEDYSZAK-RADZIEJOWSKA et al. 1999). For these reasons, the survey only distinguished whether a given farm was owner-operated or run by a hired manager, and whether it was in foreign ownership. The survey did not further differentiate legal forms of farms. In the following analysis, legal forms are thus also not distinguished. In general, only farms of the private sector were surveyed.

Table 3-3: Stratification of survey sample

Voivodship	no. of individual farms according to GUS definition	no. of private sector farms in survey frame	no. of farms in frame in % of no. of farms in GUS statistic*	no. of farms in sample	no. of farms in sample in % of no. of farms in frame	av. size of individual farms according to GUS definition (ha)	av. size of farms in sample (ha)
Szczecin	18,888	8,303	43.96	120	1.45	17.5	117.7
Tarnów	53,710	13,356	24.87	108	0.81	3.3	11.3
Rzeszów	115,757	29,627	25.59	236	0.80	3.3	10.9
Sample total	188,355	51,286	27.23	464	0.90	-	28.4
Poland total	2,041,380	-	-	-	-	7.0	-

Note: * Survey frame is no proper subset of GUS database on individual farms, see discussion in text.
Source: GUS statistics according to GUS (1998); author's calculations.

The survey is based on a random sample of farms in the record of the official extension service ODR (Ośrodek Doradztwa Rolniczego, Extension Centre of Agriculture). This contains roughly one third of all farms identified by the Central Statistical Office (Główny Urząd Statystyczny, GUS), though it is no proper subset of the GUS database on individual farms, since it also contains other organisational forms (see discussion above). In addition, the ODR record consists only of farms that show at least some degree of commercialisation and market integration and that account for the bulk of the traded agricultural produce in the research area. Farms surveyed generally are larger in size than farms identified by GUS (Table 3-3). The final sample consists of 464 farms; 120 from Szczecin, 108 from Tarnów, and 236 from Rzeszów. Within the given geographic boundaries of the three voivodships, it is a stratified one-stage random sample. In total there are 22 strata, seven forming the Szczecin voivodship, four the Tarnów, and eleven the Rzeszów voivodship. The 22 strata are identical with administrative districts (powiat). Table 3-3 shows a breakdown of the stratification of the sample on the voivodship level and the relation between the GUS database and the survey frame.

The questionnaire used was pre-tested in early 2000 and slightly modified afterwards. The final version consisted of sixteen sections. Section 1 covered the identification of the stratum the respondent belongs to. Sections 2 to 4 contained questions on household composition, occupation of household members, education, income sources, and savings behaviour. Sections 5 to 8 encompassed de-

tailed information on production activities including yields, revenues, and sales channels of plant and animal products, input use, assets and machinery of the farm, labour force, and expenses. Sections 9 to 14 entailed the core questions dealing with investment and finance including information on investment expenses, loan sources, loan applications, credit contracts, credit from suppliers, traders, relatives, and friends, and collateral. Section 15 closed with questions on farm management practice; Section 16 was intended to provide information on the course and success of the interview. Further details on sampling issues, organisation of data collection and a reprint of the questionnaire can be found in PETRICK (2001).

3.2.2 Problems due to the non-experimental nature of the data

The use of survey data for regression analysis implies a number of difficulties in applying the standard econometric tools which will be described in the following. Since detailed textbook treatments are available and because I present the employed formal estimation procedures below, I will confine myself to a brief outline. References with a particular emphasis on survey data are BEHRMAN and OLIVER (2000) and DEATON (1997).

The classical regression model assumes that the magnitude of an observed outcome variable Y (the regressand) can be explained by a set of independent variables X (the regressors) plus an error term (see e.g. GREENE 2000, pp. 213-223). The error term is assumed to be independently and identically distributed conditional on the X's, with a conditional mean of zero. Usually the interest focuses on one or several particular regressors (sometimes called 'treatment variables'), while the remaining regressors play the same role as the control group in an experiment: they allow for differences in Y that are not caused by the treatment and thus isolate the relationship of interest (DEATON 1997, pp. 92-93). All remaining statistical 'disturbances' (e.g. due to measurement error or unobserved explanatory variables) are captured by the error term. Efficiency and consistency of a regression analysis which aims at recovering the coefficients of the regressors fundamentally hinge on the assumptions concerning this disturbance term. Unfortunately, in survey data-sets it is often implausible that the standard assumptions hold, due to the nonexperimental nature of the data. The most common problems are described as follows, together with possible avenues for dealing with them.

Simultaneity

Simultaneity causes the conditional mean of the disturbance term to be *not* equal to zero. It can be made intuitive by considering a simultaneous equation system of regressions, which could for example arise in the framework of a household model (see section 2.3.1, pp. 77 et seq.). As soon as a regressor of a first equation appears as regressand in another equation, there will be a correlation between the disturbance terms and this regressor in the first equation. An example is a (structural) production function which contains variable inputs as regressors. The same inputs also occur as regressands in the (reduced-form) input demand function of the household, and are hence subject to simultaneity. The problem could also be regarded as one of an *omitted variable*. In the production function example, the exogenous determinants of the variable input quantity are not included into the equation, which leads to simultaneity (or endogeneity) bias. As a result, the regression analysis no longer yields consistent estimates of the coefficients of interest. Similar effects are produced by feedback processes, reverse causality, or measurement errors (see DEATON 1997, pp. 92-105; BÖRSCH-SUPAN and KÖKE 2002).

A possible way to address the simultaneity bias is by employing additional information in the form of variables which are correlated with the explanatory variable but not with the disturbance term. These are called 'instruments', the procedure hence *instrumental variable* (IV) regression. A common difficulty is to find instruments that have the just mentioned properties (see DEATON 1997, pp. 111-116), which is why the problem is frequently ignored (e.g. by CARTER and WIEBE 1990, KLAIBER 1988, THIJSSEN 1988, to mention a few studies cited earlier).

Selectivity

Selectivity occurs when the regression is based on observations which are *not a random subsample* of the population under investigation. It can be regarded as a special type of simultaneity, since the problem is again the correlation between disturbance term and explanatory variable. The present research provides an illustrative example. It will be seen that the farm population investigated here falls into two subsamples, borrowers and non-borrowers. The relation between, say, credit and output can hence only be estimated for the borrower subgroup. However, farmers do not become borrowers by chance but most likely have certain characteristics that influence the volume of credit obtained (being more innovative, have more collateral available, etc.). In a regression that relates output to credit and does not account for these systematic characteristics, their effects will

be captured by the disturbance term, which in turn will be correlated with the credit variable. The estimator will therefore be inconsistent (see DEATON 1997, pp. 101-105).

Among others, nobel laureate James J. HECKMAN has developed tools to address the selectivity problem (e.g. 1979; 1990). The strategy of his approach is to model the selection rule by a first-stage Probit equation, which can then be used to correct the regression of interest.

Heteroscedasticity

In the presence of heteroscedasticity, the assumption of an identical distribution of the error term conditional on the explanatory variables is violated. This may be the case, for example, if large farms show a greater variation in output than small farms, even after accounting for farm size. Heteroscedasticity hence reflects an inherent heterogeneity of the population, which is often observed in survey data. In an ordinary least squares (OLS) regression, heteroscedasticity will lead to inefficiency and incorrect standard errors. However, test procedures and robust estimators of the variance-covariance matrix which can address this issue in the framework of OLS are available.

Much more serious is the problem if *limited dependent variable models* are used for regression analysis (for example the Tobit model). In this case, heteroscedasticity can make the estimator inconsistent, and sometimes the only solution will be to rely on non-parametric methods (see DEATON 1997, pp. 78-92).

Sample design

The way the data was collected has a distinct influence on the results of a regression analysis. This influence may be due to a specific *weighting* procedure employed in the survey, or to *clustering* or *stratification* during the data collection.

To illustrate, consider the calculation of means from a sample of observations that had varying but known probabilities to be selected. It is quite intuitive that the computation must be corrected by using the known probabilities as weights if the mean of the underlying population is to be calculated. It might be suggested that this directly extends to the use of weights in regression analysis. However, there exists no straightforward procedure to incorporate weights into the regression since weighted least squares (WLS) is not guaranteed to be consistent (for a discussion see DEATON 1997, pp. 68-73). The standard approach (also followed here) is therefore to ignore the weights, which implies the assumption that behaviour across observations is homogenous.

Clustering leads to an underestimation of standard errors in regressions because clusters tend to be more homogenuous than the overall population. However, this procedure was not used in the data collection of the present study, which employed a stratification approach. It might be reasonable to pay attention to structural differences between strata and use a stratawise regression procedure (DEATON 1997, pp. 67-68). However, effects of stratification might also safely be ignored since stratification generally improves the precision of estimates (pp. 12-15; 49-51; 71). In the following analyses, an effect of sample design is thus not taken into account, which means that the sample is treated as if it were a simple random sample.

Data availability

This last section of the subchapter makes the point that (even) survey data rarely can fulfil all data wishes of the researcher, and sooner or later any emprical research comes to its limitations due to lacking data. The reasons for unavailable data may either be that, due to financial or time constraints, it simply *was* not collected, or even that it principally *cannot* be collected, for example because respondents were not able or willing to recall the necessary information. A particular problem in cross-sectional data-sets is that variation of certain variables will be quite low (for example price data), and that lagged variables (which may often be useful as instruments) by definition are not collected.

Another issue is *missing data* for a subgroup of respondents, a phenomenon commonly encountered in survey data. As soon as there is a systematic default due to some (possibly unobserved) characteristics of respondents, missing data will introduce a bias in any estimates. Although the non-response rates in the Poland farm survey 2000 were rather low (PETRICK 2001, p. 14), a certain loss of observations in the regressions was unavoidable (see below). The general lesson is hence that "data sets do not have to be perfect – they never are – and in fact much insight has been gained from data that are far from perfect in quality" (SINGH et al. 1986b, p. 66).

3.2.3 Outlier control

The use of more advanced econometric techniques requires a careful analysis of *outliers* in the data-set, in order to prevent an undue influence of single data points on the estimates (see MUKHERJEE et al. 1998, pp. 75-107; 137-148). A criterion frequently used is the interquartile range (IQR), where a data point is considered as an outlier if it lies 1.5 times the IQR below (above) the lower (upper) quartile of the sample. Based on a box plot analysis I identified several out-

lying observations (see also the histograms given in PETRICK et al. 2002, p. 207). To take an example from the given data set, with regard to total land cultivated, the upper threshold is at 60.3 ha, implying that 12.1 percent of observations must be considered as outliers. The problem is hence a relevant one. This was confirmed by explorative regression analyses which showed substantial influence of certian data points. After a careful inspection of the histograms of the employed variables, I therefore decided to generally cut off observations above some arbitrarily chosen level, which was in any case far above the previously defined outlier threshold.[75] As a consequence, 33 observations had to be dropped. It turned out that this substantially mitigated the problem of influencial data points. Nevertheless, in the subsequent regressions, particular attention was paid to the graphs of standardised residuals in order to control for any remaining influential observations.

3.3 Empirical strategy

This subchapter aims at describing the empirical approach chosen in the current research. I start with an overview and continue with the detailed presentation of the areas of empirical investigation. Descriptive statistics and results are presented in chapter 4.

3.3.1 Overview

The empirical investigation of credit rationing of Polish farm households presented in this monograph can be grouped into *three major steps*:

1. In order to evaluate the access to credit as perceived by farmers I analyse *qualitative information about credit rationing experience* collected during the interviews. This can be expressed in the form of a bivariate variable (rationed or non-rationed). Building on the theoretical analysis of subchapters 2.1 and 2.2, the *determinants of credit rationing* are investigated by a *Probit regression model*.
2. The central aims of the second step are to (a) quantify the credit-rationed household's *willingness to pay for credit* and to (b) investigate the consequences of non-separability of the households' production and consumption decisions, both by econometrically estimating an appropriately specified *household production model*. The theoretical point of reference here is the

[75] The cut-off levels employed were as follows. Short-term credit volume max. 140 ths. zł; long-term credit volume max. 600 ths. zł; total land cultivated max. 300 ha; capital stock net of farm land max. 1000 ths. zł; investment volume max. 1200 ths. zł.

two-period farm household model presented in section 2.3.1, pp. 77 et seq., which is why the focus is on the effects of *short-term loans*. Furthermore, the analysis serves the double purpose of providing a *metric measure* of credit rationing and a quantitative analysis of the *effects* of credit rationing *on farm output*.

3. My goal in the third step is to look at the effects credit rationing has on the *investment behaviour* of farmers. Based on the dynamic farm household model discussed in section 2.3.2, pp. 91 et seq., I derive an estimating investment function. This function not only allows to analyse the *determinants of farmers' investment activities* but also provides a tool to *test the implications* of the financial constraints model of investment with regard to access to *long-term loans*. It hence will give additional evidence regarding the presence of credit rationing.

The three steps are described in more detail subsequently. Before, however, an operational definition of credit rationing is required, which is given next.

3.3.2 An operational definition of credit rationing

In the empirical analysis, I regard a farm household as being credit-rationed if at the prevailing interest rate the credit volume demanded exceeds the volume offered by the lender. This definition is operationalised in different ways at various stages of the analysis as follows.

During the survey, the definition was operationalised by *asking respondents about their credit market experience* (see Approach 2 in section 3.1.3, p. 118). Credit applicants were asked whether they would have liked to borrow more at the same interest rate. If so, this is taken as evidence for an excess demand and the respondents are classified as being credit-rationed. Rationed applicants who obtained some credit are called *partially rationed*. Applicants who did not obtain a loan at all are classified as *completely rejected*. Non-applicants were asked whether they had the intention of applying for credit at a particular place in the past but did not do so because the application might have been turned down. Respondents who answered positively are classified as *discouraged non-borrowers* (see JAPPELLI 1990). Borrowers who obtained as much as desired and non-discouraged non-applicants are regarded as *not credit-rationed*.

In the household modelling analysis, credit rationing is operationalised by its *observable effects*. In the two-period farm household model, a binding credit constraint has two major implications (as presented in section 2.3.1): (a) the household's willingness to pay for credit exceeds the market interest rate offered

by the lender, and (b) production and consumption decisions become mutually dependent (see Approach 5, section 3.1.3, p. 124). I attempt to empirically detect both effects in the framework of an econometric output supply model.

In the dynamic household model, the effects of credit rationing are as follows (see section 2.3.2): (a) financial variables play a significant role in determining investment outcomes, and (b) there is a non-separability of consumption and investment decisions similar to the two-period production model. These effects shall be investigated in the framework of the investment function analysis (see also the discussion of Approach 6, section 3.1.3, p. 129).

3.3.3 Subjective experience of credit rationing

In the econometric analysis based on survey responses, the variable to be explained is the qualitative self-classification of borrowers. At first glance, the classification into several subgroups would suggest a model with a multinomial dependent variable. However, the groups of completely rejected and discouraged respondents turned out to be unimportant in the sample (see section 4.1.1, pp. 163 et seq.). I therefore merged these two categories with the group of partially constrained borrowers. As a result, the credit rationing status is expressed by a dichotomous or binary variable. It can be analysed by the following stochastic model:

$$k_i^* = \boldsymbol{\gamma}' \boldsymbol{z}_i + u_i \tag{3-1}$$

k_i^* is a latent variable denoting an excess credit demand. We observe k_i, which is a dichotomous (1, 0) variable indicating whether observation i is a credit-constrained borrower or not. $\boldsymbol{z}_i$ represents a vector of explaining variables (such as household and production characteristics). $\boldsymbol{\gamma}$ is a vector of parameters, while u_i is a random error term. (3-1) is hence a model with a discrete dependent variable (see AMEMIYA 1981). A plausible and frequently employed interpretation of this type of models is to regard its predictions as probabilities that observation i belongs to the constrained subgroup. Unfortunately, running an OLS regression on (3-1) would not ensure that the predictions are in fact bound in the (0, 1) interval. It is therefore usual practice to transform $\boldsymbol{\gamma}' \boldsymbol{z}_i$ and in this way constrain it to the desired interval. A commonly used transformation is the standard normal distribution, which gives rise to the Probit model (GREENE 2000, pp. 811-849).

In the following, the Probit model is employed to analyse the determinants of credit rationing as given by the subjective assessment of the respondents. I estimate a general and a specific model, the latter being specifically tailored to the

requirements of the output supply model investigated later. Probit models are non-linear in parameters, they are therefore usually estimated by Maximum Likelihood (ML). Furthermore, the reported coefficients do not provide the marginal effects of a change in $\boldsymbol{z}_i$ on k_i*. In non-linear models, marginal effects depend on the specific values of the regressors. They are therefore usually reported for the sample means, separately from the coefficients. Note that the Probit model implies a very general functional form. Since the exact functional relationship may be quite complex and is generally unknown, the Probit specification can only be regarded as a rough approximation to the real relationship (see the discussion in section 3.1.2, pp. 103 et seq.).

The choice of explanatory variables in the Probit model reflects the discussion of chapter 2 as summarised in sections 2.2.4, p. 74, and 2.3.3, p. 100. In particular, the following considerations were taken into account: (a) the presence of credit rationing is determined both by supply and demand, observable characteristics that guide the lending decision of the bank should hence be included, (b) this is specifically important for factors that are likely to mitigate or worsen effects of asymmetric information, for example collateral availability or the reputation of the borrower (see the discussion in section 2.2.2, pp. 55 et seq.), (c) on the other hand, consumption choices of household members are equally likely to affect the perceived rationing status of the household (see the discussion in sections 2.3.1 and 2.3.2, pp. 77 et seq.).

I first explain the specific model and then the general model. This is due to the fact that the specific model is further used in the household production analysis. The latter precedes the investment analysis, which employs the general Probit model.

In the *specific model* to be further used in production analysis, the dependent variable is credit rationing (yes/no) with regard to short-term loans taken during the production year 1998/1999. The specifity is that *only partially rationed and completely rejected short-term borrowers* are considered in this model, i.e. short-term borrowers who obtained a positive loan volume in 1998/1999 but not as much as desired and applicants for short-term loans who were fully rejected.[76] This decision was made in order to maintain consistency with the output supply model which is based on constrained short-term applicants only (see section 3.3.4, p. 149). It implies that borrowers of long-term loans (rationed or not) are considered as non-borrowers in this model.

[76] For completely rejected applicants the purpose of their loan application was known. This made their classification possible.

The following explanatory variables were chosen (expected signs are given in parentheses). Land owned (-) and land rented from private persons (+) were taken as indicators of the volume of collateralisable wealth, which is expected to play a key role in the presence of asymmetric information on the loan market. The age of newest tractor (+) was used as a simple measure of the quality of the collateralisable wealth. The years of farming practice indicate the experience of the farmer. They were also included in quadratic form, to allow an age dependent effect. Usually one would expect that up to a certain age, more years of farming experience imply a lower probability of being credit-rationed. A variable measuring the educational degree of the farmer (+) takes a value between one for the lowest and five for the highest degree. A dummy indicating the expressed habit of regularly conversing with neighbours (-) is used as a measure of village-internal information flow. Conversation with neighbours might reduce the probability of being credit-rationed due to improved information availability for the local bank. It is taken as a proxy for how well the respondent is known in the village. On the consumption side, the number of adult males and females were taken as household characteristics. The effect of the number of adults in the household is indeterminate since a higher number of household members may both increase (via increased consumption) and decrease (via generation of unearned income) the liquidity shortage. The separate inclusion of males and females is motivated by the fact that Polish women tend to benefit more from social transfer payments than men (WORLD BANK 1995, p. 117). In addition, the number of males or females may take on a signalling function for the bank. For example, more men in the households' labour force may indicate that more resources are devoted to actual farm production as opposed to household work, and hence may imply a higher creditworthiness. All explanatory variables are assumed to be exogenous or predetermined at the time of loan application.

The *general model* directly employs the definition of subjective credit rationing as given above, *independently* of any loan term. As the investment model discussed below, it covers a period of three years (1997-1999), which is nevertheless treated as a *single* decision period. A problem with investment and borrowing events is that they occur relatively rarely, as was illustrated for short-term borrowing. Confining the anlysis to one calendar year, as done for the production model, would have resulted in a lot of zero observations. The chosen approach of taking into account a period of three years considerably mitigates this effect. However, it has a number of consequences for the definition and choice of variables as compared to the specific Probit model presented previously. First, it was not necessary to restrict the analysis to a certain class of applicants only.

