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Employment and unemployment in Germany: Some results from a macroeconomic disequilibrium model

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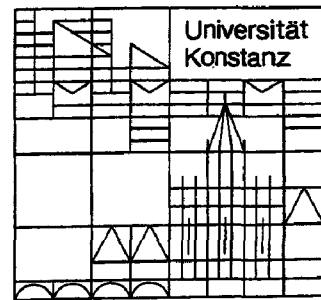
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„Internationalisierung der Wirtschaft“

Diskussionsbeiträge



Juristische
Fakultät

Fakultät für Wirtschafts-
wissenschaften und Statistik

Werner Smolny

**Employment and Unemployment
in Germany**

Some Results from a
Macroeconomic Disequilibrium Model

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Some results from a macroeconometric disequilibrium model

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Universität Konstanz

Preliminary version, comments most welcome

Abstract:

In the paper, some empirical results from a macroeconometric disequilibrium model for the Federal Republic of Germany are reported. In the theoretical model, a delayed adjustment of employment and investment is analyzed. Market disequilibrium is introduced by allowing for a *sluggish adjustment* of wages and prices. The estimation results reveal the importance of the slow adjustment of prices and quantities for the employment situation in Germany. The slow adjustment of employment and the capital stock contributed to the persistence of unemployment in the second half of the eighties.

Keywords: (un)-employment, macroeconometric disequilibrium model

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Contents

1	Introduction	1
2	The European Unemployment Program	1
3	The model of the firm	3
3.1	The basic model of the firm	3
3.2	Regimes on the goods and labour market	5
3.3	The dynamic adjustment of employment	7
3.4	Aggregation	8
3.5	Wages and prices	9
4	Empirical results	11
4.1	The structure of the empirical model	11
4.2	The underutilization of labour and capital	11
4.3	Regimes on the goods market	13
4.4	The labour market	16
4.5	Mismatch	23
4.6	Simulation studies	24
5	Conclusions	25
	Appendix	28
	References	29

List of Tables

1	Regimes on the goods and labour market	6
2	The structure of the model	12
3	Variable list	28

List of Figures

1	Changes of productivity and utilization: capital	14
2	Changes of productivity and utilization: labour	14
3	The utilization of labour and capital	15
4	Labour hoarding	15
5	Regimes on the goods market I	17
6	Regimes on the goods market II: business survey	17
7	Employment series I: LT , \hat{L}_{YC} , LS	19
8	Employment series II: LT , \hat{L}_{YD}	19
9	Regimes on the labour market I	21
10	Regimes on the labour market II: business survey	21
11	Employment and labour supply 1960-1993	26
12	Annual changes of employment	26

1 Introduction

The underutilization of capacities and labour hoarding during recessions are stylized facts of the business cycle. They indicate an excess supply and a rationing situation for firms in the short run. This can be interpreted as an indication for a slow adjustment of quantities, i.e. employment, the capital stock, and capital-labour substitution. It can also be interpreted as an indication of wage and price rigidities. In the model which is presented here it is tried to develop a framework for the analysis of the dynamic adjustment of prices and quantities. It combines the dynamic factor demand approach and the literature of the matching function and analyzes employment and investment dynamics within the fix-price approach. The adjustment of wages and prices is not treated explicitly. However, the results of some recent work are reported which reveal that a type of Phillips-curve wage and price model can be introduced consistently into the approach.

The analysis of the slow adjustment of both, prices and quantities, appears to be important for the understanding of the dynamic development of the economy. Wage and price rigidities prevent a permanent market clearing, and the slow adjustment of employment, the capital stock, and capital-labour substitution increases the persistence of disequilibria.

The theoretical model builds on the framework developed by Sneessens, Drèze (1986). It grew out of the co-work within the European Unemployment Program, a coordinated research project about unemployment in Europe.¹ Results from this research are reported in section 2. The theoretical model of the firm is presented in section 3. Empirical results for Germany with special emphasis on employment and unemployment are contained in section 4.

2 The European Unemployment Program

The European Unemployment Program (EUP) was a coordinated research project with participants from 9 European countries and the United States. The idea was to estimate a comparable model with a common theoretical specification for different countries.² The basic theoretical specification was a Keynesian Malinvaud-type model of an open economy.³ The main distinguishing features are the application of the minimum condition only to micro-markets, and a different assumption about substitution possibilities.

In the standard Malinvaud framework,⁴ aggregate employment is determined as the minimum of labour demand and labour supply. Labour demand, in turn, can be restricted by the demand for goods (Keynesian unemployment) or by real wages (classical unemployment). The impact of real wages on labour

¹See Drèze, Bean (1990) and Entorf, Franz, König, Smolny (1990).

²The proceedings are published in Drèze, Bean (1990).

³It was taken mainly from Sneessens, Drèze (1986).

⁴See e.g. Malinvaud (1977).

demand depends on the assumption of short-run substitution possibilities between labour and capital. Wages and prices are fixed in the short run, and capital is adjusted in the long run.

One major difference of the EUP approach is the assumption of a putty-clay technology with only long-run substitution between capital and labour. This excludes the short-run impact of real wages on labour demand and introduces the concept of capacity shortages. Output is determined by the minimum of goods demand, capacities, and a labour supply determined output level. Labour demand is equal to the minimum of the number of workers that are necessary to produce goods demand, and those workers that can be employed with the capital stock. This assumption reinforces the prominent role of the concept of capacity utilization as a business cycle indicator.

A second major difference of the EUP-approach is the application of the minimum condition only to micro-markets or firm's markets. In the aggregate, different micro-markets can be characterized by different supply and demand conditions. This introduces the possibility of mismatch between labour supply and demand and can account for the coexistence of unemployment and vacancies. This idea was introduced by Muellbauer (1978) and Malinvaud (1980) and refined by Kooiman (1984) and Lambert (1988). Especially the model of Lambert allows for a straightforward empirical application of the model. Aggregate employment LT is determined by some kind of matching function in terms of the aggregate concepts of labour supply LS , demand determined employment L_{YD} , and capacity employment L_{YC} . The functional form of this relation can be approximated by a CES-type function:⁵

$$LT = \{LS^{-\rho} + L_{YD}^{-\rho} + L_{YC}^{-\rho}\}^{-1/\rho}$$

ρ serves as a mismatch parameter with

$$\frac{\partial LT}{\partial \rho} > 0 \quad \text{and} \quad \lim_{\rho \rightarrow \infty} LT = \min(LS, L_{YD}, L_{YC})$$

i.e. the aggregate minimum condition is contained as a special case. The whole model can be estimated solely with aggregate data by non-linear least squares. In addition, it allows for the calculation of the weighted shares of firms constrained by labour supply, goods demand, and capacities. These shares are equal to the partial elasticities of aggregate employment with respect to the aggregate value of the constraints and can be calculated as, for instance,

$$\frac{\partial LT}{\partial LS} \cdot \frac{LS}{LT} = \text{prob}_w(LS_i < L_{YD_i}, L_{YC_i}) = \left(\frac{LS}{LT}\right)^{-\rho}$$

This property can be used to introduce standard business survey information about these shares into the empirical application. The resulting employment

⁵See Lambert (1988).

function defines some kind of u-v-curve, however labour demand is not identified from vacancies but from capacities and goods demand. Mismatch is measured by the ρ -parameter, and may originate from the labour market, but may also result from mismatch between capacities and goods demand.

The demand for goods is identified from the spillover to the foreign market. It is assumed that an excess demand for goods which cannot be satisfied by domestic producers increases imports. In the same reasoning, in case of supply shortages on the domestic market, not all export demand can be satisfied. The estimation of trade equations with indicators for supply shortages allows to measure the amount of excess demand.