The dependent variable hence indicates by one all farm households which self-classified as credit-rationed according to the definition given in section 3.3.2, p. 145, irrespectively of the term structure of the loan. This decision led to an increase of the sample size of the investment model (see below). Second, the choice of explanatory variables was slightly modified. For land owned, I used the nominal value of land owned by the farm in the beginning of the investment period expressed in thousand zł, which was calculated by subtracting land investment carried out in the period 1997-1999 from the stated value of owned land in 1999. Land quality is hence captured as well, at least as long it is reflected in monetary land values. However, since the variable is based on farmers' own assessments of their land values, individual biases are possible. The volume of land rented from private persons was excluded from the equation because it is unplausible to regard this as exogenous and stable over a period of three years. The age of the youngest tractor was also regarded als endogenous in the investment model and hence excluded. Because they did not have significant effects, the educational and years of farming practice variables were excluded as well. However, a dummy was added indicating a previously rescheduled loan (+), which illustrates the credit history of the borrower. The rescheduled loan variable was taken from the interviews where respondents were asked whether they rescheduled the repayment of a loan in the past. This is regarded as evidence for a relatively poor reputation of the borrower. Furthermore, two dummies indicating the year in which the loan was approved by the bank were added to the model.[77]

Descriptive statistics of the variables and the estimation results are presented in subchapter 4.1.

3.3.4 Effects on production

In this monograph I use a *reduced-form output supply function* as the major instrument to empirically analyse the effects of credit rationing on production outcomes. The reader may recall from the discussion of Approach 5 in section 3.1.3, p. 124, that the major alternative is to use a production function instead. The justification for my choice is as follows:

[77] This variable does not capture the year of loan application of fully rejected farmers. However, since their number is very small as compared with the partially rationed borrowers (see section 4.1.1), this deficit of the data seems to be acceptable. Note further that a three year period requires two dummies indicating two of the three years. Three dummies indicating each of the year would lead to perfect collinearity and make estimation impossible.

1. As shown in the theoretical Section 2.3.1, pp. 77 et seq., the production function can be used to estimate the shadow interest rate of liquidity, provided it is used for production (by equation (2-34), p. 83). In contrast, the output-supply equation captures the willingness to pay for credit *independent* of the use of credit in the borrowing period for either production or consumption, by equation (2-46), p. 88. Therefore the latter is regarded as a more plausible measure of the actual payment abilities of the household.
2. In contrast to the reduced-form output supply equation, the production function is a structural equation (see section 2.3.1). Structural equations pose severe econometric problems of *simultaneity*, since the household's choice of input and output levels is reasonably assumed to happen simultaneously. Both are under the control of the decision maker. A major assumption of the standard regression model hence becomes questionable (section 3.2.2, p. 141). Reduced-form equations suffer from these problems to a much lesser extent, since they are constructed in such a way that the explanatory variables are exogenous.
3. Only the output supply model can also capture the *non-separability* of consumption and production decisions. In contrast to the production function, it explicitly takes the household modelling framework into account and allows a more comprehensive analysis of credit rationing.
4. A final reason for choosing the output supply approach was the *larger sample size* available for estimation. A production function analysis is limited to producers who used working capital loans, because only for these the volume of credit financed inputs is known from the survey data. To the contrary, the output supply function is estimated for households that borrowed *any type* of short-term loan independent of its purpose. This fact led to a sample size used for the output supply model which is approximately 20 percent larger than the production function sample.

Nevertheless, also the output supply approach has some drawbacks. Usually, reduced-form equations are regarded as less stable than structural equations, and they do not allow to recover the structural parameters underlying the decision model (SADOULET and DE JANVRY 1995, p. 160). In a separate research paper, the production function approach was hence investigated further (PETRICK 2003). The results of this paper will briefly be taken up in chapter 4.

Independently of the chosen approach, one further important aspect complicates the analysis. It is the fact that a significant effect of the credit ration on output

can consistently only be expected for the *subgroup* of farmers who indeed experienced an exogenous constraint on borrowing. For the constrained subgroup the amount of credit available reasonably imposes an upper limit that is *not* under the control of the household, at least in the short run. FEDER et al. (1990) therefore argue that the reduced-form output supply equation should only be estimated for farmers who self-classified as being credit-rationed according to the qualitative criterion explained above. A related point is made by CARTER and YAO (2002) who distinguish between *local* and *global separability* in agricultural household models. They maintain that usually only a fraction of households is constrained in some markets, which is why consumption-production dependencies should only be expected for this subgroup. CARTER and YAO provide evidence for the claim that a consistent analysis of (non-) separability can only be done for an appropriately chosen subset of household data. This is therefore also the strategy favoured in the present research, although I also estimated a 'counterfactual' model on the entire sample of short-term borrowers (see section 4.2.2, pp. 176 et seq.).

A fundamental consequence of this sample splitting procedure is that the estimation related to the credit-rationed subgroup of observations is not based on a random draw of the initial sample. This in turn is a typical case of *sample selectivity* (see section 3.2.2, p. 141). Fortunately, the specific Probit estimation described in the previous section provides the necessary information to test and correct the potentially resulting bias. The procedure is to include a so-called Inverse Mills Ratio (IMR) as additional regressor in the selected equation, resulting in a two-step Heckman model (for details see HECKMAN 1979; GREENE 2000, pp. 926-937). The IMR can be computed for each sample observation by using the results of the Probit equation (3-1), p. 146:

$$IMR_i = \phi(\hat{\boldsymbol{\gamma}}' \boldsymbol{z}_i) / \Phi(\hat{\boldsymbol{\gamma}}' \boldsymbol{z}_i) \qquad (3\text{-}2)$$

In this equation, $\phi(.)$ and $\Phi(.)$ denote the density and the distribution functions of the standard normal distribution. A decision concerning a potential selectivity bias can be based on the *t*-test for the parameter of the IMR in the second-stage regression (DAVIDSON and MACKINNON 1993, pp. 542-545; GREENE 2000, pp. 932-933).

The estimating equation is hence the output-supply function under credit rationing of the two-period household model presented in section 2.3.1, p. 86, restated here for convenience:

$$y = y(r, p^c, p^x, p^y, E, \overline{K}, z^h, z^y) \qquad (2\text{-}42)$$

The estimated coefficients of this function are used to compute the marginal willingness to pay for credit of each credit-rationed household, by utilising the relationship given in (2-46). The difference between estimated ρ^* and market interest rate can be regarded as a measure of credit rationing or credit market efficiency (as postulated by SIAL and CARTER 1996).

At this point, three issues of data availability arise (see section 3.2.2, p. 143). The first concerns the availability of *price data* in cross-sectional data sets. As frequently encountered in similar settings (see for example FEDER et al. 1990, p. 1155, fn. 7), price variation is very low in the present data base. Furthermore, household specific prices are only observed for output or input bundles which are in fact produced or employed by the household. One of the quite commonly reported price variables in the sample is the wage for agricultural workers. The regional means of this wage are as follows (in zł/hour): Szczecin 39.1 (N=101); Tarnów 39.0 (N=63); Rzeszów 40.4 (N=201). The median values are all equal to 40.0. Their regional variation is hence quite small. Sufficiently disaggregated regional price indices are also not available from official statistical sources. Furthermore, in explorative regression work, price variables including the market interest rate *r* did not turn out to have any significant impact on observed behavioural outcomes. I therefore decided to *disregard any price effects* in the analysis and made the assumption that the annual vector of input and output prices is identical for all observations. All monetary values were thus used without deflation. However, a dummy variable was included in the subsequent regressions to distinguish the northern from the structurally rather different southern regions in the sample. In case that the assumption of a uniform price vector is too restrictive, any regional differences may at least be captured by this dummy.

The second issue concerns the *measurement of initial liquidity endowment E* and its delimitation from credit $\overline{K}$. FEDER et al. (1990) purport to measure *total* liquidity as the sum of cash value of product inventory, deposits in financial institutions, and fungible formal loans (p. 1155, fn. 6), and use this aggregate instead of *E* and $\overline{K}$ in equation (2-42). In my opinion it is quite doubtful whether total liquidity as a stock variable in a given year can be meaningfully operationalised at all. To which point in time is it related? How is the liquidity of physical assets (for example product inventories) determined? How are the assets evaluated in monetary terms and how do they enter the calculation? It seems unlikely that these questions can be answered in a plausible and uncontroversial way, even neglecting the practical measurement problems in a survey. In the upshot, the problems of directly measuring *E* appear to be almost unsurmountable, which is of course not the case for $\overline{K}$. Therefore, a more appropriate solution seems to

include $\overline{K}$ as given by the reported loan volumes and regard E as being captured by the farm and household characteristics entering the equation. Implicitly, this is the approach taken by SIAL and CARTER (1996).

The third issue is related to the fact that many of the farm households which self-classified as credit-rationed according to the definition given in section 3.3.2, p. 145, borrowed long-term. The value of short-term credit hence was *zero* for the *majority* of observations. This implies that for all these respondents the variation in the variable $\overline{K}$ is also zero. In explorative work it turned out to be difficult to econometrically identify any effect of credit on output if the entire subsample of credit-rationed households was used. I therefore decided to neglect the discouraged non-appplicants for estimating the output equation. The analysis is hence restricted to the subsample of *short-term borrowers*, i.e. the partially rationed respondents who obtained a short-term loan, *plus the fully rejected applicants for short-term credit*, as indicated in section 3.3.3. An unfortunate consequence of this decision is that the sample size used for the output supply estimation considerably shrank (see section 4.1.2, p. 164).

It is now possible to characterise the estimating equation more specifically. Taken together, equations (3-1) and (2-42) form a system in which (2-42) is only observed if k_i=1. After the previously explained modifications, the *estimating output supply equation* hence looks as follows.

$$y_i = y_i(\overline{K}_i, z_i^h, z_i^y) + \varepsilon_i \text{ iff } \boldsymbol{\gamma}' \boldsymbol{z}_i + u_i > 0, \tag{3-3}$$

with ε_i a random error term. In this system, ε_i and u_i are supposed to have a bivariate normal distribution with zero means and a given correlation. The *marginal willingness to pay for credit* of the rationed subsample is estimated as (see equation (2-46))

$$\hat{\rho}_i * = \frac{\partial E(y_i)}{\partial \overline{K}_i} - 1, \tag{3-4}$$

with $E(y_i)$ the expectation of y_i. The value of $\hat{\rho}_i *$ can be computed for each farm household i and then compared with the observed interest rates. This is done by regressing the estimated willingness to pay on interest rates as follows (see a similar application in JACOBY 1993):

$$\hat{\rho}_i * = b_1 + b_2 r_i + e_i, \tag{3-5}$$

with e_i again a random error term. b_1 and b_2 are parameters to be estimated. The *statistical test* of credit rationing in the sense of a market inefficiency then in-

volves the null hypothesis (b_1, b_2) = (0, 1), which can be subjected to an F-test procedure.

In the light of the theoretical discussion of transaction costs given in section 2.1.4, pp. 32 et seq., it is reasonable to ask how a farm-individual value for the exogenous market interest rate r is determined. This is the place where the earlier considerations on relevant transaction costs come into play. In the determination of r, I *include loan-related transaction costs* and hence obtain a kind of actual market interest rate in the spirit of the Ohio State tradition. If the estimated endogenous willingness to pay is still far above the market interest rate cum transaction costs, it might be concluded that *measured* transaction costs are only a small portion of the overall difference between market and willingness to pay.

I calculated loan-specific transaction costs in a rather heuristic way that makes compromises with regard to the determination of opportunity costs. My total transaction costs include (a) *travelling costs*, depending on the distance between farm and bank and the number of visits as stated in the questionnaire, and (b) what could be called *signalling costs*, which comprise actual cash expenses due to additional fees, insurance, etc., and the opportunity costs of time spent waiting at the bank, all as given in the questionnaire. I call them signalling costs because they are related to the specifities of the loan contract (as opposed to conventional trade agreements without asymmetric information) and have to be borne by the borrower (see section 2.1.5, pp. 38 et seq.). A breakdown and comparison with the willingness to pay is given in section 4.2.2, p. 180.

A further important specification issue is the selection of the *functional form*. Unfortunately, the true form is usually unknown. In this case, choice is commonly based on one or both of the following two approaches (OUDE LANSINK and PEERLINGS 2001, p. 58): (a) selection with reference to a given catalogue of ad-hoc criteria, or (b) selection based on statistical tests.[78] I made use of both approaches. Based on a number of ad hoc criteria, a pre-selection was made, which was then confronted with the data. I first explain the criteria used for pre-selection based on a survey of functional forms by FUSS et al. (1978).

Out of five *criteria for choosing functional forms* given by FUSS et al. (1978, pp. 224-225), three are of particular importance for this study. First, the functional form should contain no more parameters than are necessary for consistency with

[78] If the true functional form is known one may also use a Monte Carlo simulation approach to test various approximations.

the maintained hypothesis. Second, functional forms should be chosen in which the parameters have an intrinsic and intuitive economic interpretation, and in which functional structure is clear. Third, the chosen functional form should be well-behaved in displaying consistency with maintained hypotheses such as positive marginal products or convexity.[79]

In the present case, the first criterion is of relevance due to the limited number of degrees of freedom for the output supply regression, which is based only on a sub-sample of the entire database. This fact limits the possible number of explanatory variables for which independent parameters can be estimated with some given precision, particularly if interaction terms as commonly used in parsimonious flexible forms should be employed. The chosen model specification should therefore concentrate on the most important variables without too much restricting the flexibility of the model. This flexibility was regarded as desirable particularly for the parameters determining the marginal willingness to pay, which involves the second and third criterion of FUSS et al. My aim was to find a specification sufficiently rich to allow the estimation of a function of the willingness to pay for credit that accounts for interactions with other explanatory variables and thus to reach a maximum of flexibility. At the same time, I regarded theoretical plausibility as a decisive benchmark for specifying the model. However, in the reduced-form output supply equation, this has much less importance than in other commonly estimated relationships (such as production or profit functions), particularly if no price variables enter the equation. It was explained above that even marginal credit effects lower than the market interest rate can be a theoretically plausible outcome. Fixed production factors are expected to show positive marginal products, although, just because they are assumed to be fixed, nonpositive marginal products are by no means theoretically inconsistent.

Most of the commonly employed functional forms are based either on a linear or a log-linear specification. Augmenting by appropriately chosen interaction and quadratic terms adds flexibility to these basic forms. For example, taking the linear specification as a starting point, a second-order approximation of an arbitrary functional form is the Quadratic. Adding cross-terms to the log-linear form (or Cobb-Douglas) yields the Translog (FUSS et al. 1978, pp. 230-240). In the explorative stage of research I started with a simple linear specification. This was in turn augmented by all cross terms for credit and the fixed factors, so that

[79] The fourth and fifth criteria are computational ease and extrapolative robustness, which are both of minor importance in the present context.

a restricted version of the standard Quadratic resulted. Adding also quadratic terms of credit and fixed factors led to a serious deterioration of the precision of estimates, presumably due to the small number of degrees of freedom left. I therefore worked with the restricted version that includes only cross terms. See subchapter 4.2, pp. 171 et seq., for results.

The major alternative was to use a logarithmic specification (see the functional forms used in the studies reported in Table 3-1, p. 126). The decision between the modified Quadratic and a logarithmic alternative was based on a *statistical test*. Since the competing models are nonnested, I worked with an artificial nesting procedure in spirit of the *J*-test (DAVIDSON and MACKINNON 1981), as proposed by GREENE (1995, section 14.4.5). In the alternative variant, the dependent variable as well as all linear and cross terms of regressors excluding the dummy variable were transformed by taking logarithms. Hence, a kind of restricted Translog function obtains. Each of the regressions was augmented by the difference between the predictions from the other model and the predictions for the other model produced by the initial one. Thus, the quadratic model was augmented by an additional regressor defined as the difference between the prediction of the logarithmic model and the logarithm of the prediction of the quadratic model. If this regressor is significant as tested by a conventional *t*-test, the logarithmic model adds significant fit to the quadratic model, providing evidence *against* the latter one. The logarithmic model is analysed analogously. The results of this test are given in subcapter 4.2; they unambiguously support the choice of the modified Quadratic. One caveat is, however, that the test is only asymptotically valid, which qualifies the result given the small sample size.

As dependent variable I use aggregate output supply measured in thousand zł. Output supply includes the products consumed by the farm household for human or animal nutrition, which were aggregated by imputed unit values (see PETRICK 2001, pp. 16-17). The independent variables are fixed factors of production, credit, and household characteristics to test the non-separability hypothesis. Fixed factors are operationalised as total land cultivated (ha), capital stock of farm net of land (thousand zł), and short-term credit volume (thousand zł). The credit variable includes the total volume of short-term loans taken in the production year 1998/99. Demographic characteristics of the household are captured by the number of adult males and females, to maintain consistency with the Probit model presented above. Household characteristics are added linearly to the model, so that the coefficients are the marginal effects on output supply. This resembles the approach of FEDER et al. (1990) and is a simplified version of D.

BENJAMIN (1992).[80] In addition to the presented variables, the estimating equation also contains a dummy indicating location in the northern region and the above mentioned IMR.

3.3.5 Effects on investment

The investment analysis aims at making the theoretical considerations of section 2.3.2, pp. 91 et seq., fruitful for an empirical investigation of Polish farm households' investment behaviour. In principle, it would be possible to base an empirical investment function on the flexible accelerator (2-56), p. 98. The optimal capital stock is a function of the arguments of $M(.)$ including optimal E, which in turn is determined by the household's preferences (see also KUIPER and THIJSSEN 1996, p. 458). A broadly similar approach has been used in the adjustment costs literature, although devoid of E, for example by LOPEZ (1985). However, estimation of the capital adjustment coefficient B is not the primary goal of the present study.[81] In contrast, in the empirical analysis, I want to focus on the *basic implication of the financial constraints model*, namely that investment depends on available collateral and credit access. I will therefore attempt to extract the essence of the model by means of an estimable *reduced-form investment equation*. This can be written as follows:

$$I = I(\dot{E}, E, Z, p) \tag{3-6}$$

In this equation, the capital stock, the output price, and the existing volume of equity E are taken as given at the beginning of the planning period. The change in E, denoted $\dot{E}$, is the result of the optimal plan of the decision maker in the current period.[82] In contrast to conventional neoclassical investment equations (ELHORST 1993, p. 170), note the presence of equity formation and the equity stock as financial variables.

Unfortunately, the empirical implementation of (3-6) faces a number of problems related to $\dot{E}$. First, $\dot{E}$ is *difficult to measure* if interpreted as a general im-

[80] Since D. BENJAMIN (1992) solely focuses on the significance of demographic characteristics, he uses the number of family members *plus* the fractions of several demographic categories (sex, age) as separate regressors in a log-linear labour demand equation (pp. 301-304). This type of specification can be derived from a scaling model in spirit of POLLAK and WALES (1981).

[81] Note that B cannot be estimated directly but is usually calculated indirectly from its determining functions (LOPEZ 1985, p. 45; WITZKE 1993, p. 210). In addition, B may be non-constant (MACCINI 1991, p. 24).

[82] Transfers T are not included separately since they affect I only via equity formation.

provement in collateral availability or even more broadly in credit-worthiness. Second, $\dot{E}$ is *not exogenous* because it is ultimately determined by the consumption preferences of the household. Furthermore, as argued by WITZKE (1993, p. 266), dynamic or long-term adjustment decisions of the household via $\dot{E}$ may generally be regarded as *unimportant* if the equilibrium of the system is distorted in each period by newly incoming information (for example with regard to the access to credit function) and a subsequent revision of the optimal plan. On theoretical grounds, this of course calls into question the usefulness of the entire dynamic model. On the other hand, the existence of short-run distortions corresponds to the stated perception of borrowers who still experience that the maximum loan amount is externally dictated by the bank. According to the model of section 2.3.2, borrowers *know* the marginal cost of borrowing dependent on their E and thus the amount of credit they obtain, an assumption that should exclude any perceived excess credit demand.