The basic feature of the model is the identification of demand and capacity shortages for labour demand. The empirical estimates for the European countries revealed the importance of demand constraints for unemployment after the oil price shocks 1974 and 1980.⁶ The beginning of recessions is characterized by excess capacities which restrain investment and result in capacity constraints at the beginning of the following upturn. Another reason for the high unemployment in the eighties was an increasing mismatch which was higher in the eighties than in the sixties and seventies.⁷

A shortcoming of the EUP-model is the lack of a consistent dynamic model for the adjustment of the firm. Employment is adjusted immediately, and labour market restrictions simply reflect goods market restrictions. This assumption appears inappropriate and inconsistent with the observed slow adjustment of employment, procyclical labour productivity, and labour hoarding during recessions. In the model which is presented here, it is tried to introduce some aspects of the dynamic factor demand approach into the disequilibrium analysis. Employment setting takes place under uncertainty of demand, and adjusts slowly with respect to demand shocks. Capacities are chosen in the long run and are predetermined for the employment decision.

3 The model of the firm

3.1 The basic model of the firm

The basic model of the firm consists of the optimal choice of output, employment, the capital stock, and capital-labour substitution.⁸ The basic assumption is a delayed adjustment of employment and investment. The investment decision takes place before the employment decision and fixes both the capital stock and the capital-labour ratio. The adjustment of wages and prices is left out.⁹ This yields the following three step decision structure:¹⁰

⁶See the country papers in Drèze, Bean (1990).

⁷For a recent discussion, see Bean (1994).

⁸It is described in detail in Smolny (1993a).

⁹See section 3.5.

¹⁰The time index and the firm index are omitted for convenience. A complete list of variables is contained in the appendix.

1. Short-run adjustment of output YT with predetermined employment, capital stock K , and capital-labour ratio. Output is given by the minimum of supply and demand,

$$YT = \min(YS, YD) \quad (1)$$

with: YS : goods supply
 YD : demand for goods

Output supply is determined by a short-run limitational production function with capital and labour as inputs,

$$YS = \min[\pi_L \cdot LT, \pi_K \cdot K] = \min(Y_{LT}, Y_C) \quad (2)$$

where: Y_{LT} : employment constraint
 Y_C : capacities
 π_L : productivity of labour
 π_K : productivity of capital

The factor productivities are predetermined by the capital-labour ratio and the production function.

2. Medium-run adjustment of employment LT with uncertain output and still predetermined capital stock and capital-labour ratio. Employment is determined by the minimum condition of supply and demand.

$$LT = \min(LD, LS) \quad (3)$$

LD is labour demand, and LS denotes labour supply.

3. Long-run adjustment of the capital stock and of the capital-labour ratio k with uncertain output and employment.

The optimal behaviour of the firm follows from maximizing

$$\max E(p \cdot YT - w \cdot LT - c \cdot K) \quad (4)$$

E is the expectation operator, p is the output price, w are wages, and c are the user costs of capital. In the short run, output is chosen equal to the minimum of goods supply and demand according to eq. (1). For the medium-run choice of employment, three cases can be distinguished. First, the firm is neither constrained by the available labour supply nor by the existing capital stock and chooses employment as to equalize expected marginal returns to marginal wage costs:

$$p \cdot \text{prob}(YD > Y_{LT^*}) \cdot \pi_L = w \quad (5)$$

expected marginal returns marginal costs

The probability of the supply constrained regime is chosen equal to the full employment labour share. For a lognormal distribution of demand, optimal employment is determined as:

$$\ln LT^* = \ln L_{YD} = \ln E(YD) - \ln \pi_L - 0.5 \cdot \sigma^2 + \sigma \cdot F^{-1} \left(1 - \frac{w}{p \cdot \pi_L} \right) \quad (6)$$

F^{-1} denotes the inverse of the cumulative standard normal distribution, and σ^2 is the variance of the logarithm of demand, i.e. a measure of demand uncertainty. Optimal employment depends on expected demand, demand volatility, the productivity of labour, and the share of labour cost in nominal full employment output. Second, in case of insufficient capacities

$$LT^* = L_{YC} = YC / \pi_L = \pi_K \cdot K / \pi_L \quad (7)$$

and employment is determined by the available number of working places. This implies that the employment constraint of the production function is also binding for the goods supply, i.e. $YS = Y_{LT}$. In the final case of insufficient labour supply, the firm has not enough applicants to fill all vacancies. Employment cannot exceed this constraint, and optimal employment is equal to the labour supply:

$$LT^* = LS \quad (8)$$

The three cases can be summarized by a minimum condition for optimal employment:

$$LT^* = \min(L_{YD}, L_{YC}, LS) \quad (9)$$

In the model, the utilization of labour varies procyclically, with higher utilization in the presence of positive (unexpected) demand shocks and a *procyclically* varying measured productivity of labour. This property is in accordance with observed stylized facts and stands in contrast to conventional models of dynamic factor input adjustment, which assume immediate adjustment of employment and short-run substitution of capital and labour, thus implying an *anticyclical* movement of the productivity of labour. Optimal labour hoarding decreases with less uncertainty of demand and less labour hoarding will be observed in the presence of labour supply or capacity constraints.

In the long run, the investment decision determines the capital stock and the capital-labour ratio. Optimal capacities depend on expected demand and labour supply constraints, and profitability.¹¹ The optimal factor productivities depend on real factor prices and the probability of labour supply constraints.

3.2 Regimes on the goods and labour market

In [table 1](#) the different regime constellations of the firm on the goods and labour market are summarized. In the standard model of the New Keynesian

¹¹ For the derivation, see Smolny (1993a).

Table 1: Regimes on the goods and labour market

goods market	$YD > YS$	$YD < YS$
labour market	$YT = YS$	$YT = YD$
$LT = LS$ $LS < \min(L_{YC}, L_{YD})$	prob ₁₁ I $YT = Y_{LS}$ repressed inflation	prob ₁₂ II $YT = YD$ underconsumption
$LT = L_{YC}$ $L_{YC} < \min(LS, L_{YD})$	prob ₂₁ III $YT = YC$ capital shortage	prob ₂₂ IV $YT = YD$ mixed
$LT = L_{YD}$ $L_{YD} < \min(L_{YC}, LS)$	prob ₃₁ V $YT = Y_{LT}$ mixed	prob ₃₂ VI $YT = YD$ Keynesian unemployment

Macroeconomics only three regimes are possible. The non-simultaneity of the output, employment, and capacity decisions introduces the possibility of three further combinations of output and employment constraints. First, if the firm has to decide on employment *before* output, the possibility of underconsumption is re-introduced. Underconsumption is characterized by a rationing of the firm on both markets. If the firm decides simultaneously on output and employment, only one of the constraints, labour supply or the demand for goods, can be the binding constraint. The other modification is related to the non-simultaneity of the employment and investment decision and the assumption of a putty-clay technology. The firm decides on employment after choosing optimal capacities. This allows to distinguish two possible sources of demand constraints on the labour market. First, optimal labour demand does not exceed the available number of working places L_{YC} . Second, labour demand L_{YD} depends on goods demand expectations and profitability. The optimal labour demand can therefore be distinguished, whether it is determined by capacities or by demand expectations.

The complete set of regime probabilities can be derived from the model parameters. Note that these are the *optimal* probabilities the firm chooses by deciding on capacities YC and labour demand L_{YD} . A situation of equal probabilities of the supply and demand constrained regime, or of equality of supply and demand in expected values, i.e. $E(YD) = YS$, has no special significance in the model and does not define an “equilibrium”. The optimal probabilities, which define some kind of equilibrium, are determined by relative factor prices, the parameters of the density function, and the parameters of the production function.

The heterogeneity of the rationing constellations enriches the interpretation of the regimes, but it prevents one from simply carrying over the terms, which are used in the standard Keynesian model to characterize the rationing situa-

tions. There is a clear correspondence of the regimes of repressed inflation and underconsumption, but the terms Keynesian or classical unemployment should be used with care. In the standard model of the New Keynesian Macroeconomics, classical unemployment means a situation where the firm can realize its notional trade offers on both markets. Here this holds for the regimes III and V. In regime III, both output and employment are constrained by the capital stock. However, this capital shortage can be caused by demand expectations, i.e. the sources of the resulting underemployment may be “Keynesian”. In regime V, the main reason for the low labour demand is the too low expected demand for goods. This regime is characterized as a Keynesian situation on the labour market but a classical situation on the goods market. A similar inaccuracy holds for Keynesian unemployment: in regimes IV and VI, insufficient demand constrains output and the firm can realize its labour demand. The sources of the low labour demand are a lack of capacities (regime IV) or the expected demand for goods (regime VI). The latter can therefore be called Keynesian regime for good reasons, but the sources of the underemployment in regime IV can also be factor prices being too high, or even expected labour supply being too low.

3.3 The dynamic adjustment of employment

One can think of different routes to extend the model and to introduce more empirical relevant features.¹² One extension are dynamic constraints on the employment adjustment. Employment cannot exceed the labour supply. However, the labour supply at the firm level consists of those already employed in the firm, and job applicants. Therefore it is realistic to allow for a dependence of the current labour supply on the past employment level. One way to introduce these aspects into the employment decision is to assume a constraint on the adjustment speed of labour supply. This can be formalized as:

$$LS_t = \min [(1 + \delta^a) \cdot LT_{t-1}, \overline{LS}_t] \quad (10)$$

t is the time index. Eq. (10) reflects a constraint on the maximum rate of applications, δ^a , as well as on the absolute level of labour supply \overline{LS} . This implies that the labour supply increases if the firm increases employment, but only until it reaches an exogenous level constraint \overline{LS}_t . It seems to be important to allow for both kinds of constraints. In the short run and during recessions, the number of *applications within a time period* can restrict employment growth; in the long run and during boom periods, it is plausible that a low *level* of labour supply prevents a higher employment.

A similar dependence on past employment can be stated for the labour demand. Investments in firm specific human capital, implicit “full employment contracts”, and reputation losses give rise to costs of dismissing workers and

¹²For instance, Winker (1994) analyzes credit market failures and a financial constraints for the firms.

tend to restrict the downward adjustment of employment to normal fluctuations, i.e. quits and retirement. This can be formalized as:

$$LD_t = \max[LD_t^*, (1 - \delta^s) \cdot LT_{t-1}] \quad (11)$$

LD_t^* is the target level of employment that the firm wants to reach. The maximum condition implies a limit on the downward adjustment, and δ^s is the maximal rate of downward adjustment of employment. If for instance the costs of dismissing are prohibitive, δ^s can be identified with the rate of normal separations.¹³ Then there are three restrictions causing employment to differ from the target level of labour demand: first, the level of employment is restricted by the exogenous level constraint on labour supply; second, the decrease of employment cannot exceed maximal (optimal) separations; finally the number of job applicants within a time period can be binding. This results in some kind of matching function.¹⁴ Employment growth depends on the unemployment rate, excess demand, and capacity utilization.

One property of this kind of employment adjustment constraints is the simple way to allow for asymmetry. For $\delta^s < \delta^a$, the downward adjustment is more impeded than the upward adjustment, and $\delta^a \rightarrow \infty$ ($\delta^s = 1$) implies an unconstrained upward (downward) adjustment.¹⁵

3.4 Aggregation

Up to this stage, the analysis was confined to the behaviour of one firm. Different rationing situations on the goods and labour market are possible, and the firm's choice of employment and capacities, together with the properties of the distribution function, determine the *probabilities* of the regime constellations at the firm level. In the aggregate, at every moment in time different firms face different constraints and usually all rationing constellations coexist. A relation between the aggregate quantities can be derived by stating a density function for demand and supply on the micro-markets. If the number of firms is large, the densities can be approximated by a continuous density function. Supply and demand on the micro-markets depend on a large number of events, and it is plausible that many economic forces have a *proportional* impact. Thus the central limit theorem can be applied and the resulting distribution can be approximated by a lognormal distribution.¹⁶ Then a very simple analytical expression for the transacted quantity can be derived.¹⁷ If the weighted prob-

¹³One can also introduce an upward constraint for the labour demand which refers to the capacity of screening and training entrants.

¹⁴See Blanchard, Diamond (1989,1990) and Franz, Smolny (1992,1994). For a discussion of the empirical relevance of the different concepts of dynamic labour demand, quantity constraints and matching, see Burgess (1993) and Smolny (1993b).

¹⁵See Palm, Pfann (1990) and Pfann, Palm (1993) for the importance of an asymmetric adjustment of employment. A more detailed analysis of the non-linearities of employment adjustment is given in Smolny (1993b).

¹⁶See Smolny (1993c).

¹⁷Lambert (1988), appendix A.

abilities of the regimes are approximated by a logistic curve, it can be shown to yield the following CES-type aggregate function for output:¹⁸

$$YT = \{YD^{-\rho_y} + YS^{-\rho_y}\}^{-1/\rho_y} \quad (12)$$

ρ_y is a mismatch parameter with

$$\frac{\partial YT}{\partial \rho_y} > 0, \quad \lim_{\rho_y \rightarrow \infty} YT = \min(YD, YS)$$

Aggregate output is determined from aggregate supply and demand, and a mismatch parameter ρ_y which depends merely on the uncertainty of demand at the time of the employment decision. Employment is determined by the minimum of supply and demand, while labour demand, in turn, is given by the minimum of the capacity constraint and demand determined employment. The distribution of the minimum of two lognormally distributed variables can again closely be approximated by a lognormal distribution and aggregate employment is determined by:

$$LT = \{LS^{-\rho_m} + [LYD^{-\rho_f} + LYC^{-\rho_f}]^{\rho_m/\rho_f}\}^{-1/\rho_m} \quad (13)$$

ρ_m is related to labour market mismatch, and ρ_f is a measure of mismatch between capacities and goods demand. The aggregate counterpart of the behavioural equation for demand determined employment can also be derived: the equation containing the aggregate variables has the same structure as those for the individual firms. The only difference is a change in the normalizing constant, which is affected by the variance of these variables on the micro-markets. The aggregation procedure can also be applied to capture the constrained adjustment of employment. Eq. (11) contains a *maximum* condition but the expected maximum of two lognormally distributed variables can equally be approximated by a CES-function. The only modification is given by the change in the sign of the ρ -parameter.¹⁹ Note that the δ parameters must not be equal for all firms, the only requirement is the close approximation of the distribution of all variables by a lognormal distribution.

3.5 Wages and prices

The adjustment of wages and prices was left out of the analysis above. However, there are some recent papers which show how it can be introduced into the approach. Sneessens (1987) developed a model with a delayed adjustment of prices within the framework of the EUP-model. In a model of monopolistic competition, firms have to announce their prices before knowing the disturbance term of the demand function. De la Croix (1992) analyzed wage

¹⁸The following notation refers to the aggregate variables!

¹⁹See Smolny (1993c).

bargaining within the disequilibrium approach. Unions and firms negotiate the wage, and wage and price decisions take place before the realization of stochastic demand shocks. This leads to Phillips-curve type models for the wage and price adjustment. Price changes depend on the development of costs and the excess demand on the goods market, and wages depend on prices and the unemployment rate.

A shortcoming of both model is the assumption of an immediate adjustment of employment, i.e. labour hoarding is ruled out. Smolny (1994) developed a model with a delayed adjustment of both, prices and employment. Prices and employment are set under uncertainty about the location of the demand curve. Consider, for instance, the case when the stochastic process generating the demand shocks is autocorrelated. Then a positive demand shock increases the utilization of capital and labour today. The response of the firm depends on the presence of supply rigidities: in case of insufficient capacities or labour supply, the firm will increase the price; in case of supply flexibility, the price will remain constant, and employment will be increased. Therefore, the model predicts a different adjustment with respect to demand shocks during the business cycle. In recession periods with sufficient capacities and easy availability of labour, demand shocks result in higher employment without increasing the price. In boom periods, more and more firms attain full utilization and the price increases. The relevant variable for prices and employment from a macroeconomic viewpoint is the share of firms experiencing full utilization of supply. A similar response results in case of cost shocks. If the firm experiences supply rigidities, prices (and employment) will remain unchanged. On the other hand, with flexible supply, the firm increases the price and reduces supply.

The most important insight from these models is that the basic features of the disequilibrium model prevail as long as the adjustment of wages and prices is not frictionless. Wage and price rigidities prevent a permanent market clearing, quantity reactions prevail in the short run, and the slow adjustment of quantities may even increase the persistence of disequilibria.