For these reasons, I replaced $\dot{E}$ by the change in net borrowing, $\dot{K}$. The observed level of net borrowing $\dot{K}$ might be regarded as the ultimate outcome of household preferences, its credit worthiness, *plus* all types of short-term distortions. Note that the inclusion of $\dot{K}$ has three further advantages: first, $\dot{K}$ is easily observed. Second, $\dot{K}$ can be assumed to be exogenous for rationed borrowers who said that they wanted to borrow more. Third, it opens the opportunity to directly investigate the relationship between new borrowing and investment. The latter is of particular interest for the current study due to its *policy implications*. Since the government actively supports credit expansion in the farm sector, the marginal effect of credit on investment is quite valuable information; the point is further explored below. If $\dot{K}$ is included into the investment equation, E can be dropped, since its only effect on I is through $\dot{K}$. Two further modifications concern the exclusion of prices, for the same reason as in the output supply model discussed previously, and the inclusion of a vector of dummy variables ζ, capturing regional and farm specific effects.

I also experimented with two further dummies indicating the year of investment, and thus capturing any effects of changed overall price relations and other year-specific effects (see similarly CALOMIRIS et al. 1986, p. 458). Year effects might be included because, although the data-set is cross-sectional in nature, it comprises pooled investment data for a period of three years. However, these effects turned out to be not significant in any of the estimations and were hence neglected.

The investment equation is again estimated only for households classified as credit-rationed according to the qualitative criterion of section 3.3.3, pp. 146 et seq. I assume that the financial constraints model of investment is applicable only for these households. Furthermore, this procedure reduces the danger of endogeneity of the credit variable $\dot{K}$. Since the relevant information is available from the Probit equation, I can again test for selectivity by including the IMR.

The estimating investment equation is therefore:

$$I_i = I_i(\dot{K}_i, Z_i, \zeta_i) + \varepsilon_i \text{ iff } \boldsymbol{\gamma z}_i + u_i > 0 \qquad (3\text{-}7)$$

The determination of $\dot{K}$ is hence analysed by the first-stage Probit equation, which contains variables of collateral availability and creditworthiness as well as demographic characteristics of the household, see section 3.3.3.

For later reference, I briefly restate the expected signs of the parameters to be estimated in (3-7). By (2-55), p. 97, the relation between change in net borrowing and investment is unambiguously positive. The effect of Z on I depends on the size of the desired capital stock or farm size. A negative sign implies that farm sizes converge over time, whereas a positive sign implies diverging farm sizes. ζ includes a dummy indicating whether the farm has permanent bookkeeping, which might be taken as a measure of management skills of the farmer. It is likely that more skilled farmers invest more. A second dummy has the value of one if the farm is located in the northern region. The effect on investment is also likely to be positive.

The dependent variable in equation (3-7) poses three further specification problems, to be discussed subsequently: (a) discontinuity of the investment variable, (b) censoring of the investment variable, and (c) the choice of functional form.

First, investment may be *discontinuous* or lumpy (MUNDLAK 2001, p. 57). This problem is ignored, justified by the fact that the volume of investment is the sum of all investment expenses over a relatively long period of three years (1997-1999). Discontinuities therefore even out to a certain extent.[83]

Second, more seriously, approximately 20 percent of observations report a zero investment volume. This implies that the dependent variable is *censored* to some extent, which should be reflected in a possibly non-linear formulation of the model. In addition, non-linearity is also addressed more explicitly as a result of

[83] An innovative approach to account for lumpy investment is to use an ordered Probit model for the investment variable, see OUDE LANSINK and PIETOLA (2002).

the third problem, which is related to the choice of the *functional form*. Before explaining this, it seems useful to briefly highlight the policy implications of the credit variable.

As noted earlier, the potential effect of new borrowing on investment is of key interest due to its policy relevance. A marginal effect of credit on investment equal to or larger than one implies that additional funds are completely used for productive investment. This describes a situation where subsidised credit is fully used for investment and even triggers the additional mobilisation of other financial sources, which is clearly desirable from the point of view of the government. On the other hand, a marginal effect smaller than one implies that the marginal unit of credit is only partly used for the supposed investment purpose. However, the marginal effect is unlikely to be constant over the entire range of observations, as would be imposed by a linear model. It is of interest whether there are any size effects of credit use, or whether more credit implies a higher marginal investment effect. Due to the complex interactions between creditworthiness and investment via the access to credit function, substantial nonlinearities can be expected to be present. The *change* in the marginal credit effect can be investigated by evaluating the second derivative of the investment function with regard to credit. Therefore, the latter effect should not unduly be constrained by the choice of functional form.

To address the censoring problem, I considered a *Tobit model* (AMEMIYA 1984; GREENE 2000, pp. 905-926) in the estimation of the investment equation. Conventional marginal effects in the Tobit model vary with different values for the regressors. They give the total effect of a change in explanatories on the observed, censored investment volume. In an imaginary way, the latter effect can be decomposed into an effect on the conditional mean (and thus the size) of investment *plus* an effect on the probability that the farm invests at all (MCDONALD and MOFFIT 1980). The implicit assumption of the Tobit model is that the given regressors explain *both* effects. In the present study, the *uncensored* part of the model is the relationship of interest, whereas the qualitative choice whether to invest or not is not analysed more deeply. Regarding the zeros as implying unobserved disinvestment might provide a rationale for this approach. In this case, the marginal effects are given by the *coefficients* of the Tobit model (JOHNSTON and DINARDO 1997, pp. 436-439).

In the standard Tobit formulation, the level of investment is still explained by a model that is linear in parameters. However, by including *higher-order polynomials* into the equation, the model can be made more flexible. The aim of intro-

ducing more flexibility is to trace more closely the true functional relationship between credit and investment. I hence augmented the Tobit equation by a quadratic and a cubic term for the credit variable. This is assumed to contribute little to improve the explanatory power of the model with regard to the decision to invest at all (i.e. the qualitative choice part of the Tobit model). The virtue of this procedure is that a cubic function for the uncensored part of the investment equation obtains, which can be used for the further analysis of the credit-investment relationship.

Investment volume in thousand zł is the aggregate of all productive investment, including land, all types of agricultural machinery, farm buildings, livestock, permanent crops, to name the most important components (see the detailed description in section 4.3.1, pp. 184 et seq.). Only gross investment is considered here, to avoid the difficult choice of a depreciation rate. Credit access was measured as the total volume of credit with a repayment term of more than 12 months taken by the farmer in the period 1997-1999. There were 81 single loan contracts reported for the group of farmers under investigation. 78 percent of borrowers obtained at least one loan under the government program. The capital stock Z at the outset of the investment period was difficult to measure, since detailed statements on farm assets were only available for 1999. I used the nominal value of land owned by the farm in the beginning of the investment period, as in the Probit model. The advantage of using land as compared to other assets is that the problem of depreciation can reasonably be ignored.

3.3.6 Limitations of the approach

The previous sections aimed at making the empirical approach of the current research transparent and understandable for the reader. However, the general limitations of this type of econometric analysis as discussed in section 3.1.2, pp. 103 et seq., still apply.

A more specific limitation concerns the distinction of credit rationing and underinvestment as used in the theoretical chapter. Consistent with the discussion in subchapter 3.1, pp. 102 et seq., the previously presented methodological apparatus seems appropriate to correctly identify credit rationing as the presence of *private* excess demand (given an exogenous interest rate). To the contrary, *underinvestment* as a deviation from the social optimum can only be detected to the extent that it coincides with credit rationing. As argued in section 2.2.3, pp. 63 et seq., in the presence of asymmetric information, it is not necessarily the case that observed market interest rates correctly reflect economy-wide scarcities. Since I

analytically separate the demand side of the credit market from the supply side, I cannot perform a rigorous welfare analysis. However, if the marginal willingness to pay for credit *substantially* exceed market interest rates, this is at least suggestive evidence that remunerative investment cannot be carried out. This issue is taken up again in chapter 5.

4 EMPIRICAL RESULTS ON CREDIT RATIONING OF POLISH FARM HOUSEHOLDS

The following chapter presents the results of the empirical investigation of credit rationing in rural Poland. This consists of a number of descriptive statistics and the results of the econometric estimations as explained in detail in the previous chapter. I do neither provide an in-depth discussion of the structural properties of the farms surveyed nor of differences between regions. These issues, together with a comparison of Polish and German farms, are treated more extensively in PETRICK et al. (2002).

The structure of the chapter reflects the discussion of the empirical approach in chapter 3. In subchapter 4.1, I present the results of the qualitative choice model. Subchapter 4.2 covers the output supply model together with an examination of the difference between willingness to pay for credit and market interest rate. Subchapter 4.3 gives the results of the econometric investment analysis.

4.1 Qualitative information on credit rationing

In this subchapter I present the results of the analysis of qualitatve statements by farmers as explained in sections 3.3.2 and 3.3.3, pp. 145 et seq. After a descriptive overview is given (section 4.1.1), I present the estimates of the specific (section 4.1.2) and the general (section 4.1.3) Probit model, followed by a summary of findings (section 4.1.4).

4.1.1 Overview of credit rationing based on qualitative information

I start with a descriptive evaluation of the credit market experience of farm households in the regions surveyed.[84] Table 4-1 gives an overview of the individual assessment of rationing outcomes according to the methodology described in section 3.3.2. The calculation was made *before* the sample was reduced due to outlier control (see section 3.2.3, p. 143).

[84] This study is only concerned with formal bank credit, whereas trade credit and informal credit is neglected. Although both of the latter sources represent interesting research areas as such, they were excluded due to their relative unimportance in the sample. Out of the totally recorded 668 credit transactions in the sample, 73 percent were bank loans. The total volume of issued bank loans was 17.6 mln. zł, whereas trade credit amounted to .8 and informal credit to .3 mln. zł only.

Table 4-1: Frequency of rationing experience (total sample)

Rationing experience	*Observations*	*Percent*
satisfied applicant	185	41.4
partially rationed applicant	168	37.6
completely rejected applicant	4	.9
not interested non-applicant	71	15.9
discouraged non-applicant	19	4.3
total	447	100.0

Notes: Includes all types of loans applied for between 1997 and 1999. Key to table: satisfied applicant: applied at least at one bank, received at least one loan, and did not want to borrow more at most recent loan; partially rationed applicant: applied at least at one bank, received at least one loan, and did want to borrow more at most recent loan; completely rejected applicant: applied at least at one bank and did not obtain any loan at all; not interested non-applicant: did not apply and is not discouraged; discouraged non-applicant: did not apply because fear of rejection. Not corrected for outliers. Missing observations were skipped.
Source: Author's calculations based on Poland farm survey 2000.

The table shows that by far the most important groups are the satisfied and the partially rationed applicants. 16 percent of respondents were not interested in borrowing at all, and only a small minority was completely rejected or discouraged. It can hence be concluded that *about 80 percent of farmers in the sample are borrowers*, and that *perceived excess demand is a relevant problem for almost half of the borrowers*.

Due to the relative unimportance of fully rejected and discouraged respondents, I consider these two groups together with the partially rationed group as the pool of credit-rationed respondents in the following. In contrast, satisfied applicants and not interested non-applicants are regarded as not credit-rationed. Hence, I work with a *dichotomous* classification.

In the sequel, I also distinguish between short-term and long-term loans. Short-term loans are defined by a loan term of up to 12 months, and long-term loans by a term of more than 12 months.

4.1.2 Specific Probit model

In the specific Probit model the dependent variable captures rationed short-term applicants vis-à-vis all other respondents, as explained in section 3.3.3, p. 146.

Table 4-2 breaks down the sample into constrained and unconstrained respondents as well as borrowers and non-borrowers. The table only includes observations which are also used for the Probit estimation below. As in all following statistics, due to the exclusion of outliers as described in section 3.2.3, p. 143, there is a loss of observations as compared with Table 3-3 and Table 4-1.

Table 4-2: Frequency of rationing experience (specific model)

Rationing experience	*Observations*	*Percent*
Constrained respondents (short-term)	51	12.4
Unconstrained respondents (short-term)	361	87.6
Borrowers (short-term)	114	27.7
Non-borrowers	298	72.3
All respondents	412	100.0

Notes: Considers short-term loans taken in the production year 1998/99.
Source: Author's calculations based on Poland farm survey 2000.

Approximately three quarters of respondents did not borrow any short-term loans at all. Notice that non-borrowers (of short-term loans) might be borrowers of long-term loans (see section 3.3.3). Among the borrowers of short-term loans, 80 percent obtained a loan with a subsidised interest rate (not shown in the table). Almost half of the borrowers self-classified as credit-rationed, similar to the evaluation over all loan types given earlier. 51 farm households must be regarded as being credit-rationed with regard to short-term loans, these are the households indicated by one in the dependent variable of the Probit regression.

Table 4-3 displays a number of descriptive statistics of the variables used in the Probit regression.

Table 4-3: Description of variables used in the Probit regression (specific model)

Variable	*Mean*	*Std. Dev.*	*Minimum*	*Maximum*	*Valid observations*
Credit-rationed short-term borrower (dummy)	.1	.3	.0	1.0	412
Total land owned (ha)	13.4	16.7	.0	142.9	412
Land rented from private persons (ha)	2.4	5.6	.0	52.5	412
Age of newest tractor (years)	10.7	6.6	.0	37.0	412
Farming practice (years)	22.1	9.8	.0	60.0	412
Educational degree (1..5)[1]	3.4	.8	1.0	5.0	412
Adult males in household (no)	1.8	.9	.0	5.0	412
Adult females in household (no)	1.7	.9	.0	5.0	412
Conversation with neighbour (dummy)	.7	.4	.0	1.0	412

Notes: [1] Educational degree indexed as follows: 1=not completed primary education, 2=completed primary education, 3=completed vocational school, 4=completed technical school or liceum, 5=completed university.
Source: Author's calculations based on Poland farm survey 2000.

The results of the Probit estimation are given in Table 4-4. The table also contains marginal effects, which are calculated at sample means and are expressed in percentage points (for example, one ha additional land owned reduces the probability of being credit-rationed by about .09 percent at sample means). For the farming practice variable no marginal effect is given, since there exists no straightforward way to calculate it for interacted variables (AI and NORTON 2003).

Table 4-4: Probit estimates of the probability of being credit-rationed (specific model)

	Coefficient	t-*value*	*Marginal effect*
Constant	-2.693	-4.089	–
Total land owned (ha)	-.005	-.762	-.086
Land rented from private persons (ha)	.053	3.920	.931
Age of newest tractor (years)	.034	2.562	.601
Farming practice (years)	.012	.352	–
Farming practice square	>-.001	-.508	–
Educational degree (1..5)	.121	1.052	2.109
Adult males in household (no)	-.157	-1.547	-2.732
Adult females in household (no)	.267	2.696	4.651
Conversation with neighbour (dummy)	.453	2.086	6.953
χ^2 *of* γ*=**0*** *(significance)*	36.242 (<.001)		
Percent correctly predicted (threshold= .5)	0s: 99.4, 1s: 7.8		
Percent correctly predicted (threshold= .12)	0s: 65.4, 1s: 74.5		
Observations	412		

Notes: Marginal effects in percentage points, calculated at sample means.
Source: Author's calculations based on Poland farm survey 2000.

The coefficients of four out of nine explanatory variables are significant at least at the five percent level; significance of the other five is weaker. To the extent that they were derived theoretically, all statistically significant coefficients but one have the expected sign.

The key indicators of collateralisable wealth suggest that collateral is of major importance as a determinant of credit rationing: less land in owned property, as well as a higher amount of rented land, imply a higher probability of being credit-constrained. According to its *t*-value, the amount of land rented from private persons is the most important determinant of credit rationing. The quality of the collateral also has a statistically significant influence, since farms with older tractors are more likely to be credit-rationed.

Somewhat surprisingly, neither the farming experience nor the education of the farmer play a significant role for the probability of being credit-rationed. Regarding the other household characteristics, the coefficient of the number of females is significant at less than one percent. Apparently, more women in the farm household tend to tighten the credit constraint, which is in contrast to the conjecture that higher public transfer payments for females increase the available liquidity. Alternatively, more women in the household could make the farm less creditworthy due to a higher share of labour devoted to farm production as opposed to household work. The reverse holds for men, however less significant.

The positive coefficient of the dummy on village internal information flow is contrary to expectations. Given this fact, the interpretation of the coefficient is difficult, although it has a statistically significant impact. A possible explanation is that better information about farming activities of a given borrower led the bank to the impression that this borrower is in fact *not* creditworthy. He may thus have obtained less credit than expected and consequently classified himself as credit-constrained.

The null hypothesis that all coefficients of the model except the constant are zero as represented by the χ^2-statistic is clearly rejected. The given fit measures are in a range commonly observed in the literature. Since the distribution of the dependent variable is very unbalanced, the percentage of the correctly predicted values is given for two thresholds for predicting $k^* = 1$: the standard value .5 and the share of the 1s in the sample, .12 (for further discussion see GREENE 2000, pp. 833-834). As expected, the second threshold resulted in a substantially higher percentage of correctly predicted 1s, at the cost of fewer correctly predicted 0s.

4.1.3 General Probit model

The general Probit model is directly related to the qualitative statements tabulated in Table 4-1, p. 164. It is general in the sense that it does not filter out any rationing events by restricting the investigation to short-term loans. All types of loans over the whole reporting period 1997-99 are captured by the dependent variable in this regression. However, as explained previously, to obtain a dichotomous variable, partially rationed, fully constrained, and discouraged respondents were all simply considered as being credit-rationed and not distinguished further. The variables used are described in Table 4-5.

Table 4-5: Description of variables used in the general Probit model

Variable	*Mean*	*Std. Dev.*	*Minimum*	*Maximum*	*Valid observations*
Credit-rationed (dummy)	.5	.5	.0	1.0	345
Total land owned beginning of 1997 (thousand zł)	65.2	88.6	.0	600.0	345
Adult males in household (no.)	1.7	.9	.0	5.0	345
Adult females in household (no.)	1.7	.9	.0	5.0	345
Previous loan rescheduled (dummy)	.1	.3	.0	1.0	345
Conversation with neighbour (dummy)	.7	.5	.0	1.0	345
Year of loan approval = 1997 (dummy)	.3	.5	.0	1.0	345
Year of loan approval = 1998 (dummy)	.2	.4	.0	1.0	345

Source: Author's calculations based on Poland farm survey 2000.

It may be noted in passing that the exact mean of the Previous loan rescheduled variable is .125, which means that 12.5 percent of respondents rescheduled a loan in the past. The survey data does not allow to calculate a repayment rate for agricultural loans; KARCZ (1998, p. 96) reports that this is commonly quite high among Polish farmers (98 percent).

The regression results of the general Probit model are displayed in Table 4-6. The results broadly support the findings of the specific model. The only exception is the collateral variable Total land owned beginning of 1997, the coefficient of which is not significant. To the extent that the volume of available collateral is appropriately measured it can hence be concluded that it is of less importance in the general observation of credit rationing. On the other hand, the reputation effect as measured by the Previous loan rescheduled dummy is quite important, with a *t*-value of almost three. At sample means of all other variables, the subgroup of respondents who rescheduled a loan in the past had a 30 percentage points higher probability of being credit-rationed than the subgroup with a better reputation. Reputation thus plays a key role in determining credit access of farm households. Household characteristics have a similar influence as in the specific model, although the relative significance of males versus females changed as compared with the earlier results.

Table 4-6: Probit estimates of the probability of being credit-rationed (general model)

	Coefficient	t-*value*	*Marginal effect*
Constant	-.272	-1.163	–
Total land owned beginning of 1997 (ths. zł)	<-.001	-.300	-.010
Adult males in household (no.)	-.217	-2.652	-8.581
Adult females in household (no.)	.149	1.813	5.894
Previous loan rescheduled (dummy)	.737	2.998	29.151
Conversation with neighbour (dummy)	.448	2.850	17.711
Applied in 1997 (dummy)	-.258	-1.691	-10.199
Applied in 1998 (dummy)	-.086	-.453	-3.402
χ^2 *of* γ=**0** *(significance)*	26.985 (<.001)		
Percent correctly predicted (threshold= .5)	0s: 70.9, 1s: 47.4		
Observations	345		

Notes: Marginal effects in percentage points, calculated at sample means.
Source: Author's calculations based on Poland farm survey 2000.