4 Empirical results

4.1 The structure of the empirical model

The structure of the model is depicted in table 2. The model was estimated with quarterly data for the private sector of the German economy for the period 1960.1–1989.4, i.e. the estimation sample ends before unification. The detailed estimation results are reported in Smolny (1993a,b). The estimation of the model consists of two steps. First, the optimal productivities and the demand for goods are determined. The choice of the optimal productivities is part of the long-run decision of the firms. They depend on real factor prices, expected labour supply constraints, and technical progress. The actual productivities deviate from the optimal ones by the respective utilization of the factor DUL and DUC . The data from the ifo-institute on capacity utilization q were used as an indicator for the utilization of capital. A dynamic specification of q was employed as an indicator for the utilization of labour. The estimation of productivity equations allows to identify the utilization of the factors and the optimal productivities. Capacities are calculated from capital productivity and the capital stock, and goods supply is determined from the employment constraint of the short-run limitational production function.

The demand for goods is identified from the spillover to the foreign market.²⁰ An excess demand which cannot be satisfied by domestic producers leads to an increase of imports, and actual imports M are higher than structural imports MD . Accordingly, in case of supply constraints, the export demand cannot be satisfied completely. Therefore, actual exports X are lower than export demand XD . Supply constraints are identified from the utilization of supply which is equal to the utilization of labour DUL . Total demand consists of private consumption C , investment I , residual demand components G , and $XD - MD$.

The employment series are calculated according to eqs. (21) and (22). The calculation of these series allows, in a second step, the estimation of the CES-functions for the goods and labour market. Output is estimated according to eq. (24) in table 2, and finally employment is estimated by a dynamic CES-function according to eqs. (25).

4.2 The underutilization of labour and capital

The estimation of the productivity equations allows to identify the optimal productivities of labour and capital.²¹ Actual productivities are related to real factor costs and an indicator for the utilization of the factor. The significance of these indicators provides also a first test of the underlying assumptions of the

²⁰For a detailed analysis of spillovers, see Franz, Heidbrink, Scheremet (1992), Franz, Heidbrink (1993), and Heidbrink (1994).

²¹The estimation is based on eq. (14) and eq. (15). The estimated equations are reported in detail in Smolny (1993a).

Table 2: The structure of the model

supply:	
labour productivity:	$\ln \left(\frac{YT}{LT} \right)_t = \ln \pi_L [(w/p)_t, t, UR_t] + \ln DUL_t$ (14)
labour utilization:	$\ln DUL_t = 0.444 \cdot (\ln q_t - 0.408 \cdot \ln q_{t-1})$ (0.06) (0.10)
capital productivity:	$\ln \left(\frac{YT}{K} \right)_t = \ln \pi_K [(c/p)_t, t, UR_t] + \ln DUC_t$ (15)
capital utilization:	$\ln DUC_t = 0.509 \cdot \ln q_t$ (0.04)
employment constraint:	$\ln Y_{LT} = \ln LT_t - \ln \pi_L$ (16)
capacities:	$\ln YC_t = \ln K_t + \ln \pi_K$ (17)
demand:	
imports:	$\ln M_t = \ln MD(\cdot) + \ln M'_t(\text{excess demand})$ (18)
exports:	$\ln X_t = \ln XD(\cdot) - \ln X'_t(\text{excess demand})$ (19)
spillover:	$\ln M'_t = 4.049 \cdot \ln DUL_t$ (1.4)
	$\ln X'_t = 2.532 \cdot \ln DUL_t$ (1.3)
goods demand:	$YD_t = C_t + I_t + G_t + XD_t - MD_t$ (20)
employment series:	
capacity employment:	$\ln L_{YC} = \ln YC_t - \ln \pi_L$ (21)
demand determined employment:	$\ln L_{YD} = \ln YD_t - \ln \pi_L$ (22)
labour necessary to produce output:	$\ln L_{YT} = \ln YT_t - \ln \pi_L$ (23)
output:	$\ln YT_t = -1/\rho_y \cdot \ln \{ Y_{LT}^{-\rho_y} + YD_t^{-\rho_y} \}$ (24)
employment:	$\ln LT_t = -1/\rho_l \cdot \ln \{ LS_t^{-\rho_l} + LD_t^{-\rho_l} \}$ (25)
labour demand:	$LD_t = \left\{ LD_t^{*\rho_l} + [(1 - 0.010) \cdot LT_{t-1}]^{\rho_l} \right\}^{1/\rho_l}$ (0.003)
target level of labour demand:	$LD_t^* = \{ L_{YD}^{-\rho_l} + L_{YC}^{-\rho_l} \}^{-1/\rho_l}$
labour supply:	$LS_t = \left\{ (LT_t + U_t)^{-\rho_l} + [(1 + 0.006) \cdot LT_{t-1}]^{-\rho_l} \right\}^{-1/\rho_l}$ (0.001)

Standard errors in parentheses.

model. Significant underutilizations of labour during recessions indicate a slow (downward) adjustment of labour as well as a downward rigidity of prices: with an immediate adjustment of prices or employment, the productivity of labour should not be cyclical at all; significant underutilizations of capital indicate a slow adjustment of the capital stock. It is expected that the average utilization of labour is higher than the utilization of the capital stock.

A graphical impression of the short-run correlation of the factor productivities and the factor utilizations is depicted in figures 1 and 2. The annual changes of capital productivity can nearly completely be “explained” by changes in the utilization of capital.²² The picture is less pronounced for the utilization of labour, but again changes in utilization account for a large and highly significant part of changes in labour productivity. Figure 3 depicts the estimated degrees of utilization of both factors. The average utilization of capital was about 95 percent, in recessions it fell below 90 percent. The utilization of labour was always higher than the utilization of capital, the corresponding average is about 97 percent and the minimum is slightly below 94 percent. The implied amount of labour hoarding can be seen in figure 4 as the difference between employment and the amount of labour necessary to produce output. Average labour hoarding amounted to about 600 000 workers, and labour hoarding exceeded 1 million in the recessions 1966/67, 1974/75, and 1981/83.²³ This implies an enormous inefficiency during the business cycle, in addition to the inefficiency associated with open unemployment.

4.3 Regimes on the goods market

While the procyclical productivities of labour and capital indicate a downward rigidity of prices, the estimation of trade equations²⁴ revealed an upward rigidity of prices. Supply constraints on the domestic market lead to a significant increase of imports and reduced exports, after controlling for relative price and income effects. Again, the adjustment of prices was not immediate and quantity effects take place.

Goods demand is calculated from the spillover of the trade equations according to eqs. (18)–(20). Goods supply is calculated from the employment constraint of the production function according to eq. (16), and the CES-function for output is estimated by non-linear least squares. Then the regime shares are calculated from the estimated ρ_y -parameter as

$$\text{prob}_w(YS_i < YD_i) = \left(\frac{YS}{YT} \right)^{-\rho_y}$$

and respectively for the demand constrained regime.

The regime shares on the goods market give a picture of the short-run economic situation and can serve to predict the medium-run adjustment of

²² A hat indicates an estimated series. The outlier in 1963.1 is due to a strong winter.

²³ The data in the figures are seasonally adjusted by constant seasonal factors.

²⁴ The results are reported in detail in Smolny (1993a).