The regression also reveals that applying in 1997 significantly reduced the probability of being credit-rationed. This finding is quite in line with the fact that governmentally subsidised credit expansion in the farm sector showed a clear peak in this year (see Figure 1-4, p. 10). In subsequent years, governmental credit programs were cut down, which arguably resulted in a relative deterioration of credit access of farmers (see subchapter 1.2, pp. 7 et seq., and CZERWIŃSKA-KAYZER 2000, p. 12).

It might be suspected that rationing of farmers was due to the *depletion of government funds* for subsidising credits. Since most farmers borrowed under the preferential state program, this could be expected. Whereas prior to 1995 government subsidies were not fully utilised, this was apparently no longer the case in 1996 (CHRISTENSEN and LACROIX 1997, p. 18). Due to the subsequent cut in credit lines, it is unlikely that there were unused subsidies in the years 1997-1999. However, POGANIETZ and WILDERMUTH (1999, p. 539) suggest that rationing due to exhaustion of government funds would have taken the form of *complete rejection* of borrowers. This is because credits were extended accord-

ing to the first-in-first-out principle, up to the point where there were no funds left. This is in contrast to the fact that respondents in the current sample overwhelmingly report *partial* rationing (Table 4-1), which considerably weakens the argument of exhausted government funds.

4.1.4 Summary

The results of the analysis of qualitative information on credit rationing can be summarised as follows. According to statements of farmers made during the survey, 80 percent of farm households took at least one loan in the reporting period 1997-1999. Almost *half of the borrowers* obtained *less credit than desired* and are hence regarded as credit-rationed. Completely rejected applicants and discouraged non-applicants are of minor importance in the sample.

Central determinants of credit rationing as revealed by a Probit regression analysis are the *reputation of the loan applicant* as well as *demographic household characteristics*. Over all loan types, respondents with a good credit history have a 30 percentage points lower probability of being rationed than borrowers who rescheduled a loan in the past. In addition, more adult males in the household decrease the probability of being credit-rationed, while more females increase it. This is assumed to be an effect of higher liquidity demand for consumption purposes by women or a signalling effect due to the higher share of male labour force. If only short-term borrowing is considered, *collateral availability* is an additional key factor of credit rationing, since more land owned and less land rented decrease the likelihood of becoming rationed. Finally, there is some evidence *against* the view that a *depletion of subsidised funds* is a major reason for rationing outcomes.

4.2 Output supply model

The empirical output supply model is the major tool to analyse the effects of credit on farm output, as discussed in detail in section 3.3.4, pp. 149 et seq. In particular, it allows to quantify the marginal willingness to pay for credit as a metric measure of credit rationing and to trace the effects of household characteristics on output supply, see the theoretical section 2.3.1, pp. 77 et seq.

In section 4.2.1 I present the basic results of the estimation. In section 4.2.2 the marginal willingness to pay for credit is analysed further and compared with farm-specific market interest rates, and the non-separability hypotheses is examined. Section 4.2.3 summarises the findings of this subchapter.

4.2.1 Results of the estimation

First, I give an overview of the variables used in the estimations. Table 4-7 presents a number of descriptive statistics based on the subsample used for estimation, which consists of rationed applicants for short-term loans (see section 3.3.4).

Table 4-7: Description of variables used in the output supply model (rationed subsample)

Variable	*Mean*	*Std. Dev.*	*Minimum*	*Maximum*	*Valid observations*
Aggregate output supply (thousands zł)	62.9	54.8	1.2	243.5	46
Total land cultivated (ha)	22.7	27.1	1.8	145.0	46
Capital stock of farm net of land (ths. zł)	223.0	152.9	21.5	843.0	46
Credit volume short-term (ths. zł)	6.9	10.2	.0	60.0	46
Adult males in household (no.)	1.7	.7	1.0	4.0	46
Adult females in household (no.)	2.0	1.0	.0	5.0	46
Farm is located in northern region (dummy)	.2	.4	.0	1.0	46

Source: Author's calculations based on Poland farm survey 2000.

Table 4-8 presents the results of two different specifications of the reduced-form output supply model. Model I is the base model as discussed in section 3.3.4. Model II is regressed over the entire sample of short-term borrowers, including non-rationed farmers, and is hence called counterfactual. The rationale for estimating Model II is explained shortly below. However, I first concentrate on Model I.

Table 4-8: Estimates of reduced-form output supply model

	Base model on rationed subsample (I)		*Counterfactual on entire sample (II)*	
	Coefficient	t-*value*	*Coefficient*	t-*value*
Total land cultivated (ha) [A]	5.421	5.085	-.082	-.194
Capital stock of farm net of land (ths. zł) [B]	.094	2.491	.074	2.198
Credit volume short-term (ths. zł) [C]	.805	.324	2.741	2.600
A * B	-.012	-3.294	.003	2.879
A * C	-.048	-3.813	.015	1.187
B * C	.018	1.591	-.008	-3.805
Credit-rationed short-term (dummy) * C	–	–	1.684	2.269
Adult males in household (no.)	-.364	-.057	4.479	1.212
Adult females in household (no.)	11.216	2.012	3.251	.856
Farm is located in northern region (dummy)	-50.630	-2.554	-19.204	-1.573
Inverse Mills Ratio I	15.530	1.122	–	–
Inverse Mills Ratio II	–	–	13.437	.826
F-*value (significance)*	10.75 (<.001)		18.61 (<.001)	
Adjusted R²	.684		.651	
Observations	46		105	

Notes: Regressions include constant. All *t*-values corrected for selection according to HECKMAN (1979).
Source: Author's calculations based on Poland farm survey 2000.

F-value and adjusted R² of Model I indicate that the significance and the explanatory power of the entire model are quite satisfactory. Furthermore, the majority of coefficients could be identified with sufficient precision to allow a rejection of the null hypotheses that the coefficient is not significantly different from zero.[85] Exceptions are the direct credit effect, the cross term B*C, the

[85] The critical values from the *t*-distribution for 35 degrees of freedom are 1.690 at the 90 percent level, 2.030 at the 95 percent level, and 2.724 at the 99 percent level.

Adult males variable, and the Inverse Mills Ratio. The first two affect the marginal effects of the fixed production factors and the credit variable, of which the latter is of central interest in this research. I hence calculated the marginal effects on output of land, capital, and credit together with their *t*-values by employing the so-called *delta method* (DEATON 1997, pp. 128-129; GREENE 2000, pp. 357-360).[86] The delta method allows to compute standard errors of transformations of estimated coefficients. In the given linear case, the standard errors can be simply obtained as linear combinations of the elements of the covariance matrix (GREENE 2000, p. 85). The usual *t*-value can then be used to test the null hypothesis that the marginal effects at given sample means of the involved variables are zero (pp. 273-274). I also calculate marginal effects at sample medians, since the distribution of the variables is rather dispersed, as becomes clear by comparing means with minimum and maximum values in Table 4-7.

Table 4-9: Marginal effects of fixed production factors and credit at sample means and medians

Marginal effect calculated at...	*means*	*(t-value)*	*medians*	*(t-value)*
Total land cultivated (ha)	2.399	4.905	2.850	5.248
Capital stock of farm net of land (ths. zł)	-.058	-1.503	.027	.906
Credit volume short-term (ths. zł)	3.638	3.795	3.824	3.738

Notes: Calculations based on coefficients and covariance matrix of Model I.
Source: Author's calculations.

Table 4-9 displays marginal effects and their *t*-ratios computed at means and medians of the rationed subsample. The table suggests that the marginal effects are usually positive, with the exception of fixed capital calculated at sample means, which is barely negative. However, it could not be identified to be significantly different from zero anyway. It can hence be concluded that the marginal contribution of fixed capital to output supply is quite small. To the contrary, marginal effects for land and credit are significantly positive and were estimated quite precisely.

As set out in the theoretical discussion (section 2.3.1, pp. 77 et seq.), marginal effects of credit as calculated here are a correct measure of the marginal willingness to pay for credit only if there are no effects of credit on inputs *not* under the credit constraint. To test this, a reduced-form *input demand function* completely analogous to (3-3), p. 153, was estimated. I used the same regressors, the same

[86] I am grateful to Vassilis HAJIVASSILIOU for an instructive hint.

functional form and the identical selection mechanism as for the output supply equation.[87] The dependent variable was taken from the survey results and measures intermediate input purchases which are not credit financed (see PETRICK 2003). Its mean is at 26.7 thousands zł with a standard deviation of 30.3, the minimum is .3 and the maximum value 124.4 for the selected sample. The marginal effect of credit on input demand at sample means was .363 with a *t*-value of .628, which is not significantly different from zero at any conventional level of significance. The chosen approach is hence a consistent way to estimate the marginal willingness to pay for credit, following equation (2-46), p. 88.

The credit effect will be examined in more detail in the following section, as will be the significance of the demographic variables. The validity of the marginal effects of land and capital can be assessed by a comparison with descriptive farm indicators given by PETRICK et al. (2002), which are based on the same data set as the present research. With regard to land, the authors report an *average* revenue from farm production ranging between 1.974 and 3.043 ths. zł per ha.[88] This is quite the order of magnitude of the marginal effect of land on output given in Table 4-9. Similarly, the average return on fixed capital is reported to be quite low or even negative, which fits well into the picture of an almost zero marginal effect of capital on output.

The signs of the cross-terms can be interpreted as follows. First, the marginal effect of land on output decreases with increasing capital. This could be explained by a lower labour intensity with regard to land on capital-intensive farms. Second, the marginal effect of credit increases with increasing capital stock, but decreases with increasing land. This implies a *ceteris paribus* higher willingness to pay on farms operating capital-intensively, or farms with relatively more capital and less land. To the extent that land is a collateral which is more valued by banks than capital, this is a plausible result, although nothing is said about the ownership structure of land and capital (in contrast to the Probit model examined in section 4.1.2, pp. 164 et seq., where the amount of rented land enters the equation with a positive sign).

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[87] Note that there would have been no efficiency gains from estimating the input demand equation jointly with the output supply equation in a Seemingly Unrelated Regression. This is due to the fact that there are the same explanatory variables in both equations and no cross restrictions because of missing prices (see GREENE 2000, pp. 616-617).

[88] This is the range of gross revenue per ha given for median farms in the three regions surveyed (PETRICK et al. 2002, p. 206). The values were transformed into zł by using the average rate 4.227 zł = 1 €.

The estimates of Model I can be used to assess the importance of *selectivity bias* in the output supply equation. This is done by testing the significance of the IMR, as explained in section 3.3.4, p. 151. The reported *t*-value is clearly below any of the usually used critical values, so that there appears to be *no* significant selectivity bias.

Due to the limited number of observations, I did not pursue a stratawise regression (see section 3.2.2, p. 142). However, a *dummy* was added indicating whether the farm belongs to the northern region of the survey. The dummy thus allows a linear shift of the output supply function to accomodate different structures in the northern versus the two southern regions. As Table 4-8 shows, the coefficient of the dummy is significant. The implication is that, *all other things equal*, credit-rationed farms in the more largely structured north on average supply *less* output than their small-scaled counterparts in the south (see section 3.2.1, p. 136). An explanation for this could be the lower labour intensity on the northern farms, which reduces the average output per fixed factor. This is consistent with the indicators presented by PETRICK et al. (2002).

As indicated earlier, I tested the *functional form* of the given model against an alternative using logarithmic transformations of the variables by an artificial nesting procedure (see section 3.3.4). The coefficient of the additional regressor in the quadratic model (defined as the difference between the prediction of the logarithmic model and the logarithm of the prediction of the quadratic model) was 10.202 with a *t*-value of .324. In contrast, the coefficient of the additional regressor in the logarithmic model (defined as the difference between the prediction of the quadratic model and the prediction of the logarithmic model above *e*) was .025 with a *t*-value of 2.389. This is unambiguous evidence *in favour* of the quadratic model.[89]

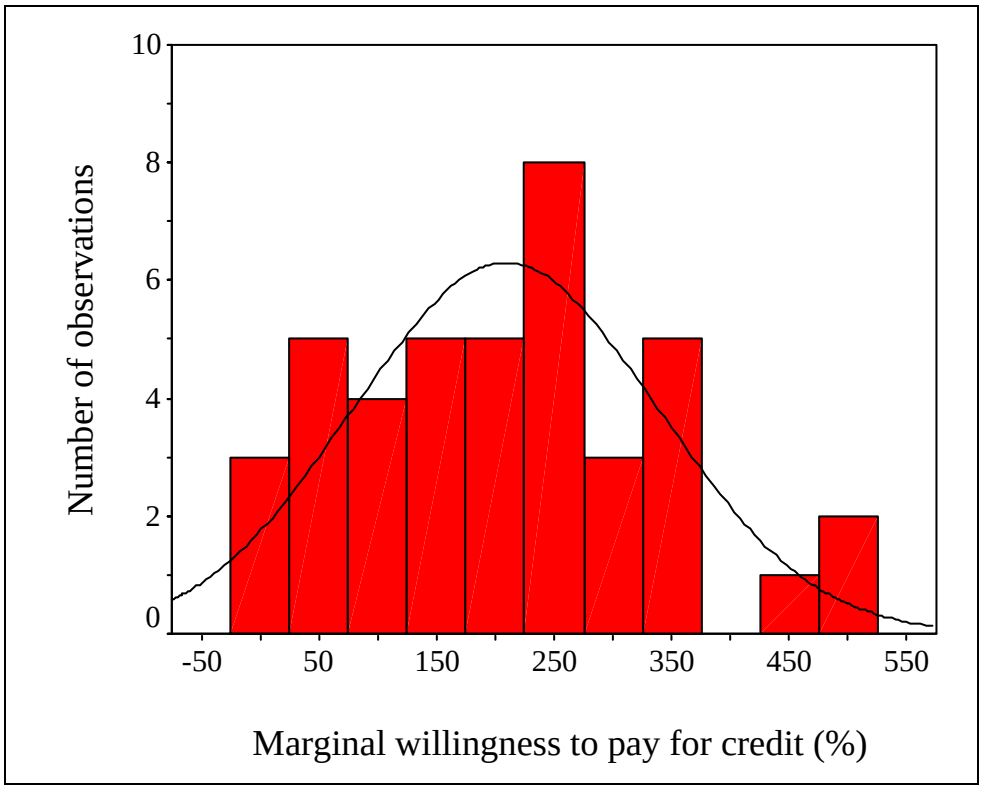
4.2.2 Marginal willingness to pay for credit and non-separability hypothesis

In a second step, the coefficients of the output supply model for rationed farms were taken to compute the *farm individual willingness to pay for credit* as given by equation (3-4), p. 88. The procedure is to compute marginal effects of credit

[89] The test was carried out without accounting for selectivity. When estimating logarithmic models the problem arises that only strictly positive values can be transformed into logarithms. To allow an estimation of the logarithmic model on the same dataset as the quadratic model, I restricted the estimation to partially rationed borrowers, added .1 to all variables, and estimated both the logarithmic and the quadratic model on these modified variables.

for the farm specific values of land and fixed capital and subtract one. The results are summarised in Figure 4-1.

Figure 4-1: Distribution of marginal willingness to pay for credit



Notes: Mean = 208.8; Std. Dev. = 129.5; N = 41. Solid line in figure shows a normal distribution based on mean and variance of the underlying sample.
Source: Author's calculations.

The figure is based on 41 observations only, since five observations were excluded as outliers according to the IQR criterion explained in section 3.2.3, p. 143.[90] The marginal willingness to pay for credit is net of repayment. All observations are in the plausible positive range, with slightly more mass in the left tail. On average, credit-constrained farm households were thus able to yield a return of 209 percent per annum on an extra unit of credit, with principal already deducted.[91] Given an average nominal annual interest rate on credit of 10 per-

[90] The initial calculation was done for all 46 observations for which Model I was estimated.

[91] Throughout the study, liquidity management *within* the 12 month period is neglected. This is due to the fact that the output measure is only known on an annual basis. Of the 51 loans included in the credit variable, there are nine with repayment periods smaller than 12

cent in the sample, the presented estimations already point at *substantial evidence for credit rationing*. The qualitative separation examined above is hence supported and the extent of credit rationing has been quantified.

The estimates might be compared with the results of a *production function analysis* given in PETRICK (2003) (see the discussion in section 3.3.4, pp. 149 et seq.). In that paper I attempt to quantify the *shadow interest rate* by estimating a Cobb-Douglas production function on the same data set as the present research. In the production function, I distinguish between credit financed and non-credit financed variable inputs. The marginal productivity of credit financed variable inputs is taken as an estimator for the shadow interest rate of working capital loans. The results are quite similar to those presented in this section. The shadow price of the production function analysis has a mean of 184 percent. 92 percent of the estimated shadow rates are positive, with the following quantile values: 68.0 (25%-quartile); 129 (median); 250 (75%-quartile). The number of observations in the sample was 34. Overall, *the result of an internal return on credit in excess of nominal market interest rates is hence supported*. However, recall from section 3.3.4 that the production function only captures direct credit effects, whereas the output supply equation captures both direct and indirect effects of credit (for example, via consumption). Somewhat surprisingly, the average shadow rate calculated on the basis of the production function is a bit smaller than the marginal willingness to pay presented earlier in this section. Contrary to the expectation in the theoretical model, there seem to be *positive indirect effects of credit on output* at work.

It appears therefore instructive to have a look at the reported uses of short-term credit among the rationed respondents (Table 4-10). The by far most frequent use of credit is indeed for input purchases, followed by some investment purposes such as machinery, livestock, or plant purchases. These investment expenses may partially be the reason for the positive indirect effects of credit. Another possible explanation could be that consumptional uses hidden in the ‘household assets’ or ‘other’-items have positive effects on output, for example via human capital formation or nutritional improvements (see HEIDHUES 1994).

months: one with 3, 5, 6, and 10 months, two with 8, and three with 9 months repayment period. For these loans, the real marginal willingness to pay is probably underestimated, so that they might be even stronger rationed than expressed in the figures.

Table 4-10: Uses of short-term credit (rationed sub-sample)

	Responses (%)
Input purchases	77.6
Agricultural machinery purchases	6.9
Livestock or plant purchases	5.2
Renovation of buildings	1.7
Purchase of household assets	1.7
Land purchases	.0
Automobile purchases	.0
Tractor purchases	.0
Purchases of non-agricultural machinery	.0
Other	6.8

Notes: 51 loan contracts in the sample. Multiple answers possible
Source: Author's calculations based on Poland farm survey 2000.

In accordance with the empirical strategy outlined in section 3.3.4, I also tested the difference between marginal willingness to pay and market interest rates. As suggested above, I used the nominal market interest rate corrected for loan-specific transaction costs for comparison.

Table 4-11: Description of transaction costs and interest rates of loans for rationed farms

	Mean	*Minimum*	*Maximum*	*Valid observations*
Transport costs per farm and loan contract (zł)	8.7	.1	111.4	48
Signalling costs per farm and loan contract (zł)	195.2	3.0	1612.0	42
Transaction costs per farm and loan contract (zł)	204.4	3.1	1614.9	42
Transport costs in % of loan volume	.4	<.1	12.9	48
Signalling costs in % of loan volume	2.4	.2	17.0	42
Transaction costs in % of loan volume	2.8	.2	17.1	42
Marginal nominal interest rate of short-term loans (%)	9.8	5.3	24.5	48
Marginal interest rate including transaction costs (%)	12.8	6.6	35.5	42

Notes: Definitions see text.
Source: Author's calculations.

Table 4-11 gives an illustration of the size and composition of the interest rate used for the comparison. *Transport costs* are defined as the sum of direct expenses for travelling plus opportunity costs of time spent for travelling. Both are based on the distance between farm and bank from which the loan was received, as stated in the interviews. Time spent for travelling and travel costs were then calculated according to average numbers given by GUS (2000, p. 328).[92] *Signalling costs* consist of cash expenses required by the bank in addition to the interest rate (various fees, insurances) plus opportunity costs of time expenses for negotiating at the bank as given in the interviews. Both components sum up to (total) transaction costs per farm and loan contract. If the number of loans taken was more than one, transport and signalling costs were averaged over the given loan contracts. Of the 42 valid observations reported for transaction costs per farm and loan, 36 farmers took only one short-term loan, 5 took two, and 1 took

[92] A km of travelling is valued with .12 zł according to the travel fare of slow PKS bus for the 41-50 km distance in 1999. Travelling time is calculated with an average speed of 50 km/hour or .02 hours/km. Opportunity costs of time are valued with 6 zł/hour, which consists of 5 zł/hour as the average salary of an agricultural worker as given in the survey results plus an (arbitrary) extra premium of 20 percent for management skills of the farm head.

three. The table gives transaction costs and their components in absolute values and expressed in percentage of the loan volume.

As a reference for the marginal *nominal* interest rate I used the nominal rate reported for the loan. In case that there was more than one loan taken, I used the *maximum* interest rate reported from all loan transactions, assuming that this was the marginal one. Adding the transaction costs in percentage of loan volume to the marginal nominal interest rate yields the marginal interest rate including transaction costs, which is used for the empirical test of credit rationing.

Before presenting the results of the test, it might be instructive to have a look at the composition of the actual interest rates faced by farmers. Table 4-11 shows that signalling costs contribute the major part (96 percent) to the total amount of transaction costs. These in turn have the size of almost 30 percent of the nominal interest rate if expressed in percentage of loan volume. They hence make up a substantial proportion of actual interest rates to be taken into account by the farmer, why it is inaccurate to ignore them.

Table 4-12: Test of equality of willingness to pay and market interest rates including transaction costs

	$\hat{b}_1$	$\hat{b}_2$	F-*test*	*Significance*	*Valid observations*
			for the restriction		
Interest rate equation	321.962	-7.698	63.352	<.001	35
	(7.274)	(-2.437)			

Notes: *t*-values in parentheses. Null-hypothesis for the *F*-test: $(b_1, b_2) = (0, 1)$ in equation (3-5), p. 153.
Source: Author's calculations.

The results of the test of equality of marginal willingness to pay and market interest rates including transaction costs as explained in section 3.3.4 are shown in Table 4-12. The *F*-test strongly rejects the null-hypothesis of equal marginal willingness to pay and effective interest rates. For the given sample of farm households, the marginal willingness to pay is thus significantly different from interest rates. The constant term is positive, large, and highly significant. This allows two conlusions. First, the earlier result that the marginal willingness to pay by far exceeds market interest rates is supported by a statistical test. Second, since measurable transaction costs have been taken into account, it becomes clear that these costs do *not* necessitate to withdraw loan applications, at least ex-post. The latter could only be claimed if farmers' willingness to pay for credit

were observed in the range *between* nominal and nominal cum transaction cost interest rates. High transaction costs are therefore *not* the reason that farmers cannot obtain credit.

I now turn to the significance of the *household characteristics*. Table 4-8 shows that the effect of the number of adult females in the household is significant at the five percent level. The positive sign indicates that one more adult female household member increases the volume of output by about 11 thousand zł. In contrast to that, an effect of the number of adult males could not be borne out empirically. It cannot be read off from the reduced-form model through which pathways demographic characteristics have an impact on output supply. The positive sign of the effect suggests that more women tend to *decrease* the liquidity demand and hence increase the volume of output supplied, which is in contrast to the effect in the Probit equation (section 4.1.2). Alternatively, consumption expenditures of female household members might positively affect production in other ways, for example, if used for human capital improvement. In any case, although not fully conclusive, the significance of this demographic variable is additional evidence for a market imperfection that breaks separability of production and consumption decisions.

Finally, I also estimated the so-called *counterfactual model*, the results of which are given in the right columns of Table 4-8. The model is estimated on the entire sample of short-term loan recipients (both rationed and non-rationed), which is counterfactual for two reasons (see section 3.3.4): (a) significant effects of credit and demographic variables on output are theoretically consistently only to be expected for the rationed subsample, and (b) credit demand is an endogenous choice of the non-rationed farm households, which undermines the consistent one-stage estimation of the output supply equation. The problem is the mixture of observations for which credit demand is endogenously or exogenously determined. The estimates of Model II must therefore interpreted with caution. However, the major virtue of the counterfactual model is the ability to illustrate the *gap in the willingness to pay* between rationed and non-rationed farm households. This virtue can be captured in full by introducing an additional variable ‘credit volume short-term’ times the credit rationing dummy, as shown in Table 4-8. For non-rationed farms it takes the value zero. If the willingness to pay for rationed farms is in fact higher than for non-rationed farms, the variable must have a positive sign. Two further specification issues are relevant for this model: first, the three constrained non-borrowers in the sample are neglected, because for them the credit volume is zero and hence the ‘credit times credit-rationing-dummy’-variable would (misleadingly) also be zero. Second, the fact that only

borrowers are regarded introduces a different selection mechanism. This was taken into account by estimating the probability of being a borrower by an additional Probit equation, which produced the Inverse Mills Ratios for the counterfactual Model II.[93]

Indeed, the coefficient of the 'credit times credit-rationing-dummy'-variable has the expected positive sign and is statistically significantly different from zero. The magnitude of the coefficient reveals that being a credit-rationed borrower increases the willingness to pay for credit by 168 percentage points as compared to an otherwise identical non-rationed borrower. The average willingness to pay for credit at sample means for both subgroups is 184.2 percent for constrained borrowers and only 31.3 percent for unconstrained borrowers. The willingness to pay of rationed farms is hence about six times as high as for the non-rationed sub-sample. Furthermore, the *t*-value of the 'adult females' variable is much lower than in Model I, so that the evidence in favour of a market imperfection diminishes. The results of the counterfactual model are thus quite in line with theoretical expectations, therefore providing additional support for the overall approach.[94] The results of the counterfactual model are taken up again in section 5.2.1, pp. 199 et seq.

4.2.3 Summary

The econometric analysis of this subchapter consistently supports the earlier finding that more than 40 percent of borrowers experienced pronounced credit

[93] The Probit equation contained the following explanatory variables: total land owned, land rented from private persons, capital stock of farm net of land, adult males in household, adult females in household, farm has permanent book-keeping (dummy), farmer participated in additional training courses (dummy), farmer is member of co-operative bank (dummy), and farm experienced harvest failure (dummy). The null of $\gamma=0$ for this model could be rejected at any conventional significance levels. The borrowing decision is analysed in more depth by PETRICK and LATRUFFE (2003).

[94] Another 'counterfactual' regression (suggested by Feder *et al.*, 1990) would be to estimate model I on the *non*-rationed sub-sample of respondents. The results of such a regression supported the expectation that neither credit nor household characteristics have a significant influence on output. Two problems with this regression are that (a) credit is an endogenous choice for this subgroup and hence not a consistent explanatory variable in the reduced-form output supply equation, and (b) it is not clear whether the non-significance of the credit variable is indeed reflecting actual farmers' behaviour or is only due to the fact that there are many non-borrowers in the subsample (see Table 4-2). For all the non-borrowers credit takes the value of zero, which makes an estimation of its effect difficult. The results are therefore not presented in detail.

rationing by rural banks. For so rationed farms, credit plays a highly significant role in determining output. These farms display *a marginal willingness to pay for credit of on average 209 percent net of principal*. The willingness to pay increases with increasing capital intensity with regard to land. It it significantly different from individual interest rates for credit that account for loan specific transaction costs, which are 13 percent per annum on average. Measurable transaction costs were shown to be in the range of 30 percent of nominal interest rates faced by farmers, with additional fees forming the major part of these transaction costs. These costs, however, do not necessitate a withdrawal of loan applications and therefore cannot explain credit rationing of farmers.

In the group of credit-rationed farms, *household characteristics have a significant effect on output supply*. This is evidence for a violation of separability between production and consumption decisions and thus lends empirical support to the existence of a market imperfection.

The results were backed by a comparison with an alternative estimation based on a production function approach. Furthermore, a counterfactual model estimated on all short-term credit recipients demonstrated that the willingness to pay is substantially higher on rationed than on non-rationed farm households.

4.3 Investment model

The investment model is used to investigate the effect of credit rationing on the investment behaviour of Polish farm households, as described in section 3.3.5, pp. 157 et seq. Of particular interest is the relationship between governmentally promoted credit access and actual amounts spent for productive investment purposes.

Section 4.3.1 gives an overview of the investment outcomes based on the survey data. Section 4.3.2 presents the estimation results, whereas the marginal effect of credit on investment is analysed in more detail in section 4.3.3. Section 4.3.4 summarises the findings of this subchapter.

4.3.1 Overview of investment activities

As a background for the later interpretation of the results it seems useful to give an overview of the reported investment activities of farmers. Farmers were asked to indicate which relative share the various investment activities take in their total investment volume. In Table 4-13, I present the mean shares of various investment purposes in the total investment portfolio of each farm. The average investment volume per farm has a mean of 39.1 ths. zł and a standard deviation

of 47.8. The analysis in this section is restricted to repondents who reported positive investment in the period 1997-1999.

Table 4-13: Mean shares of various investment activities of credit-rationed farm households (in descending order)

Investment purpose	*Mean share (%)*	*Investment purpose*	*Mean share (%)*
1. Renovate or extend residential building	20.27	12. Link farm to/ modernise the sewage network	0.98
2. Buy automobile	14.48	13. Improve roads and/ or farmyard (P)	0.98
3. Renovate or extend farm buildings (P)	13.04	14. Buy machinery/equipment for non-agricultural use (P)	0.97
4. Buy agricultural machinery (P)	13.01	15. Buy personal computer system (PC) (P)	0.96
5. Buy tractor (P)	10.54	16. Buy mobile phone	0.8
6. Buy land (P)	5.87	17. Link farm to/ modernise the gas network	0.65
7. Buy animals (P)	5.42	18. Establish/ renovate guestrooms for agrotourism (P)	0.52
8. Link farm to/ modernise the drinking water network	2.74	19. Link farm to/ modernise the electricity network (P)	0.33
9. Link farm to/ modernise the telephone network (P)	2.53	20. Buy plants (P)	0.22
10. Modernise the heating system	2.42	Other (P)	3.26

Notes: N = 144. Based on respondents with positive investment in 1997-1999. (P) marks items classfied as productive investment.
Source: Author's calculations based on Poland farm survey 2000.

In Table 4-13, I marked with (P) those investment activities which can be reasonably classified as productive investment, that is items that are primiarily regarded as enhancing the productive capacity of a farm. The table shows that the major investment activities were related to the extension of residential buildings and to automobile purchases, items that arguably do *not* fall under this category.

Only on the third to sixth positions follow investments in productive assets, in particular buildings, machinery, land, and livestock. I conclude that investment priorities of Polish farm households are such that growth in agriculture is ranked *lower* than what could be labelled 'durable consumption goods'. Investment in business activities *not* directly related to agriculture rank even lower, such as machinery/equipment for non-agricultural uses or establishment of guestrooms for agrotourism. Including *not* credit-rationed respondents into the analysis grossly does not change the picture, as PETRICK et al. (2002, p. 211) show. The latter paper also demonstrates that productive investment is concentrated in the northern regions and in the group of more profitable farms.

Table 4-14: Uses of long-term credit (rationed sub-sample)

	Responses (%)
Agricultural machinery purchases	19.5
Renovation of buildings	19.5
Input purchases	14.8
Tractor purchases	14.8
Land purchases	9.4
Automobile purchases	7.4
Livestock or plant purchases	4.7
Purchases of non-agricultural machinery	2.0
Purchase of household assets	1.3
Other	6.7

Notes: 93 loan contracts in the sample. Multiple answers possible
Source: Author's calculations based on Poland farm survey 2000.

The reported use of long-term credit by rationed farm households (Table 4-14) supports the previous analysis. The renovation of buildings is equally important as the purchase of agricultural machinery. Also automobile purchases rank relatively high.

A major aim of the subsequent econometric analysis is to find out how productive investment of Polish farm households is related to governmentally promoted credit access. The investment variable used in the estimations is the farm individual aggregate of all investment items marked as 'productive' in Table 4-13.

4.3.2 Results of the estimation

The pool of credit-rationed respondents as described in sections 4.1.1 and 4.1.3, pp. 163 et seq., is used for the estimation of the investment equation. Note however that only 79.5 percent of these respondents reported positive investment, and only 44.1 percent took long-term loans. The characteristics of the subsample are illustrated by a number of descriptive statistics in Table 4-15, net of drop outs due to data cleaning and missing values. I display values separately for all constrained respondents and for constrained non-zero investors.

Table 4-15: Description of variables used in the investment model (rationed subsample)

	Mean	*Std. Dev.*	*Minimum*	*Maximum*	*Valid observations*
All rationed respondents					
Investment volume 1997-1999 (ths. zł)	24.8	42.4	.0	322.5	156
Credit volume 1997-1999 (ths. zł)	20.6	43.2	.0	400.0	156
Land owned beginning of 1997 (ths. zł)	65.7	97.3	.0	600.0	156
Farm has permanent book-keeping (dummy)	.4	.5	.0	1.0	156
Farm is located in northern region (dummy)	.3	.5	.0	1.0	156
Respondents with positive investment					
Investment volume 1997-1999 (ths. zł)	31.2	45.5	.0	322.5	124
Credit volume 1997-1999 (ths. zł)	24.8	47.4	.0	400.0	124
Land owned beginning of 1997 (ths. zł)	60.2	88.4	.0	520.0	124
Farm has permanent book-keeping (dummy)	.5	.5	.0	1.0	124
Farm is located in northern region (dummy)	.3	.5	.0	1.0	124

Source: Author's calculations.

The results of the estimations are presented in Table 4-16. I report the results for three specifications. Mainly for purposes of exploration and comparison, I esti-

mated a linear investment equation by Ordinary Least Squares (OLS) (I). This equation is also used for testing selectivity, it is therefore estimated in a two-stage procedure together with the general Probit equation presented in section 4.1.3, pp. 168 et seq., as explained in section 3.3.5, pp. 157 et seq. The second specification is a conventional Tobit model (II), to account for the censoring of the investment variable. Marginal effects at sample means are reported in a separate column of Table 4-16. The third specification is the cubic Tobit model (III), which includes the credit variable in quadratic and cubic form. For this model, marginal effects are analysed separately below.

Table 4-16: Estimated investment equations

	Linear (I)	*Standard Tobit (II)*		*Cubic Tobit (III)*
	Coefficient	*Coefficient*	*Marg. effect*	*Coefficient*
Constant	3.478 (.437)	-.782 (-.229)	–	1.558 (.442)
Credit volume 1997-1999 (ths. zł)	.739 (14.237)	.783 (13.161)	.602	.418 (2.031)
Credit ^ 2	–	–	–	.003 (1.392)
Credit ^ 3	–	–	–	<-.001 (-1.120)
Land owned beginning of 1997 (ths. zł)	-.051 (-2.139)	-.082 (-2.678)	-.063	-.100 (-3.131)
Farm has permanent book-keeping (dummy)	7.868 (1.853)	10.597 (2.087)	8.145	14.195 (2.684)
Farm is located in northern region (dummy)	17.267 (3.393)	20.909 (3.422)	16.070	23.387 (3.813)
Inverse Mills Ratio	1.521 (.162)	–	–	–
Log-Likelihood	-714.319	-610.996		-608.950
Adjusted R^2	.666	–		–
N	156	156		156

Notes: *t*-values in parentheses. *t*-values of the linear model corrected for selectivity. Marginal effects calculated at sample means of selected observations.

Source: Author's calculations.

A number of important conclusions can already be derived from the linear model. First, in contrast to received neoclassical thinking, the financial variable *does* have an effect on investment outcomes. Credit access is of overwhelming importance in the linear model (as measured by the *t*-value). This is consistent

with the self-classification of borrowers as being credit-rationed. Furthermore, it supports the theoretical predictions of the financial constraints model of investment behaviour as presented in section 2.3.2, pp. 91 et seq.

The coefficients of all other regressors have the expected signs and are significant, at least at the ten-percent level. The coefficient of the land variable is significant at five percent, indicating that farms with fewer assets at the outset invest more. The coefficient of the Inverse Mills Ratio which tests the impact of selectivity fails to be significant, it can hence be assumed that there is no selectivity bias in the equation. For this reason I ignore selectivity in all other estimations.

A further conclusion concerns the marginal effect of credit on investment in the linear model. The effect is smaller than one, which already points at an underutilisation of credit for productive investment purposes. This is quite in accordance with the farmers' reported use of credit funds for what I called durable consumption goods in section 4.3.1. As a side information, only for 50 percent of borrowers does the amount of productive investment exceed the credit volume. However, the linear model imposes that this effect is constant over the entire range of observations, as noted earlier. The coefficients of the two dummy variables are significant and have the expected sign. The implication is that farms with permanent bookkeeping and farms in the northern region systematically invest more.

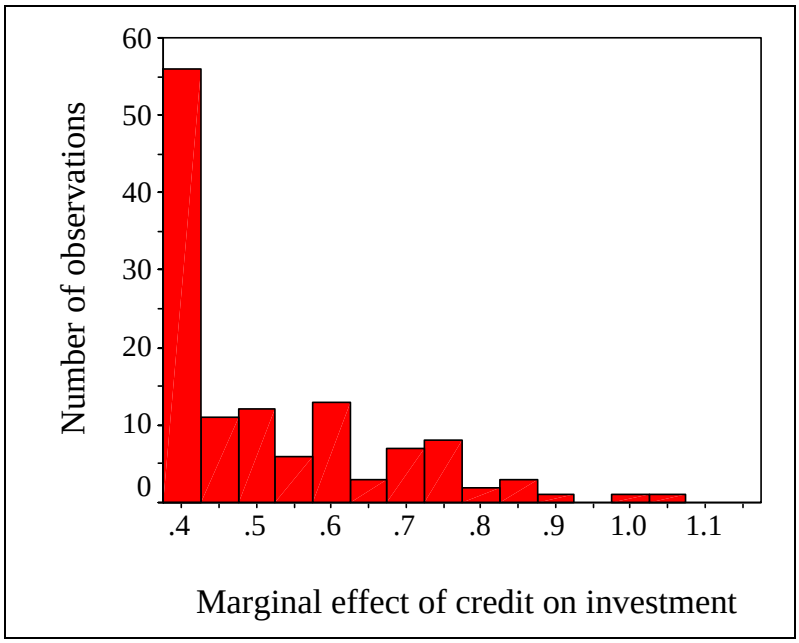
The two other specifications are primarily used to further examine the marginal credit effect. Since they introduce additional flexibility into the specification, they should trace this effect more accurately. As can be seen from the values of the Log-Likelihood function, the fit of Models II and III continuously improves as compared with the linear model.

4.3.3 The marginal effect of credit expansion

The marginal effect given in Table 4-16 for the *standard Tobit model* is the partial derivative of expected investment with respect to credit, evaluated at sample means. This marginal effect is smaller than one, even lower than in the linear model. Since I am primarily interested in the slope of the uncensored part of the investment function, the coefficients of the standard Tobit model represent the correct marginal effects. They also indicate a slope smaller than one. The general result of a diversion of the marginal credit funds from investment is hence supported.

The *cubic Tobit model* achieves the best fit of the data in terms of the Log-Likelihood, although the improvement as compared to the standard Tobit is small. It might be taken as the most flexible and therefore also the most accurate depiction of the true relationship.[95] However, as compared to the two other models, flexibility increases at the cost of less precisely estimated coefficients of regressors, as shown by their *t*-values. To check the precision of the marginal effect, I calculated the latter together with its standard error at sample means of non-zero investors, based on the coefficients of the cubic Tobit model given in Table 4-16. The procedure is similar to the one for calculating *t*-values for marginal effects in section 4.2.1, pp. 172 et seq. This resulted in a marginal effect of .559 with a *t*-value of 4.502, which is significantly different from zero at the one percent level. Therefore using the coefficients of the cubic Tobit model, I computed marginal effects individually for all investors in the sample (Figure 4-2).