Figure 1: Changes of productivity and utilization: capital

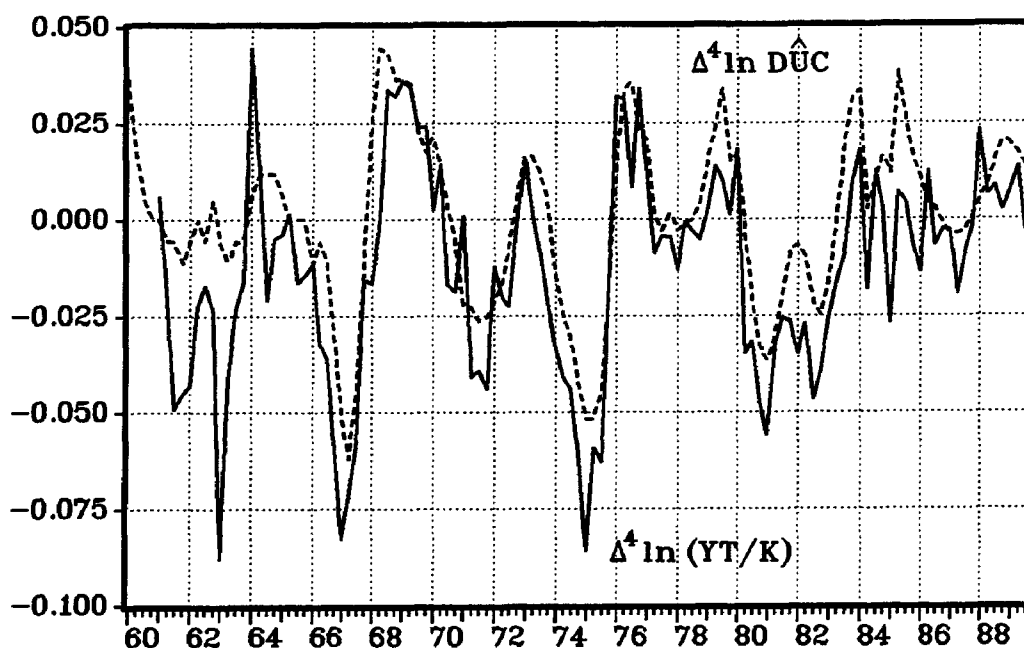
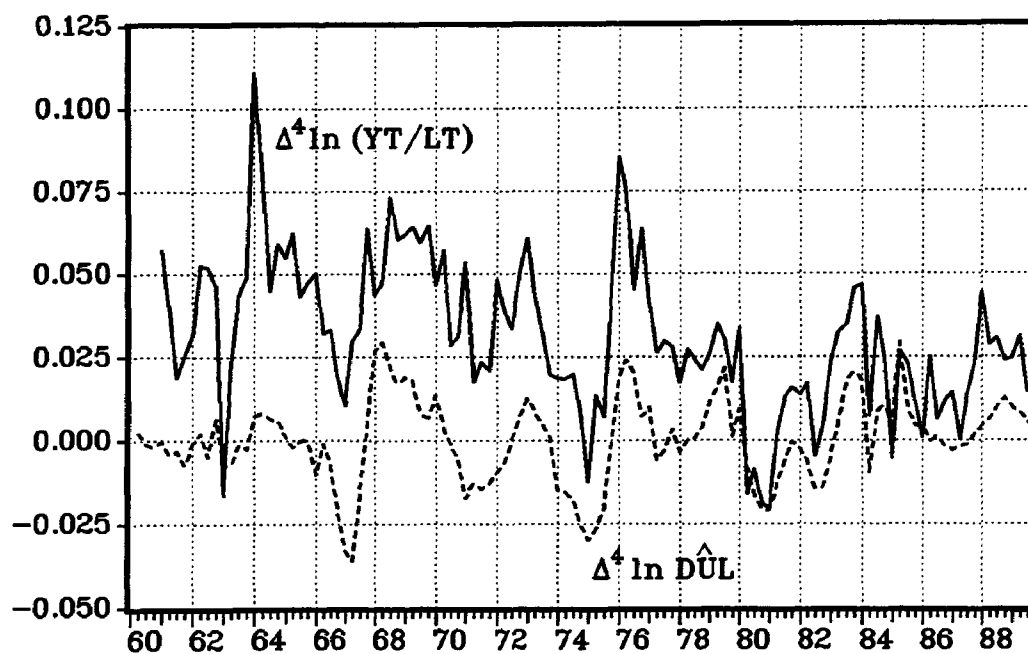


Figure 2: Changes of productivity and utilization: labour



Annual changes.

Figure 3: The utilization of labour and capital

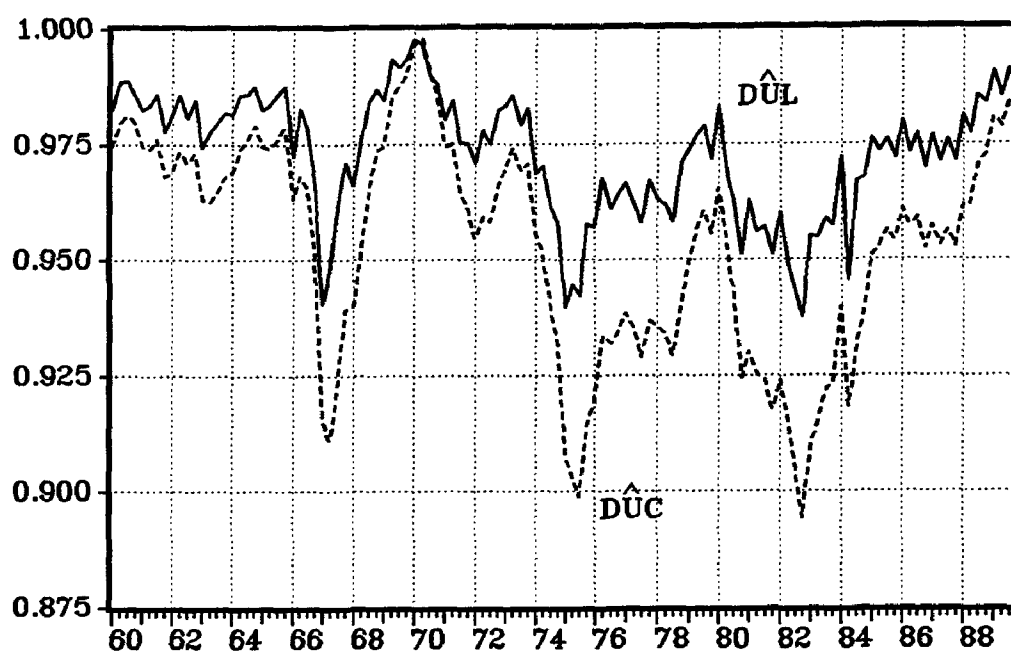
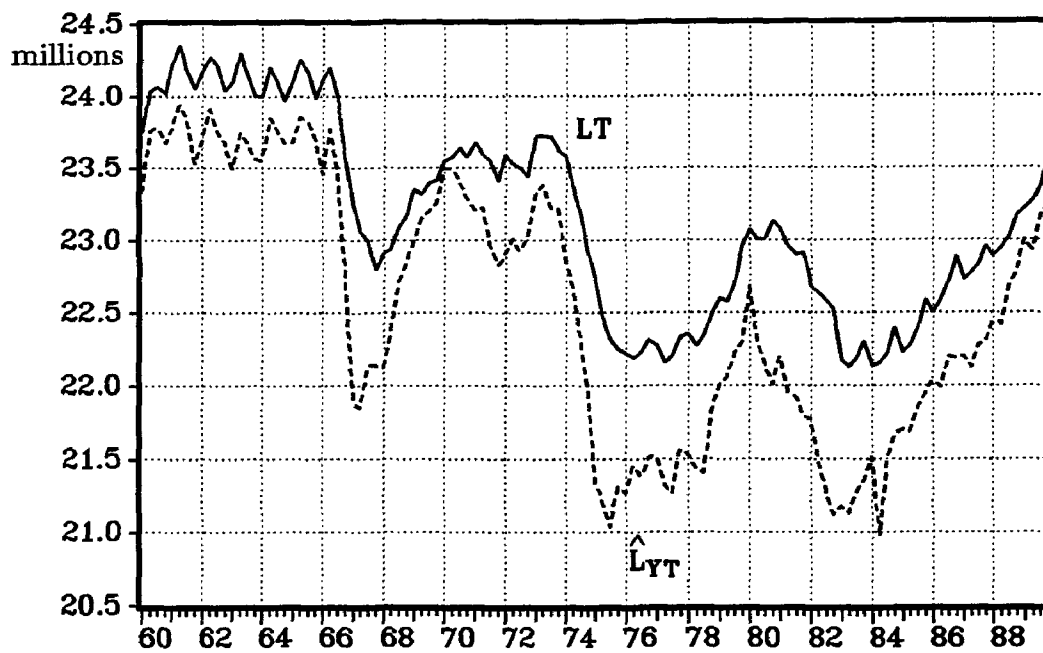


Figure 4: Labour hoarding



employment: demand constraints on the goods market tend to decrease employment, supply constraints imply a fully utilized labour force. In case of sufficient capacities, firms can increase supply by increasing employment.