Figure 4-2: Distribution of marginal credit effects



Notes: Mean = .526; Std. Dev. = .144; N = 124.

Source: Author's calculations based on cubic Tobit model.

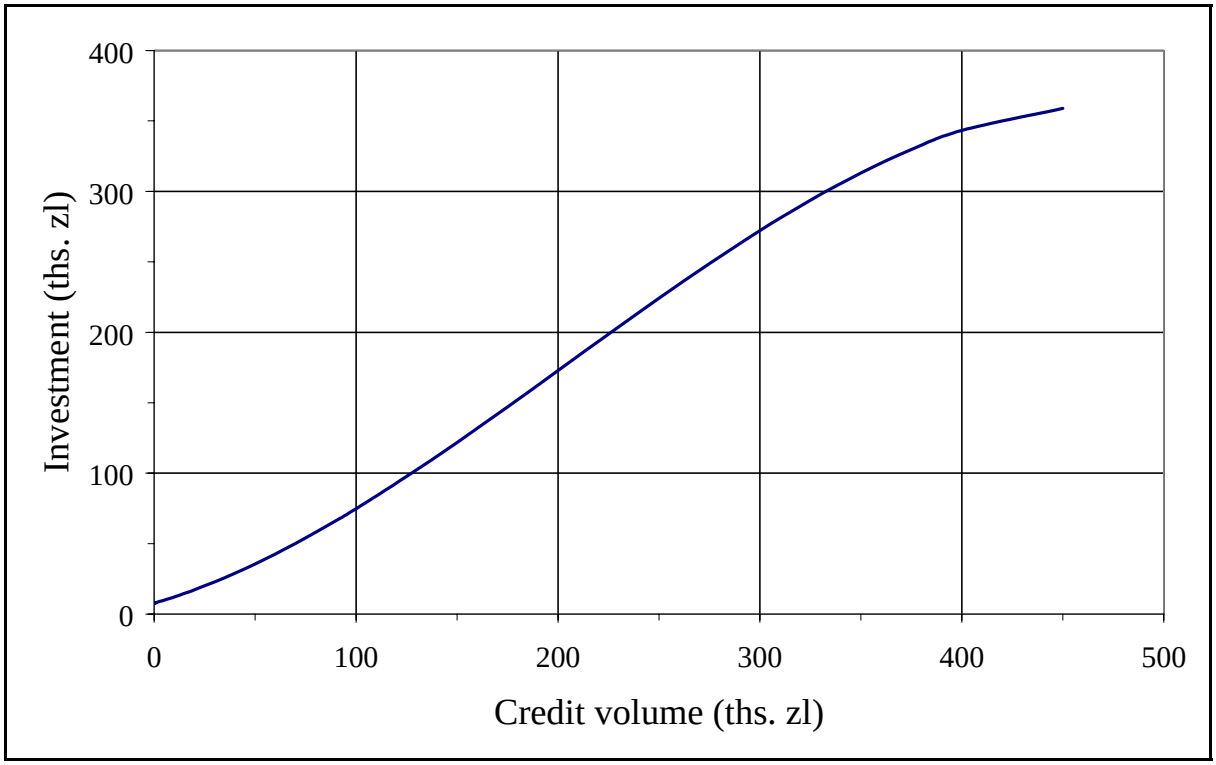
The shown histogram offers two interesting insights: first, almost all observations fall below the threshold of one (98.4 percent, to be precise). Second, the

[95] A possible objection to the Tobit results concerns the presence of heteroskedasticity (see section 3.2.2). In order to address this problem, I estimated the cubic investment equation for investors only, by using OLS. The resulting coefficients support the results of the presented Tobit model.

mean of these individual marginal effects is substantially below the (constant) marginal effects obtained from the coefficients of Models I and II.

A further analysis of the relationship between credit and investment based on the cubic Tobit coefficients was done at sample means of all other variables (based on all rationed respondents), see Figure 4-3.

Figure 4-3: The functional relationship between credit and investment



Notes: Calculated at sample means of all other variables.

Source: Author's calculations based on cubic Tobit model.

The figure reveals that, over the range of smaller credit volumes, the marginal effect slightly increases with increasing credit volume. The function is hence convex, i.e. the second derivative is positive. Only at a credit volume of 200 ths. zł, there is an inflection point, indicating a decreasing marginal effect for larger credit volumes. In the range between 150 and 275 ths. zł credit volume, the slope is almost stable at about one or even slightly higher. In terms of additional mobilisation of funds, this could thus be called an optimal credit volume range. However, only 1.6 percent of actual observations fall in this range. Almost 95 percent of the observed credit volumes are below 100 ths. zł and hence in a range of the function where its slope is clearly smaller than one. This might be taken as evidence for a *band-wagon effect*, i.e. small loan amounts are taken on

favourable terms to finance consumption activities, whereas there is no actual investment project available.[96]

If the land variable is taken to measure farm size, the following relationships can be traced empirically. There is a significant positive correlation of .22 between farm size and investment volume, i.e. large farms seem to invest more. The correlation between credit volume and land owned is .30. Accordingly, particularly if non-borrowers are neglected, high farm-individual marginal credit effects are found in the group of relatively larger farms. However, net of the credit effect, *large farms invest less*, as can be seen from the regression results. The implication is that, out of a group of farms with equal credit volume, smaller farms devote a higher amount of money to investment. There are hence two opposing effects with regard to investment: larger credit volumes imply more, but larger farm sizes as such (i.e. controlling for credit volume) imply less investment. Overall, it is therefore incorrect to say that large farms invest more, but if they use credit for investment, they obtain larger credit volumes and hence divert less to non-productive activities.

4.3.4 Summary

An ex-post evaluation of investment activities suggested that *non-productive investment ranked high* on the priority list of interviewed farmers. Residential buildings and automobile purchases were the two items with the largest share of farm-individual investment expenses in the reporting period, whereas machinery and land purchases followed on lower positions.

The econometric investment analysis led to two major results. First, *credit access proved to be a significant factor of investment decisions of credit-rationed farmers*. This supports the theoretical prediction of the financial constraint model of investment behaviour and is consistent with the qualitative self-classification of respondents. Second, the analysis provides evidence that *subsidised credit funds are partly diverted to non-productive purposes*. In various specifications of the credit-investment relationship, the marginal effect of credit on productive investment was clearly smaller than one. Based on a cubic Tobit estimate of the investment function, the mean of the farm-individual marginal effects was at .53 on average. Other, less flexible models presented as well prin-

[96] The survey data does not allow assessment of the return on investments carried out by farmers. Since complete defaults are of minor relevance in Poland irrespective of credit use, it must be assumed that many investment loans used for consumptive purposes are repaid out of current household income rather than direct investment returns.

cipally support this result. Every second borrower invests less in productive assets than he borrows. Only 1.6 percent of the selected respondents with positive investment displayed farm-individual credit effects larger than one. Over the observed range of credit volumes, the marginal effect increases with an increasing credit volume. However, the results provide evidence against the view that investment is positively related to farm size.

5 DISCUSSION

The final chapter aims at synthesising and discussing the findings of this study. In subchapter 5.1, I summarise the results of the theoretical and empirical analysis. Subchapter 5.2 attempts to place the findings in the wider context of economic research. In subchapter 5.3, I present and discuss the policy recommendations that follow from the study. Subchapter 5.4 concludes with a number of suggestions for further research.

5.1 Overview of major findings of the study

The following provides a concise summary of the major findings of the previous theoretical and empirical analysis:

1. The theoretical investigation of credit markets sets out that credit rationing as a persistent private excess demand for loans is by definition excluded in the traditional neoclassical market model (sections 2.1.2 and 2.1.3, pp. 24 et seq.). The introduction of positive transaction costs is a first step to a more realistic depiction of credit market outcomes (section 2.1.4, pp. 32 et seq.). However, the claim that empirically observable transaction costs could be regarded as a source or measure of credit rationing is shown to be unwarranted. Only models that explicitly account for asymmetric information between market participants can establish a situation of persistent credit rationing (section 2.1.5, pp. 38 et seq.).

2. The further analysis suggests that credit rationing is a likely outcome on markets with asymmetric information (sections 2.2.1 and 2.2.2, pp. 50 et seq.). However, theory does not provide unambiguous propositions regarding the welfare implications of credit rationing (section 2.2.3, pp. 63 et seq.). Since the presence of asymmetric information cancels the functioning of the price mechanism, the traditional concepts of social efficiency are no longer valid. As a consequence, credit rationing does not necessarily imply underinvestment, and it generally does not create a case for straightforward government policy. It seems therefore reasonable to analytically decouple the analysis of credit rationing as a privately perceived excess demand and underinvestment as a socially undesirable situation. The subsequent analysis in this monograph focused on the former of these two issues.

3. The extent to which asymmetric information has harmful effects on investment outcomes depends on the availability of counteracting instruments or arrangements, such as collateral, joint liability, or reputation of borrowers

(section 2.2.2, pp. 55 et seq.). The way in which governments can improve on these instruments and arrangements will play a vital role for successful policy action. Any intervention measures should consider the conditions and causes that are responsible for an undesirable market outcome, in case that this has been successfully identified.

4. In the framework of a two-period farm household model, the consequences of introducing a binding credit constraint are examined (section 2.3.1, pp. 77 et seq.). The market interest rate loses its relevance for household internal allocation of funds and is replaced by an endogenous, unobservable shadow interest rate. Compared with a first-best world without credit rationing, the household will reduce output, which implies a loss of income. An increase in government transfers relaxes the liquidity constraint and thus has positive effects on farm output.

5. In a multi-period household model with endogenous equity formation, credit rationing results in a positive shadow price of equity, since equity (for example as collateral) has a value for financing production in the future (section 2.3.2, pp. 91 et seq.). Investment cannot immediately attain its optimal level due to credit rationing. The household thus reduces current consumption in favour of equity formation, which would be superfluous in the presence of a perfect capital market. Since the ultimate goal of the household is current and future consumption, possible liquidity effects on production as a result of increased public transfers are only of a short-term nature. Additional funds are likely to be consumed in the long run. Similarly, improvements in access to credit have conflicting short- and long-term effects on investment.

6. The presence of a perfect capital market allows the convenient separation of production or investment decisions on the one hand and consumption decisions on the other. Both farm household models suggest that this cannot be maintained under a binding credit constraint, which has two important consequences. First, there is no objective criterion anymore which allows to assess the (private) efficiency of input use or investment activities. Both decision complexes can only be made simultaneously with the household's consumption plan and are thus affected by the household's preferences. Second, any empirical production or investment analysis has to take these interdependencies into account. Household preferences have to be made amenable to measurement and must not be neglected in the analysis.

7. The third chapter starts with a reflection on the methodological foundations of empirical economic analysis (section 3.1.2, pp. 103 et seq.). It is argued that econometrics cannot be the fundamental benchmark for the falsification of theories, in particular because there are no universal laws in economics and there are huge opportunities for data mining in the research process. Furthermore, there are no absolute standards for the statistical rejection of hypotheses. The methodological standpoint of critical rationalism should therefore be left behind and be replaced by a more pragmatic and instrumentalist position.

8. A survey of possible methodological approaches to the empirical analysis of credit rationing revealed that there are a number of techniques available in the literature (section 3.1.3, pp. 114 et seq.). The empirical results of the present study are primarily based on a regression analysis of cross-sectional survey data, which combines qualitative and quantitative indicators of credit rationing. The empirical strategy is discussed extensively in subchapter 3.3, pp. 144 et seq.

9. According to statements of farmers made during the survey, 80 percent of farm households took at least one loan in the reporting period 1997-1999. Almost half of the borrowers obtained less credit than desired and are hence regarded as credit-rationed. Completely rejected applicants and discouraged non-applicants are of minor importance in the sample (section 4.1.1, pp. 163 et seq.).

10. Central determinants of credit rationing as revealed by a Probit regression analysis are the reputation of the loan applicant as well as demographic household characteristics (section 4.1.3, pp. 168 et seq.). Over all loan types, respondents with a good credit history have a 30 percentage points lower probability of being rationed than borrowers who rescheduled a loan in the past. In addition, more adult males in the household decrease the probability of being credit-rationed, while more females increase it. This is assumed to be an effect of higher liquidity demand for consumption purposes by women or a signalling effect due to the higher share of male labour force. If only short-term borrowing is considered, collateral availability is an additional key factor of credit rationing, since more land owned and less land rented decrease the likelihood of becoming rationed (section 4.1.2, pp. 164 et seq.). Furthermore, there is some evidence against the view that a depletion of subsidised funds is a major reason for rationing outcomes.

11. The econometric analysis of output supply supports the earlier finding that more than 40 percent of borrowers experienced pronounced credit rationing by rural banks. For so rationed farms, credit plays a highly significant role in determining output (section 4.2.1, pp. 172 et seq.). These farms display a marginal willingness to pay for credit of on average 209 percent net of principal. The willingness to pay increases with increasing capital intensity with regard to land. It is significantly different from individual interest rates for credit that account for loan specific transaction costs, which are 13 percent per annum on average (section 4.2.2, pp. 176 et seq.). Measurable transaction costs were shown to be in the range of 30 percent of nominal interest rates faced by farmers, with additional fees forming the major part of these transaction costs. These costs, however, do not ex-post rationalise a withdrawal of loan applications and therefore do not constrain borrowers. In the group of credit-rationed farms, household characteristics have a significant effect on output supply. This is evidence for a violation of separability between production and consumption decisions and thus lends empirical support to the existence of a market imperfection. A counterfactual model estimated on all short-term credit recipients demonstrates that the marginal willingness to pay for credit is substantially higher for rationed than for non-rationed farm households.

12. An ex-post evaluation of investment activities suggests that non-productive investment ranks high on the priority list of interviewed farmers. Residential buildings and automobile purchases are the two items with the largest share of farm-individual investment expenses in the reporting period, whereas machinery and land purchases followed on lower positions (section 4.3.1, pp. 184 et seq.).

13. The econometric investment analysis leads to two major results. First, credit access turns out to be a significant factor of investment decisions of credit-rationed farmers (section 4.3.2, pp. 187 et seq.). This supports the theoretical prediction of a financial constraint model of investment behaviour and is consistent with the qualitative self-classification of respondents. Second, the analysis provides evidence that subsidised credit funds are partly diverted to non-productive purposes. In various specifications of the credit-investment relationship, the marginal effect of credit on productive investment is clearly smaller than one (section 4.3.3, pp. 190 et seq.). Based on a cubic Tobit estimate of the investment function, the mean of the farm-individual marginal effects is at .53 on average. Other, less flexible models presented as well principally support this result. Every second borrower invests less in produc-

tive assets than he borrows. Only 1.6 percent of the selected respondents with positive investment display farm-individual credit effects larger than one. Over the observed range of credit volumes, the marginal effect increases with an increasing credit volume. However, net of the investment effect of the credit volume, small farms invest more.

In summary, the analysis provides evidence that credit rationing is a relevant phenomenon in rural Poland. A significant fraction of borrowers could substantially increase their productivity if access to working capital were improved. However, the examination of long-term loans revealed that farmers often prefer the investment in non-productive assets to growth investment. Credit rationing hence is unlikely to be the ultimate constraint for modernisation and structural change in the Polish farm sector. Government intervention in its current form has clearly failed to eliminate credit rationing, and the targeting of state sponsored funds turns out to be rather dubious. An alternative government policy should aim to improve the general creditworthiness of prospective borrowers and address the causes of loan default in the past that led to a poor reputation of certain borrowers.

5.2 Integration with existing research and theory

In this subchapter I wish to discuss the implications of the previous results for the current scientific debate. In the first section, I comment on the relation to other studies on the same topic and to research that used a similar methodology in a different country. The second section aims at investigating the repercussions on economic theory formation.

5.2.1 Relation to existing empirical research

The results of the previous analysis confirm the earlier conjecture in WORLD BANK (2001) that credit rationing is a relevant problem in rural Poland. Interestingly, both studies arrive at an almost identical result regarding the frequency of subjectively experienced credit rationing. As noted in section 1.4.3, p. 18, the World Bank study found that about one half of borrowers said they wanted a larger loan on the same terms (WORLD BANK 2001, p. 66). The result in the present study was that 47.6 percent of borrowers self-classified as being credit-rationed (section 4.1.1, p. 164). I re-examined the Wold Bank finding that investment is determined by current income and investigated it in a methodologically more robust way. Instead of current income, which arguably is subject to simultaneity bias, I directly investigated the effect of credit access on the in-

vestment volume. This turned out to be highly significant, which is interpreted as evidence in favour of a financial constraint (section 4.3.2, pp. 187 et seq.).

The empirical investment analysis in this monograph also substantiates the suggestions of POGANIETZ and WILDERMUTH (1999) and JÓZWIAK (2001) concerning the diversion of credit funds to non-productive purposes. As presented in section 4.3.1, p. 185, renovation of residential buildings and automobile purchases rank highest among farmers' investment expenses. However, the extent of diversion diminishes with increasing loan size.

In its empirical approach towards a detection of credit rationing, the current study joins the research cited in section 3.1.3, pp. 114 et seq. With regard to the output supply analysis, it may be recalled from the overview in the above section that results by other authors were highly country-specific. For example, the estimated shadow interest rates varied in a range from negative values to plus 300 percent. The average willingness to pay estimated in the current study was 209 percent, thus also relatively high. A possible objection to the results is that a high willingness to pay may have other causes than credit rationing. Two alternative explanations could be that a high internal value of credit is due to (a) restricted access not to credit but to *inputs* which are financed by credit or (b) *risk averse production behaviour* of the farmer, which can also be interpreted as a result of missing markets for insurance. In general, as compared with a risk neutral farmer, the marginal expected product of input use is reduced by a risk averse decision maker, so that the ex-post observed marginal productivity of input use exceeds marginal factor costs (HARDAKER et al. 1997, pp. 127-133). Whether risk aversion leads to non-separability of production and consumption depends on the specification of the risk (FABELLA 1989).

Of course, it cannot be totally ruled out that restrictions in access to inputs play a role in the Polish farm sector. Furthermore, it is quite plausible that Polish farmers cannot insure all risks and therefore exhibit some degree of risk aversion (also suggested by WORLD BANK 2001, pp. 65-66). It is possible that both factors act through the credit variable in the output supply regression and thus reinforce the estimated effect of credit rationing. However, they are likely to affect rationed and non-rationed borrowers in an equal way. A possibility to *isolate* the credit rationing effect is by analysing the results of the counterfactual model in Table 4-8, p. 173 (see also the discussion at the end of section 4.2.2, pp. 176 et seq.). Although to be treated with caution due to potential simultaneity bias, the estimates of the counterfactual model essentially show that the marginal willingness to pay for credit is much lower for non-rationed farms and household

characteristics are less significant for output supply if non-rationed borrowers are included into the sample. Notice that the credit rationing dummy allows a very precise identification of the group of borrowers for which an increased willingness to pay and local non-separability due to credit rationing can consistently be expected. The obvious difference in willingness to pay between rationed and non-rationed can therefore directly be attributed to credit rationing itself. However, the willingness to pay for non-rationed borrowers still slightly exceeds the average market interest rate. The willingness to pay estimated for non-rationed borrowers may therefore be taken to reflect the effects of other input constraints and of risk aversion, net of the credit rationing effect, which is given by the gap between both subgroups.

Given this evidence, one may suspect that farmers have a large incentive to divert investment loans to use them for working capital. However, borrowers of long-term loans and borrowers of short-term loans are two almost completely separate groups. Among the 168 partially credit-rationed survey respondents (Table 4-1, p. 164), only four borrowed short-term loans *and* in the same time period a long-term loan. Only one of these reported that he used some part of the investment loan for purchasing inputs.

The results of the empirical investment analysis as portrayed in subchapter 4.3 show that credit rationing with regard to long-term borrowing does exist also in the Polish farm sector. This finding is hence consistent with several studies from other countries, as summarised in section 3.1.3, Approach 6, pp. 129 et seq. I go on to discuss the implications for theory formation in the following section.