In figure 5, the results are depicted. In the recession periods 1966/67, 1974/75, and 1982 about 70 percent of firms were constrained by insufficient demand, while in boom periods this share amounted to less than half of this value. On the other hand, if the argument is reversed, even in the recession periods 30 percent of the firms worked with a fully utilized labour force, and in the boom periods, this share did not increase above 80 percent. This result can be seen as evidence for a rather quick adjustment of employment with respect to demand changes: in the medium run, the firm can realize the optimal probability of demand constraints on the goods market by employment adjustment.²⁵

For a comparison, in figure 6 the regime shares from the business survey of the ifo-institute are depicted. These data should be interpreted with care, especially the “no constraint” regime has no clear correspondence to the theoretical model here.²⁶ Figure 6 depicts the high values and the increasing importance of the “no constraint” regime π_{nc} .²⁷ In 1989, only 20 percent of firms answered that they were constrained at all, which stands in some contrast to the reported high values of capacity utilization. Therefore, the levels of the regime shares cannot be compared directly. Only the time pattern of the regimes can be compared. The development of the share of demand constrained firms π_d corresponds rather closely to the estimated shares of the model. The peaks and troughs in the business survey data are more pronounced, but the turning points coincide closely.

4.4 The labour market

Perhaps the most important outcome of the approach are the employment series. They are calculated according to eqs. (21) and (22) and depicted together with actual employment in figures 7 and 8. The labour supply was treated as exogenous in the basic model, but its endogeneity was taken into account for the dynamic adjustment of employment. From figure 7, it can be seen that the labour supply is an endogenous variable on the aggregate level, too. It decreased during recessions and increased during boom periods. There are two factors accounting for this:²⁸ first, the dependence of international factor mobility on the employment situation in the FRG and second, the inverse relation between the unemployment rate and the participation rates of workers

²⁵ In the model, the optimal probability of the supply constrained regime is mainly determined by the share of labour costs in value added.

²⁶ In addition, it is not clear, whether the regimes correspond to the labour market situation or to the goods market situation.

²⁷ π_{nc} is the amount above the upper line in figure 6.

²⁸ Some determinants of the labour supply in the FRG are analyzed by Franz, Smolny (1990) and Smolny (1992).

Figure 5: Regimes on the goods market I

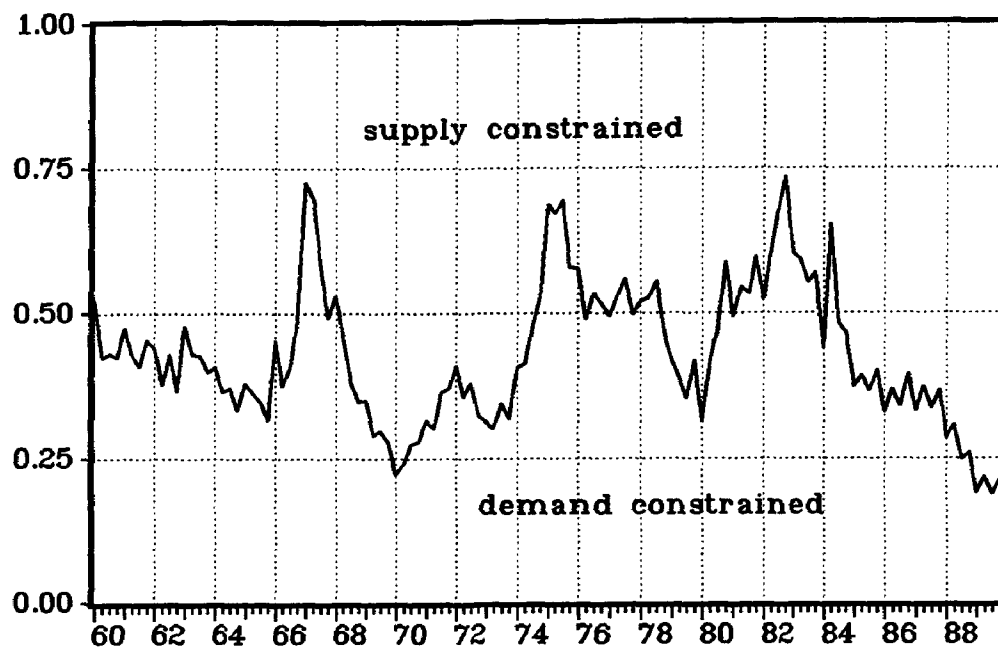
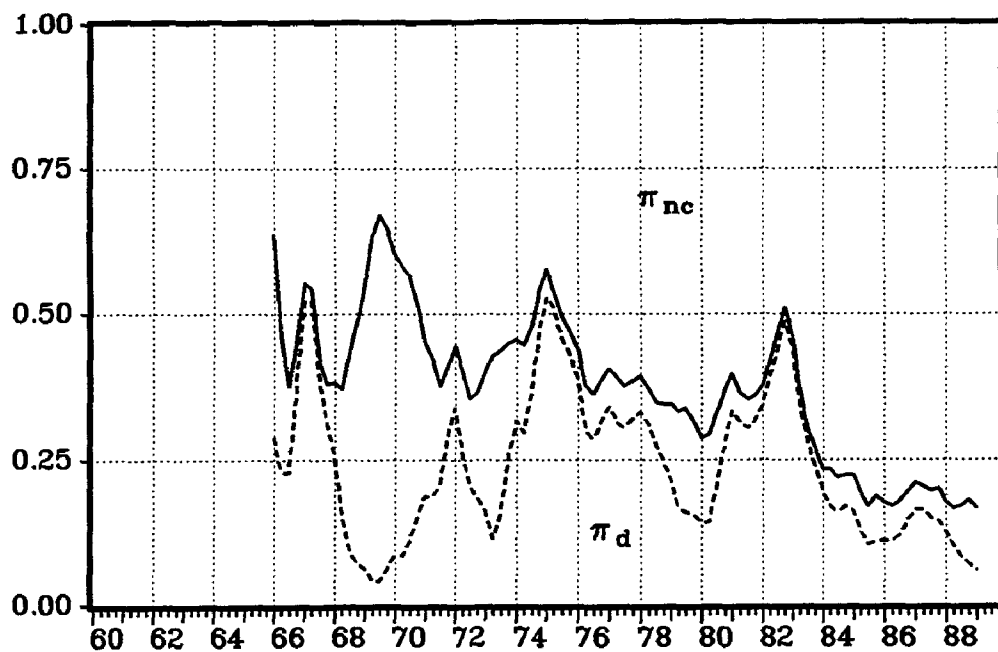


Figure 6: Regimes on the goods market II: business survey



in Germany.²⁹ From the figure one can also see the distinct development of unemployment. There was virtually no unemployment in the sixties until 1973, apart from the short recession in 1966/67. Then the number of unemployed people increased to about one million. Despite the partial recovery of the employment level in the late seventies, the unemployment rate remained high due to the sharply increasing labour supply. The mild decrease of the unemployment rate was terminated abruptly by the recession at the beginning of the eighties and the number of unemployed increased to more than two million people. Since then, it remained rather stable and decreased only slowly since 1986, despite the enormous increase in employment since 1983.

Demand determined employment is calculated from the estimated demand and the optimal productivity of labour and is depicted in figure 8. The most striking characteristic of this series is its high variance over the business cycle. During recession periods, it lied far beyond the employment level, while in boom periods it increased faster than employment. This gives a hint to labour hoarding: the employment level that is necessary to produce output is always less than or equal to L_Y and $L_Y < IT$ implies labour hoarding.³⁰ On the other hand, during boom periods, demand determined employment increased faster than employment. These distinct developments already indicate the importance of adjustment constraints for employment. Referring solely to the figure, employment adjusted only slowly with respect to demand during the upswing and during the downswing.

The development of capacity employment was smoother than actual employment. The recessions 1966/67 and 1974 are less pronounced in L_{YC} than in employment. In addition, L_{YC} lagged behind employment which indicates the slower adjustment of capacities with respect to demand.

Taken together, until 1966, an equilibrium situation can be stated. The labour supply was slightly below capacity employment, goods demand equals capacities, and the unemployment rate was about one percent. In addition, employment and the degrees of utilization of labour and capital remained fairly stable.³¹ This picture changes sharply with the recession in 1966. Demand determined employment decreased and the unemployment figures increased to above 500 000 people, despite the remigration of many guest workers. Capacities adjusted downward and in the first quarter in 1967, gross investment was nearly 20 percent below the corresponding level of the preceeding year. However, the recession was only short-termed and demand increased again until 1970, brought about mainly by higher exports caused by the undervaluation of the Deutsche Mark and high growth rates of the world economy. The labour supply and capacities adjusted only slowly, and in 1970, shortages of capital and labour supply were the main factors restraining a higher growth rate of the

²⁹ For instance, net migration inflows into the FRG amounted to about 400.000 people per year from 1967 and 1973, see Smolny (1992).

³⁰ See also figure 4.

³¹ See also figure 3.

Figure 7: Employment series I: LT , \hat{L}_{YC} , LS

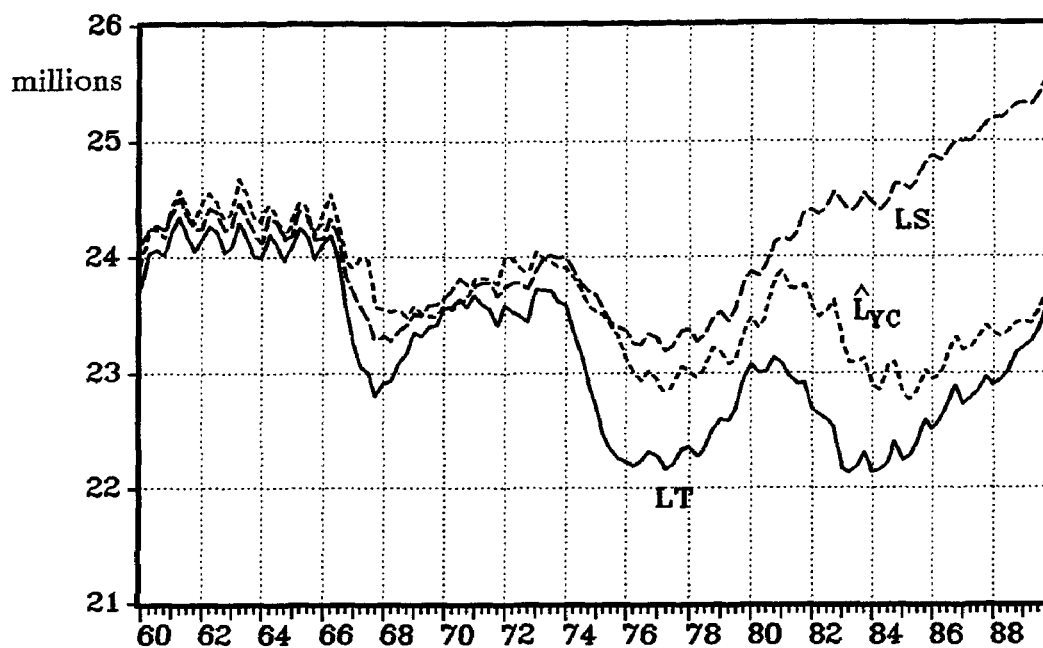
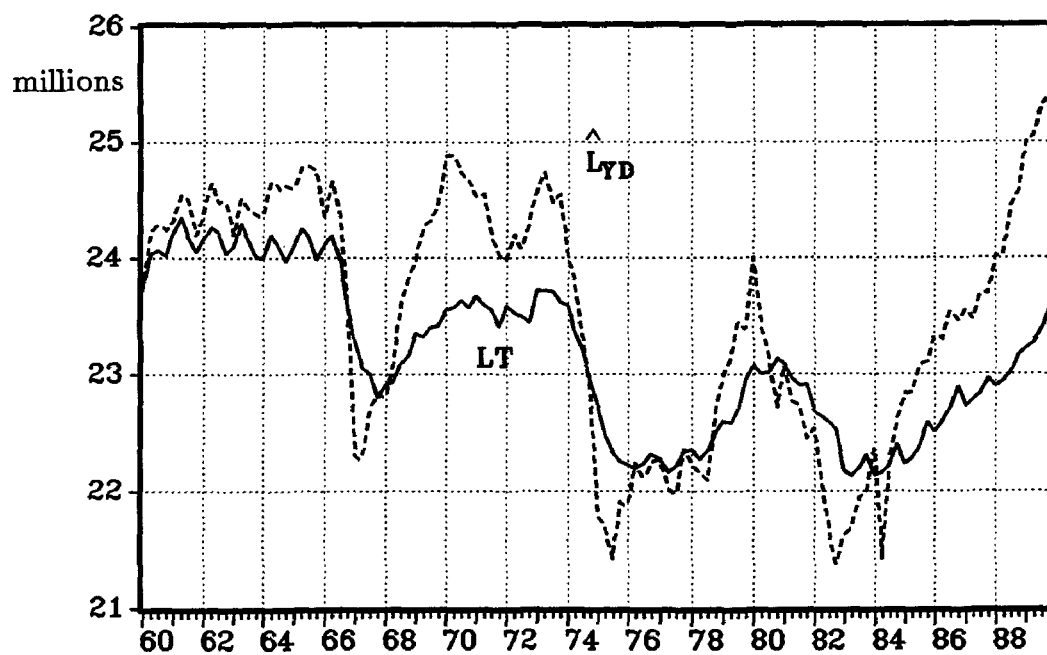


Figure 8: Employment series II: LT , \hat{L}_{YD}



economy. The following slowdown of demand in 1971 had hardly consequences for employment and investment, and the economy boomed when the first oil price shock hit the German economy. In addition, high inflation rates at the beginning of the seventies, caused by the enormous wage push in 1970, and increases in the monetary growth in course of the breakdown of the Bretton-Woods exchange rate system induced the Deutsche Bundesbank to switch to a restrictive policy. Short-run interest rates exceeded 14 percent and reduced investment and consumption demand, and exports declined in consequence of the slowdown of world demand. In 1975, the unemployment figure exceeded one million and the utilizations of labour and capital decreased to very low levels. The partial recovery since then was terminated with the second oil price shock. Again high inflation rates induced a restrictive monetary policy.³² Between 1979 and 1981, the money supply remained below the minimum of the target set by the Deutsche Bundesbank and interest rates were high. In consequence, investment and consumption decreased in real terms. Furthermore, the fiscal authorities changed to a restrictive course and in 1983, the unemployment figure exceeded two millions. Since then, the economy switched on a path of sustained growth and the figures indicate that a higher employment growth at the end of the eighties is mainly impeded by the slow adjustment of capacities.

The CES-approach of employment determination allows to calculate the share of firms facing the different constraints for employment determination. These shares are equal to the elasticities of aggregate employment with respect to the aggregate value of the respective constraint and can serve as an useful indicator for the evaluation of policy instruments; in case of an increase in demand, only those firms will increase employment which are in the demand constrained regime. Therefore, an expansionary demand policy affects only those firms' employment. The regime shares are calculated from the employment equation and are depicted in figure 9. The share of labour supply constrained firms is calculated from

$$\text{prob}_w(LS_i < LD_i) = \left(\frac{LS}{LT} \right)^{-\rho}$$

and respectively for the other regimes. In general, these regime shares provide a similar picture of the situation prevailing on the labour market as the employment series in figures 7 and 8: they are calculated from them. However, the regime shares allow for a closer look at the relative importance of the regimes. During the sixties until 1973, the labour supply was the most important binding constraint for employment. On average, nearly 50 percent of firms were constrained by an insufficient labour supply. This was interrupted only by the short recession in 1966/67 and by the capital shortage in 1970. The picture changed dramatically with the first oil price shock in 1973/74. Since

³² Another reason for the restrictive monetary policy was a deficit in the trade balance and a devaluation of the Deutsche Mark.