5.2.2 Implications for current theory

The empirical approaches to the analysis of credit rationing as pursued in this study uniformly substantiate the view that credit rationing is an important phenomenon of reality. The aim of this section is to explore some of the potential consequences of this finding for the future development of economic theory. I want to proceed in such a way that I comment the previous finding from the viewpoint of each of the three theoretical positions presented in section 2.1.3, pp. 30 et seq., in turn.

The empirical detection of credit rationing certainly stands in marked contrast to the assumptions of the perfect market model as presented in section 2.1.2, pp. 24 et seq. A first question I want to raise is whether this finding provides an *empirical refutation* of the neoclassical market model. It was shown in section 3.1.2, pp. 103 et seq., that even if one believes that an empirical falsification of eco-

nomic theories is principally possible and desirable, neoclassical equilibrium theory is not very amenable to such an attempt. If reality is not in accordance with the assumptions of the model, the model does not claim validity and can hence also not be refuted empirically (SCHNEIDER 1992, p. 537). A model that does not yield explanations of certain relevant phenomena in reality may however still serve a role in the scientific debate. First, there still may be situations in which the model is applicable (STIGLITZ 2002, p. 488, mentions the markets for wheat or corn). Second, certain aspects of the model, such as its formal consistency or plausibility, or the simple fact that it is well known and thus provides a common point of reference, can make it useful in communication processes. The ultimate purpose of the theory is thus a *rhetorical* one (in the sense of section 3.1.2).

Of course, it is usually regarded as desirable to have theories that *are* capable of explaining the empirical phenomena one is interested in, and these theories are also likely to be more plausible. One approach also followed in this monograph is to introduce *appropriate modifications* of the standard neoclassical model which allow certain real world events to occur in the model – for example credit rationing. STIGLITZ (2002) regards this as a *change in the paradigm* of economics. Although only single assumptions of the perfect market model are changed, fundamental consequences result (as demonstrated to some extent in subchapter 2.2, pp. 49 et seq.). In particular, the economic world analytically becomes much more complicated because many convenient separation theorems break down. Among these are the separability of consumption and production or investment decisions, the analytical independence of supply and demand, or the separation of efficiency and equity in welfare theory. As a consequence of asymmetric information on markets, the optimal production plan cannot be made without knowledge of the households' consumption preferences, a change in the demand structure for some good has direct consequences for supply, and efficient resource allocation may very well depend on the initial wealth of the producers.

With regard to the study of loan markets, two broad groups of insights could be gained from an agency theoretic analysis as pursued in chapter 2. First, there is no ambiguity that several properties of the standard neoclassical model do *not* hold on credit markets with asymmetric information or are restricted to a very specific range of applicability. This has profound consequences for the choice of an appropriate analytical approach to real-world events. Second, agency theory is able to identify important mechanisms to *overcome* the problems of asymmetric information and to include these mechanisms into the theoretical model. The *empirical* analysis of this monograph provides evidence that *supports* these

propositions. The presence of credit rationing could be detected empirically by a number of complementary methods. It was demonstrated that privately undesirable market outcomes can be avoided by pledging collateral and establishing a good reputation as a borrower. Furthermore, the non-separability of consumption and production decisions could be empirically verified. The traditional neoclassical model can therefore be regarded as a definitely inappropriate description of the Polish rural credit market, whereas agency theory seems to take many crucial characteristics of this market correctly into account.

On the other hand, there are a number of traits of agency theory that make its application and handling difficult and thus invited legitimate criticism. One line of criticism partly comes from the proponents of this theory themselves and concerns the lack of predictive power of the models, which is due to their sensitivity with regard to the specific set of assumptions made. The precise way in which markets react under asymmetric information is often not easy to foresee. It is set out that the exact pathways in which counteracting mechanisms work could be painstakingly modelled and hence exactly be traced. However, since the theoretical analysis is carried out on a very high level of abstraction that only allows for punctually relaxing the assumptions of the standard model, predictions for real-world events are hard to make. The following quote from HELLWIG (1987, p. 325) may illustrate this:

> "For the applied economist who studies, e.g., the regulation of credit or insurance markets, the discrepancy between the predictions of the different game-theoretic models presents a fundamental dilemma. On the one hand, it is important that he determine which of the different models is appropriate for the market at hand. On the other hand, this may be impossible to determine because matters like the order in which people make moves, which make all the difference for the game-theoretic specification, may not be observable and may not even be fixed in a given market."

The same argument equally applies to, for example, the distribution of the riskiness of credit projects as discussed in section 2.2.3, pp. 63 et seq. A related point is made by SUTTON's (1990) comment titled 'explaining everything, explaining nothing?'. It is this lack of robustness that led TERBERGER (1994, p. 143) to the conclusion that concepts of NIE are even more difficult to test empirically than much of traditional neoclassical economics (see section 3.1.2). There are few events that agency theory can definitely rule out to occur in a real-world situation under investigation. Furthermore, the lack of predictive power of these models goes hand in hand with the problem that straightforward policy recommendations can rarely be derived. This issue is taken up again in subchapter 5.3.

Whereas STIGLITZ (2002, p. 486) argues that already small changes in the set of assumptions lead to tremendous consequences within the traditional, neoclassical framework, others would say that these small changes do not go far enough and even lead to inconsistencies. FURUBOTN and RICHTER (1997, p. 356) regard formal agency theory as a *hybrid* or mixture of the neoclassical and the 'true' new institutional position. Although they acknowledge that agency theory offers a genuine extension of the neoclassical standard (and thus argue against the view that transaction and information costs could be simply integrated into the orthodox approach, as suggested for example by STIGLER 1961), they also point to a number of potential problems. These include (FURUBOTN and RICHTER 1997, p. 458): (a) a set of contradictory assumptions, namely that individuals face (prohibitively high) information costs in some dimensions whereas they possess perfect information with regard to all others, (b) the fact that hybrid models assume the availability of data (e.g. on production or utility functions) that cannot be known to a boundedly rational decision maker acting in a neoinstitutional environment, (c) only one mode of decision making (rational choice) is allowed although other modes might be preferable by a boundedly rational individual, and although rational choice leads to an infinite regress if decision-making is costly, and (d) hybrid models are thus fundamentally misleading because they assume data and decision procedures that are effectively beyond the power of real-life individuals.

Any reference to a formal 'first-best' world is therefore rejected as leading to a 'nirvana fallacy' (DEMSETZ 1969, p. 1). The efficiency criterion is only framed in very loose terms as a "device that separates relatively more desirable alternatives from less desirable ones" (FURUBOTN 1999, p. 193). FURUBOTN adds the following (p. 194):

> "It should be clear that efficiency criteria that can never be met by actual people faced with the major constraints characterizing a neoinstituional economy are essentially irrelevant. Efficiency standards that show inefficiency always in existence in the real world are not very valuable guides to policy."

Consequently, TULLOCK (1999) proposes to abandon the concept of Pareto optimality, since in his view it cannot be applied in any useful way.

Proponents of this more radical branch of NIE clearly break with the neoclassical tradition and usually also refrain from the more mathematically oriented way of analysis. The precise identification of causal relations as possible in mathematically structured models of the economy is relinquished. However, the resulting loss in exactness is beyond what many economists find acceptable. It is ob-

jected that the increased 'vagueness' also opens the way to undue data mining, and definitely reduces the theoretical preconditions to be fulfilled by an empirical analysis (as for example known from neoclassical production theory). On the other hand, it is argued that a verbal argumentation based on plausibility considerations as for example used in Transaction Cost Economics improves the predictive power of the theory, thereby making this branch of NIE an "empirical success story" (O.E. WILLIAMSON 2000, p. 607). Furthermore, it was seen above that the clear-cut propositions of neoclassical analysis vanish anyway even if only the modifications proposed by formal contract theory are introduced. In addition, it is doubtful whether the perceived rigour of traditional economic reasoning is indeed an appropriate depiction of the existing world and thus 'real', or whether it is 'rhetoric' in the sense that it is merely a device for persuasion and argumentation (see section 3.1.2).

Currently it seems that broadly two basic positions can be distinguished which have in common a critical attitude towards the orthodox neoclassical approach but are divided with respect to the question of how far an appropriate modification should go. Whereas more mathematically oriented approaches as presented in this monograph are deemed a "prematurely formal theory" by proponents of a more radical position (O.E. WILLIAMSON 1993, p. 43), the latter, often more verbal and 'story-based' way of argumentation is rejected by advocates of formal contract theory because it "glosses over all those details that matter" (HELLWIG 1988, p. 204).

The approach in this monograph was to follow a more formal way of analysis which does not cut all connections to the neoclassical standard. The theoretical analysis highlighted the virtues and the deficits of such an approach. However, in my opinion, the empirical application also demonstrated that it can be a useful guide for the examination of real-world problems in a rigorous, methodologically consistent, and therefore plausible way. Although it is legitimate to point out the weaknesses of this procedure and to call for more far-reaching changes in economic theory, I doubt whether the ultimate decision can be made on purely empirical grounds. The future landscape of economic theory is therefore likely to be characterised by much more heterodoxy than it used to be.

5.3 Policy recommendations

The international experience as summarised in section 1.4.2, pp. 14 et seq., of this monograph suggests that the type of policy intervention currently in place in Poland is usually difficult to justify on economic grounds. Beneficiaries of simi-

lar programmes in other countries often did not increase the efficiency of their operations, access to subsidised funds frequently was very unequal, funds could rarely be targeted effectively, capital subsidies implied negative incentives for the development of financial intermediaries, and governmental investment promotion often turned out to be prone to politically motivated abuse. For these reasons, economists tend to refuse this type of market intervention.

The previous theoretical and empirical analysis investigated a number of these issues and aimed at scrutinising the role government policy has in addressing potential deficiencies of credit markets in general and the Polish rural loan market in particular. Although the current debate in the literature is far from being settled, it seems to become a widely accepted view that a theory of credit markets with pervasive agency relations concedes government activity a potential role in improving market outcomes. The problem is that, although unfettered markets are likely to lead to suboptimal allocation of funds, it is almost impossible to predict from a theoretical analysis alone *which type* of government intervention is optimal. A major result of the previous analysis was that any policy measure should tackle the *causes* of undesired market outcomes. Although theory suggests potential causes, their ultimate identification has to be made on empirical grounds.

With regard to credit markets, it was shown that credit rationing does not necessarily imply *underinvestment* as compared with a first-best solution. However, the empirical detection of underinvestment was seen to be not straightforward, and was dropped from the research agenda of this study. Furthermore, the discussion in the previous subchapter leads to doubts whether a purely hypothetical comparison with an idealised fist-best world is of any value for practical policy advice.

Policy recommendations therefore must focus on the role of government *within* a world of asymmetric information and opportunism. The dilemma is that governments are likely to face the same problems of, say, adverse selection or moral hazard as other economic agents do. Frequently it is the case that eliminating certain agency problems by government action even creates new ones. An example is the granting of public loan guarantees in order to mitigate the problems of loan collateralisation. Depending on the precise design of the programme, banks' incentives to properly screen and monitor borrowers might be diluted because the government effectively takes over the risk of loan default. The agency relation between the bank and the borrower is then simply transformed into an agency relation between the government and the bank. For these reasons

economists still tend to be sceptical with regard to direct market intervention by governments. Even so, the government can and should make use of its power that no other economic agent possesses. Altough the government has no advantage of its own in assessing risks and premiums, it should foster the adequate use of screening and monitoring procedures, for example by an appropriate regulation and supervision. Furthermore, it can assign property rights in such a way that collateral problems are reduced, which in turn enables to overcome existing agency relations.

The theoretical analysis of agricultural household models has shown that credit rationing has a number of undesired consequences for the performance of farms. In particular, the more severe the credit restriction, the higher are the reductions in farm output and hence farm income, and the slower is farm growth (provided there are profitable investment opportunities available). Any government should therefore be interested in removing binding credit constraints in their farm sectors.

The empirical analysis of credit rationing in the Polish agricultural sector provides a host of valuable information for policy advice. It may be useful to again summarise the major findings that are relevant in this respect:

1. 80 percent of surveyed farmers took some type of loan between 1997 and 1999 (the survey does not include pure subsistence farms).
2. About 40 percent of borrowers are rationed by rural banks in the sense that they would have liked to borrow more at the same interest rate than they obtained.
3. Credit rationing was shown to be due inter alia to a poor reputation of borrowers and to depend on the number of male and female household members. The availability of collateral plays a role in short-term lending, whereas reputation effects are particularly pronounced if all types of loans are considered.
4. Credit rationing restricts farm productivity to a substantial extent. With regard to working capital loans, farmers' call for more credit is hence legitimised ex-post.
5. The existing governmental subsidy scheme does not eliminate credit rationing. On the other hand, there is evidence that it is not the ultimate source of rationing.

6. With regard to investment loans, funds are frequently diverted to non-productive uses, particularly if loan sizes are small. However, per unit borrowed, small farms invest more than large farms.

The results show that the rural credit market provides resources for most farmers in the sample. However, credit rationing is a relevant phenomenon. The analysis highlights the role of devices to overcome problems of asymmetric information (collateral, reputation), which could be a first hint for policy advice. In addition, other factors (demographic characteristics) come into play as well. The empirical investigation also suggests that there are several critical points of current government intervention. It is clearly not successful in removing credit rationing, which is no surprise if a lack of collateral or reputation are at the core of the problem. With regard to long-term loans, the targeting of credit is rather dubious. On the other hand, it might be seen as a virtue that lending apparently does not discriminate against small farms, since land owned has no significant effect on the probability of being credit-rationed. If only short-term borrowers are considered, there is a weakly significant, negative effect of land owned on the probability of being rationed.

Based on the previous considerations, the following policy recommendations can be given:

1. The Polish government should reconsider the objectives of its agricultural credit policy. The current policy of subsidising interest rates is not successful in eliminating credit rationing. In addition, it is neither well targeted to improve farm productivity nor does it effectively foster investment in farm growth and productive assets. The government should therefore consider to phase out the current subsidisation scheme, since the dubious benefits are unlikely to justify the costs of funding and administering this programme.

2. Adequate policy measures should address the problems of lacking collateral and poor borrowers' reputation. It should be checked to what extent government policy can improve this. Since mortgaging land is widely practised in Poland, there seem to be no decisive bottlenecks in the legal basis for this. However, it should be examined how far macroeconomic factors or a widespread policy uncertainty were relevant for the earlier defaults of borrowers.

3. More attention should be paid to the availability of working capital loans. Even so, there appears to be even a kind of saturation on the market for investment loans. Although farmers are willing to borrow more long-term loans than they currently obtain, these loans are to a considerable extent used

for the purchase of durable consumption goods. This diversion of governmentally sponsored investment funds should be avoided.

4. The appropriateness of banking technology and screening and monitoring practices should be checked. The econometric analysis provides a number of hints for this task. It should be examined what is behind the fact that household characteristics play a role in the probability of credit rationing. Are these characteristics taken into account by the banks' decision to grant a loan, and, if yes, why is this the case? Does this point to some sort of discrimination? It was shown that transaction costs, and in particular fees, considerably mark up the effective interest rate farmers have to pay. Although careful screening of borrowers is an important task of banks, it should be looked at whether banking practices can be streamlined to reduce these costs. Whereas the overall transition of the Polish banking industry has been widely successful, there is evidence that the unfinished restructuring and reconsolidation process of the *rural* banking sector might be partly responsible for still inefficient banking practices. Government policy should support this process. Other potential government activities include the establishment of a private credit rating agency, financial support to assessing credit worthiness of borrowers, and the general support of market information systems (KOESTER 2001, p. 314).

5. The government should take short-term liquidity effects of potential future direct payments under the CAP into account. An important side-effect of these payments might be that they effectively bridge the working capital shortage of farms. As a result, hectare- or livestock-based payments would not only provide an incentive to keep land and livestock, but would also directly lead to an expansion of production on currently credit-rationed farms.[97] However, permanent payments are unlikely to induce a persistent increase of the capital stock of farms.

Since agency problems on rural loan markets are a fact of life, there are no simple solutions to overcome credit rationing, and the channelling of funds towards the most efficient use is a complicated task. A prudential government policy will align its policies with its democratically legitimised objectives and primarily at-

[97] It is less likely that this will lead to significant changes in overall Polish agricultural output, since only a fraction of farmers is constrained on working capital. The limited availability of land and the difficult economic situation of farms suggest that sectoral output changes will be at best moderate (PETRICK et al. 2002, p. 213).

tempt to address the causes and not the symptoms of any undesired outcome on agricultural credit markets.

5.4 Recommendations for future research

The aim of this final subchapter is to look at the implications of the previous analysis for potential future research activities. Since only a fraction of open questions raised in the course of the study could be addressed explicitly within this monograph, and because many of the proposed answers might be regarded as tentative or unsatisfactory, it seems useful to identify a number of key research areas for the time to come. I restrict the following considerations to the narrower range of issues that formed the core of this research. The recommendations can be grouped as follows:

1. The analysis has demonstrated that the theoretical understanding of many relevant real-world phenomena not explicable in the standard neoclassical models has progressed over recent years, but there are still many unresolved problems. The theoretical landscape has evolved neither in a uniform nor in a necessarily consistent way. This is of course natural and only to be expected in a rapidly growing research field. However, it seems particularly desirable to develop *more robust theoretical models* for predicting the implications of asymmetric information, or the consequences of dropping other assumptions of the neoclassical tradition. One question to be raised is whether the highly abstract and mathematically oriented way of analysis can and should be retained. Communication processes with proponents of more verbally oriented theoretical approaches such as Transaction Cost Economics should be sought.

2. This should go hand in hand with a further exploration of the *empirical applicability of NIE concepts* in general. Although the consequences of agency theoretic models for the empirical analysis of real-world events are increasingly understood, there is still a gap between the abstract and often highly simplifying theoretical models and the practical policy problems at hand. MATTHEWS (1986, p. 917, as cited in EGGERTSON 1990, pp. 31-32) is still right in arguing that

   > "[b]ecause economic institutions are complex, they do not lend themselves easily to quantitative measurement. Even in the respects in which they do, the data very often are not routinely collected by national statistical offices. As a result, the statistical approach which has become the bread and butter of applied economics is not straightforwardly applicable."

The present study has provided an example of how the economic analysis of institutions can be undertaken by using econometric modelling techniques. However, the approach has still been carried out on a rather general level, for example in terms of specifying functional relationships. It seems therefore desirable to further strengthen the link between theoretical concepts and representative empirical and policy-oriented analysis.

3. On the other hand, it appears also desirable to make progress in developing *analytical tools for practical policy advice on markets with pervasive agency relations*. In particular, I have in mind a clarification whether traditional concepts of welfare theory are still useful devices for policy analysis or how far they can and should be replaced by other concepts more capable of reflecting the 'frictions' of the real world.

4. With regard to the empirical analysis of rural credit markets, it might be a rewarding task to try *other methods for empirically detecting credit rationing*, as presented in section 3.1.3, pp. 114 et seq., and check their convergence with the results of this study. To have available a suitable toolbox of empirical methods will be a crucial prerequisite for potential advances in theorising and policy advice as outlined in the previous paragraphs.

5. Future work on the Polish case could extend the current research in a number of directions. A first could be to investigate *other sources of finance* in Polish agriculture, in particular informal sources or trade credit. These have been largely neglected in this study because they are of less quantitative relevance as compared to formal credit. However, they may be important for small-scale and subsistence farms. A second approach could be to carry out a more comprehensive *cost-benefit analysis of Polish credit market intervention*. This would be a challenging task, in particular with regard to a proper measurement of the programme's benefits. A third issue not investigated in this monograph concerns the *political aspects* of governmental intervention on credit markets in Poland. Future research could possibly draw on earlier work by WENZELER (1999), who provides an analysis of bank sector restructuring in Poland based on political economy considerations.

6. A final most important task for subsequent research concerns a further in-depth analysis of the *determinants of structural change in the Polish farm sector*. The current study has failed to provide a comprehensive explanation based on credit rationing. In contrast, the empirical analysis demonstrates that credit access seems *not* to be the decisive bottleneck for farm investment and growth. Future work should investigate other reasons for slow structural

change in Poland. A promising starting point for such an investigation will be the *rural labour market*, the current shape of which effectively blocks the outflow of agricultural labour force or even forces people into the sector to secure a most basic livelihood (DRIES and SWINNEN 2002; PETRICK and TYRAN 2003). Structural change and the development of labour and land relations in Polish agriculture are thus of high political interest for the years to come. At the same time, rural labour markets are among the least understood phenomena of transition (TANGERMANN and SWINNEN 2000, p. 198).

Overall, there are fundamental research questions yet to be answered in the theoretical, empirical, and policy-oriented spheres of this field. Following HANF (1997), it is to be hoped that agricultural economists with their rare blend of experience in all three dimensions of research accept the challenge.

EXECUTIVE SUMMARY

On the verge of EU accession, Poland's agricultural sector is characterised by a number of distinct structural weaknesses, which are a major reason for the unsatisfactory income situation of rural households. Among these weaknesses are that farm productivity is substantially below EU standards, investment has performed much weaker as compared with the overall Polish economy, and structural change has been very small. It has been suggested that credit access is a crucial factor for overcoming these undesired outcomes. Furthermore, the Polish government massively intervenes on rural credit markets, in particular by granting subsidies on working capital and investment loans for agriculture. Against this background, the aim of the present research is to discover how far potential deficiencies on rural credit markets can be made responsible for the structural weaknesses of the Polish farm sector and thereby provide an economic rationale for government activity.

Central to the analysis is the notion of credit rationing. This notion abounds in the recent literature on credit market problems, although it is not used in a uniform way. In this monograph, credit rationing is understood to indicate a situation of persistent private excess demand for credit. The subsequent theoretical and empirical analysis explores how far this concept can be made fruitful for the understanding of the Polish rural credit market and the effects of governmental intervention.

The major findings of the study can be summarised as follows:

1. The theoretical investigation of credit markets sets out that credit rationing is by definition excluded in the traditional neoclassical market model, whereas it is a likely outcome on markets with asymmetric information. However, theory does not provide unambiguous propositions regarding the welfare assessment of credit rationing. Since the presence of asymmetric information cancels the functioning of the price mechanism, the traditional concepts of social efficiency are no longer valid. As a consequence, credit rationing does not necessarily imply underinvestment, and it generally does not create a case for straightforward government policy. It seems therefore reasonable to analytically decouple the analysis of credit rationing and under- or overinvestment. The subsequent analysis in this monograph focused on the first of these.

2. The extent to which asymmetric information has harmful effects on investment outcomes is shown to depend on the availability of counteracting ar-

rangements, such as collateral, joint liability, or reputation of borrowers. The way in which governments can improve on these instruments will play a decisive role for successful policy action. Any intervention measures should consider the conditions and causes that are responsible for an undesirable market outcome, in case that this has been successfully identified.

3. In the framework of a two-period farm household model, the consequences of introducing a binding credit constraint are examined. The market interest rate loses its relevance for the household internal allocation of funds and is replaced by an endogenous, unobservable shadow interest rate. Compared with a first-best world without credit rationing, the household will reduce output, which implies a loss of income. An increase in government transfers relaxes the liquidity constraint and thus has positive effects on farm output. In a multi-period household model with endogenous equity formation, credit rationing has the effect that investment cannot immediately attain its optimal level. The household thus reduces current consumption in favour of equity formation.

4. The presence of a perfect capital market allows the convenient separation of production or investment decisions on the one hand and consumption decisions on the other. Both farm household models suggest that this cannot be maintained under a binding credit constraint. As a consequence, there is no objective criterion anymore which allows to assess the (private) efficiency of input use or investment activities. Both decision complexes can only be made simultaneously with the household's consumption plan and are thus affected by the household's preferences. Any empirical production or investment analysis has to take these interdependencies into account.

5. In a reflection on economic methodology, it is argued that econometrics cannot be the fundamental benchmark for the falsification of theories. The methodological standpoint of critical rationalism should therefore be left behind and be replaced by a more pragmatic and instrumentalist position. The empirical results of the present study are primarily based on a regression analysis of cross-sectional survey data, which includes qualitative and quantitative indicators of credit rationing.

6. According to statements of farmers made during the survey, 80 percent of farm households took at least one loan in the reporting period 1997-1999. Almost half of the borrowers obtained less credit than desired and are hence regarded as credit-rationed. Central determinants of credit rationing are the reputation of the loan applicant as well as demographic household character-

istics. Over all loan types, respondents with a good credit history have a 30 percentage points lower probability of being rationed than borrowers who rescheduled a loan in the past. In addition, more adult males in the household decrease the probability of being credit-rationed, while more females increase it. If only short-term borrowing is considered, collateral availability is an additional key factor of credit rationing.

7. The econometric analysis of output supply supports the earlier finding that more than 40 percent of borrowers experienced pronounced credit rationing by rural banks. These farms display a marginal willingness to pay for credit of on average 209 percent net of principal. The willingness to pay is significantly different from individual interest rates for credit that account for loan specific transaction costs. These individual interest rates are 13 percent per annum on average. Transaction costs, however, do not ex-post rationalise a withdrawal of loan applications and cannot be regarded as the ultimate cause of perceived credit rationing. In the group of credit-rationed farms, household characteristics are proven to have a significant effect on output supply. This is evidence for a violation of separability between production and consumption decisions and thus lends empirical support to the existence of a market imperfection. A counterfactual model estimated on all short-term credit recipients demonstrates that the willingness to pay is substantially higher for rationed than for non-rationed farm households.

8. An ex-post evaluation of investment activities suggests that non-productive investment rank high on the priority list of interviewed farmers. Residential buildings and automobile purchases are the two items with the largest share of farm-individual investment expenses in the reporting period. The econometric investment analysis demonstrates that credit access is a significant factor of investment decisions of credit-rationed farmers. This supports the theoretical prediction of a financial constraint model of investment behaviour and is consistent with the qualitative self-classification of respondents. Furthermore, the analysis substantiates the evidence that subsidised credit funds are partly diverted to non-productive purposes. In various specifications of the credit-investment relationship, the marginal effect of credit on productive investment is clearly smaller than one. Based on a cubic Tobit estimate of the investment function, the mean of the farm-individual marginal effects is at .53 on average. Every second borrower invests less in productive assets than he borrows. Only 1.6 percent of the selected respondents with positive investment display farm-individual credit effects larger than one. Over the observed range of credit volumes, the marginal effect increases with an increas-

ing credit volume. However, the results do not support the view that investment is positively related to farm size.

In summary, the analysis provides evidence that credit rationing is a relevant phenomenon in rural Poland. A significant fraction of borrowers could substantially increase their productivity if access to working capital were improved. However, the examination of long-term loans revealed that farmers often prefer the investment in non-productive assets to growth investment. Credit rationing hence is unlikely to be the ultimate constraint for modernisation and structural change in the Polish farm sector.

Government intervention in its current form has clearly failed to eliminate credit rationing, and the targeting of state sponsored funds turns out to be rather dubious. An alternative government policy should aim to improve the general creditworthiness of prospective borrowers and address the causes of loan default in the past that led to a poor reputation of certain borrowers. Policy action that improves the access to working capital should be given priority. One of the potential side-effects of the introduction of direct payments under the CAP could be to relax exactly this constraint on working capital for currently credit-rationed farm households.

Beyond a further integration of theory and empirics in the area of New Institutional Economics, an important focus of future research should be the development of analytical tools for practical policy advice on markets with pervasive agency relations. With regard to Poland, political aspects of governmental credit market intervention as well as a more comprehensive analysis of the determinants of structural change in the farming sector appear to be promising research fields.

ZUSAMMENFASSUNG

Im Vorfeld des angestrebten Beitritts Polens zur Europäischen Union ist der Agrarsektor des Landes von erheblichen Strukturproblemen geprägt. Diese stellen einen Hauptgrund für die unbefriedigende Einkommenssituation ländlicher Haushalte dar. Zu den Strukturproblemen in der Landwirtschaft gehören die im Vergleich zur EU niedrige Produktivität der Betriebe, die gegenüber der gesamten polnischen Volkswirtschaft überaus schleppend verlaufende Investitionstätigkeit, sowie der nur sehr langsam sich vollziehende Strukturwandel. Häufig wird der Zugang zu Krediten als ein Schlüsselproblem für die Überwindung dieses unerwünschten Zustandes angeführt. Die polnische Regierung interveniert auf ländlichen Kreditmärkten massiv durch die Bereitstellung von Subventionen für Betriebsmittel- und Investititonskredite im Agrarbereich. Vor diesem Hintergrund untersucht die vorliegende Arbeit, inwieweit ein mögliches Versagen der ländlichen Kreditmärkte für die genannten Strukturprobleme verantwortlich gemacht werden kann und ob dieses Versagen daher eine Rechtfertigung für die Staatseingriffe bietet.

Der Begriff der Kreditrationierung kennzeichnet das zentrale Konzept der Analyse. Dieser Begriff findet sich häufig in der jüngeren Literatur, obwohl er nicht einheitlich verwendet wird. In dieser Arbeit bezeichnet Kreditrationierung eine Situation andauernder privater Überschussnachfrage nach Kredit. Die nachfolgende theoretische und empirische Analyse untersucht, inwieweit dieses Konzept für ein Verständnis des ländlichen Kreditmarktes und der Effekte von Staatseingriffen in Polen fruchtbar gemacht werden kann.

Die wesentlichen Ergebnisse der Arbeit können wie folgt zusammengefasst werden:

1. Die theoretische Untersuchung von Kreditmärkten legt dar, dass Kreditrationierung im traditionellen, neoklassischen Marktmodell per Definition ausgeschlossen ist, während Rationierungsergebnisse auf Märkten mit asymmetrischer Informationsverteilung wahrscheinlich sind. Die wohlfahrtsökonomische Analyse der Kreditrationierung liefert jedoch keine eindeutige Bewertung. Da das Vorhandensein von asymmetrischer Informationsverteilung die Funktionsweise des Preismechanismus außer Kraft setzt, sind herkömmliche Konzepte der gesamtwirtschaftlichen Effizienz nicht länger gültig. Eine Konsequenz hiervon ist, dass Kreditrationierung nicht notwendigerweise mit Unterinvestition einhergeht und keine eindeutigen Politikmaßnahmen aus dem Vorliegen von Kreditrationierung abgeleitet werden können. Es scheint daher

sinnvoll, die Analyse von Kreditrationierung und die Analyse von Unter- bzw. Überinvestition zu trennen. Die folgende Untersuchung konzentriert sich auf Kreditrationierung.

2. Es wird gezeigt, dass das Ausmaß, mit dem asymmetrische Informationsverteilung schädliche Effekte auf das Investitionsergebnis ausübt, von der Verfügbarkeit entgegenwirkender Arrangements abhängt, wie zum Beispiel Sicherheiten, gemeinschaftlicher Haftung oder der Reputation des Schuldners. Staatliches Handeln sollte die Wirksamkeit solcher Arrangements verbessern helfen. Mögliche Interventionsmaßnahmen sollten daher die Bedingungen und Ursachen in Betracht ziehen, die für ein unerwünschtes Marktergebnis verantwortlich sind, sofern letzteres erfolgreich aufgespürt werden konnte.

3. Im Rahmen eines zweiperiodischen Betriebs-Haushalts-Modells werden die Auswirkungen der Einführung einer bindenden Kreditobergrenze untersucht. Der Marktzinssatz verliert unter diesen Umständen seine Bedeutung für die haushalts-interne Allokation von Finanzmitteln und wird durch einen endogenen, unbeobachteten Schattenzinssatz ersetzt. Verglichen mit einer first-best Allokation ohne Kreditrationierung wird das Produktionsvolumen des Haushalts reduziert, was einen Einkommensrückgang nach sich zieht. Erhöhte staatliche Transferzahlungen lockern die Liquiditätsobergrenze und üben daher einen positiven Effekt auf das Produktionsvolumen aus. In einem mehrperiodischen Haushaltsmodell mit endogener Eigenkapitalbildung bewirkt Kreditrationierung, dass das Investitionsvolumen nicht unmittelbar seinen optimalen Wert annehmen kann. Der laufende Konsum wird daher zugunsten von Eigenkapitalbildung verringert.

4. Geht man von einem vollkommenen Kapitalmarkt aus, so erlaubt dieser die analytisch bequeme Trennung von Produktions- und Investitionsentscheidungen auf der einen Seite und Konsumentscheidungen auf der anderen Seite. Beide Betriebs-Haushalts-Modelle zeigen, dass diese Separierung bei einer bindenden Kreditobergrenze nicht aufrechterhalten werden kann. Als Konsequenz verschwindet jedoch das objektive Kriterium, anhand dessen die (private) Effizienz von Faktorallokations- oder Investitionsentscheidungen beurteilt werden könnte. Über beide Entscheidungskomplexe kann nur simultan mit dem Konsumplan des Haushalts entschieden werden, so dass die Präferenzen des Haushalts in die Planung eingehen. Eine empirische Analyse von Produktions- oder Investitionsentscheidungen sollte diese Abhängigkeiten berücksichtigen.

5. Im Rahmen einiger Überlegungen zur Forschungsmethodolgie in den Wirtschaftswissenschaften wird argumentiert, dass ökonometrische Analysen nicht das ausschlaggebende Entscheidungskriterium für die Falsifizierung von Theorien liefern können. Der methodologische Standpunkt des kritischen Rationalismus sollte daher durch eine mehr pragmatische und instrumentalistische Sichtweise ersetzt werden. Die empirischen Ergebnisse der vorliegenden Arbeit stützen sich vorwiegend auf eine Regressionsanalyse von Befragungsdaten aus einer Querschnittserhebung. Die Analyse umfasst sowohl qualitative als auch quantitative Indikatoren der Kreditrationierung.
6. Entsprechend den Angaben von Betriebsleitern aus der Befragung nahmen in der Periode 1997-1999 80 Prozent der Haushalte mindestens ein Darlehen auf. Etwa die Hälfte der Kreditnehmer erhielt weniger Kredit als gewünscht, diese Teilgruppe wird daher als kreditrationiert angesehen. Zentrale Bestimmungsgründe der Kreditrationierung sind die Reputation der Kreditnachfrager sowie demografische Haushaltscharakteristika. Betrachtet man alle in der Stichprobe vorkommenden Kreditfristigkeiten zusammen, so gilt für Nachfrager mit einer vorteilhaften Kreditgeschichte eine 30 Prozentpunkte niedrigere Wahrscheinlichkeit, kreditrationiert zu sein als für solche Nachfrager, die in der Vergangenheit eine Kreditrückzahlung verschieben mussten. Darüber hinaus führen mehr männliche Erwachsene im Haushalt zu einer Verringerung der Wahrscheinlichkeit, kreditrationiert zu sein, während eine höhere Zahl weiblicher Erwachsene sie erhöht. Werden nur kurzfristige Kredite betrachtet, beeinflusst auch die Verfügbarkeit von Sicherheiten das Auftreten von Kreditrationierung.
7. Die ökonometrische Analyse des Produktangebots stützt das vorgenannte Ergebnis, nach dem mehr als 40 Prozent der Kreditnehmer als kreditrationiert gelten müssen. Diese Betriebe weisen eine marginale Zahlungsbereitschaft für Kredit von im Durchschnitt 209 Prozent auf, wobei die Rückzahlung des Kreditbetrages bereits subtrahiert wurde. Die ermittelten Zahlungsbereitschaften unterscheiden sich signifikant von individuellen Kreditzinssätzen, die unter Einbeziehung von kreditspezifischen Transaktionskosten berechnet wurden. Diese Kreditzinssätze belaufen sich im Durchschnitt auf 13 Prozent pro Jahr. Transaktionskosten liefern jedoch ex-post keine Begründung für die Zurückziehung des Kreditantrags und können daher nicht als grundsätzliche Ursache für die wahrgenommene Kreditrationierung angesehen werden. Es wird gezeigt, dass Haushaltscharakteristika in der Gruppe der kreditrationierten Betriebe einen signifikanten Einfluss auf das Produktionsergebnis haben. Dies belegt die Verletzung der Separabilitätsannahme hinsichtlich Produkti-

ons- und Konsumentscheidungen und spricht daher zusätzlich für die Existenz von Marktunvollkommenheiten. Ein auf Basis aller Kreditnehmer geschätztes Alternativmodell zeigt, dass Zahlungsbereitschaften für rationierte Betriebe wesentlich höher sind als für nicht-rationierte Kreditnehmer.

8. Eine ex-post Evaluierung der Investitionsaktivitäten ergab, dass nicht-produktive Investitionen für die befragten Betriebsleiter einen hohen Stellenwert haben. Investitionen in Wohngebäude und Automobilkäufe sind die zwei Aktivitäten mit dem höchsten Anteil betriebsindividueller Investitionsausgaben im untersuchten Zeitraum. Die ökonometrische Investitionsanalyse zeigt, dass der Zugang zu Krediten im Entscheidungsprozess kreditrationierter Landwirte eine signifikante Rolle spielt. Dieses Ergebnis stützt die theoretische Vorhersage des Investitionsmodells bei beschränktem Kreditzugang und stimmt mit der qualitativen Selbstklassifizierung der Befragten überein. Die Analyse belegt außerdem, dass subventionierte Kreditmittel teilweise für nicht-produktive Zwecke verwendet werden. In verschiedenen Spezifikationen der Kredit-Investitions-Beziehung ist der marginale Effekt der Kreditausweitung deutlich kleiner als eins. Basierend auf einer kubischen Tobit-Schätzung der Investitionsfunktion wurde ein betriebsindividueller marginaler Effekt von durchschnittlich 0,53 ermittelt. Jeder zweite Kreditnehmer investiert weniger in produktive Anlagen als er Kredit erhalten hat. Nur bei 1,6 Prozent der ausgewählten Befragten mit positivem Investitionsvolumen liegt der Krediteffekte über eins. Über die Spannweite der beobachteten Kreditvolumina steigt der marginale Effekt mit zunehmendem Kreditvolumen an. Die Ergebnisse stehen allerdings im Widerspruch zu der Sichtweise, dass das Investitionsvolumen positiv mit der Betriebsgröße korreliert.

Insgesamt belegt die Analyse, dass Kreditrationierung im ländlichen Polen ein relevantes Phänomen darstellt. Ein maßgeblicher Teil der Kreditnehmer könnte seine Produktivität deutlich erhöhen, wenn der Zugang zu Krediten erleichtert würde. Die Untersuchung von langfristigen Krediten ergab allerdings, dass Betriebsleiter nicht-produktive Investitionen oftmals gegenüber Wachstumsinvestitionen bevorzugen. Kreditrationierung ist daher vermutlich nicht das entscheidende Hemmnis für Modernisierung und Strukturwandel im polnischen Agrarsektor.

Der gegenwärtigen Subventionspolitik der Regierung ist es nicht gelungen, Kreditrationierung zu beseitigen. Gleichzeitig erscheint die Zielorientierung der Zuweisung von staatlich verbilligten Mitteln höchst fragwürdig. Eine alternative Politik sollte sich um die Verbesserung der allgemeinen Kreditwürdigkeit poten-

zieller Nachfrager bemühen sowie die Ursachen bekämpfen, die in der Vergangenheit zu Kreditausfällen und damit zu einer schlechten Reputation bestimmter Kreditnehmer geführt haben. Maßnahmen, die den Zugang zu Betriebsmittelkrediten verbessern, sollten bevorzugt umgesetzt werden. Einer der möglichen Nebeneffekte der Einführung von Direktzahlungen unter einer Gemeinsamen Agrarpolitik der EU könnte die Lockerung der Liquiditätsobergrenze für kreditrationierte Betriebe sein.

Im Rahmen einer weiteren Integration von Theorie und Empirie im Bereich der Neuen Institutionenökonomik sollte die Entwicklung von Analyseinstrumenten für Märkte mit Anreiz- und Überwachungsproblemen einen Fokus künftiger Forschungstätigkeit darstellen. Außerdem besteht weiterer Forschungsbedarf im Hinblick auf die politischen Aspekte der staatlichen Kreditmarktintervention in Polen sowie die Bestimmungsgründe von Strukturwandel im polnischen Landwirtschaftssektor.

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