Figure 9: Regimes on the labour market I

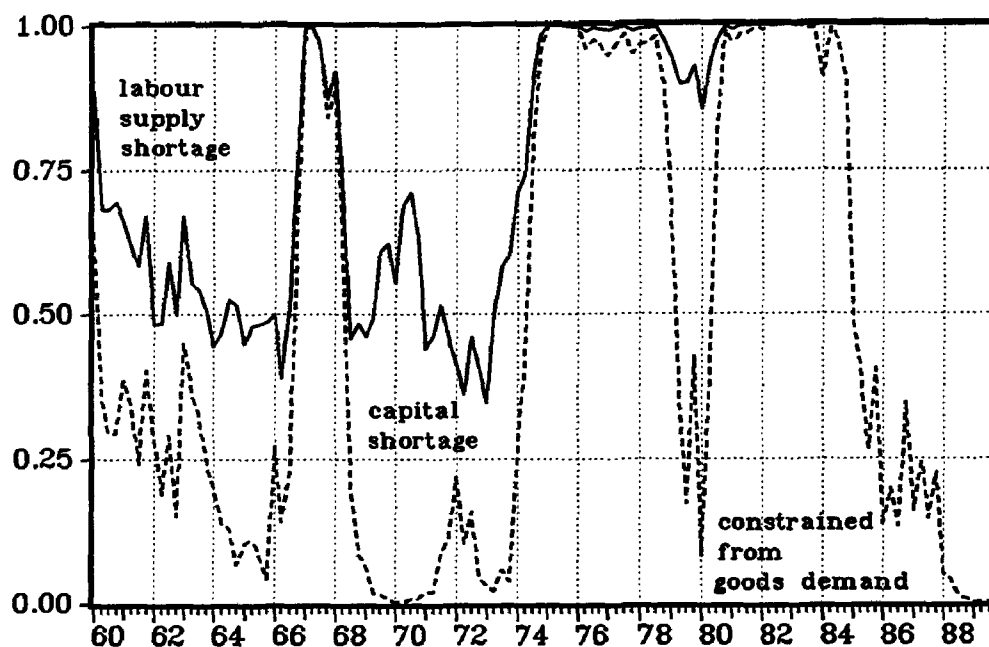
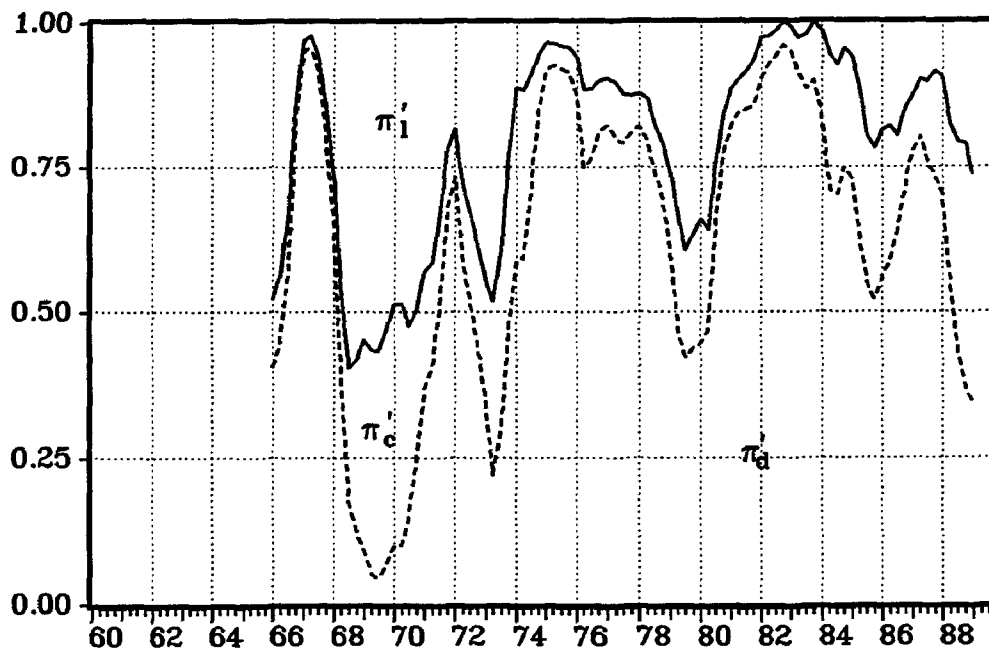


Figure 10: Regimes on the labour market II: business survey



then, the labour supply was never again an important constraint during the observation period. This gives also a hint to wage rigidities. Until 1973, the labour supply was an important constraint which was not removed by wage increases, while in the second half of the seventies, the high unemployment did not cause sufficient wage decreases.

In the second half of the seventies, the demand for goods was the most important constraint for employment. At this stage, a comment concerning the dynamic adjustment of employment is necessary. In the model, the dynamic adjustment is the more important, the more rapid the changes in the desired employment level are. The CES-approach of employment adjustment allows for a detailed look at the importance of these constraints. Two further "adjustment" regimes can be distinguished, i.e. the share of firms that were constrained in their upward adjustment of employment, and the share of firms that were constrained in their downward adjustment. Figure 9 gives the impression that in 1979 and since 1985 the capital stock was the binding constraint for employment for most firms. On the other hand, the degree of utilization of capital was lower than in the sixties, and far beyond the maximum values observed in 1970.³³ The inconsistency is removed when looking at the exact definition of the regimes. "Capital constrained" implies that $L_{YC} < L_{YD}$, LS . It does *not* imply that the capital stock is actually binding. Employment increased very fast but stayed always below capacity employment L_{YC} . Capacity utilization was not very high, actual employment was mainly constrained by the *past employment level*: a large share of firms was increasing employment with maximal speed. The CES-approach of employment adjustment allows to calculate this share, and while it was not very high for most of the observation period, in 1979 and since 1985 it became dominant.³⁴ This underlines the importance of the dynamic adjustment of employment. Capital was not really binding for employment, but the number of applicants per period, or the "capacities" of hiring and training entrants. In the second half of the eighties, employment was neither constrained very much by the capital stock, nor by goods demand, and nor by the labour supply, but a main reason for the persistence of unemployment was the constraint on employment growth, together with the increasing labour supply.

This interpretation is confirmed by the regime shares from the business survey of the ifo-institute. These shares are depicted in figure 10. For comparability, they are corrected for the "no constraint" answer. The depicted shares are calculated as the share of firm declaring a constraint, in relation to all firms declaring a constraint. In general, the development of these shares is similar to those obtained from the model. The turning points coincide, and until 1978, even the levels of the regimes are comparable. Only the short demand slow-down 1971/72 is more pronounced in the ifo-data. A first important difference

³³ See figure 3.

³⁴ Similar, the downward adjustment regime was not very high for most of the observation period, but was dominant in 1966, 1974, and 1982.

can be seen for 1979. For this year, the ifo-data reveal only a slight increase of the share of capital constrained firms π'_c , but a more important increase of the "labour shortage" regime π'_l . This is consistent with the interpretation above that the labour market situation in this year can be characterized by an "adjustment constraint": the exact term of the question in the business survey is "Mangel an Arbeitskräften" (lack of employees) which allows very well an interpretation of labour shortage as an adjustment constraint. A similar consideration can be applied to the situation in the eighties, however, the ifo-data are not very reliable for this period, because less than 25 percent of firms declared that they are constrained at all since 1984.

4.5 Mismatch

One cause of the high and persistent unemployment in Europe found in the empirical analysis of the European Unemployment Program was the increasing importance of mismatch in the seventies and eighties.³⁵ For instance, Entorf, Franz, König, Smolny (1990) found a "structural unemployment rate", i.e. the unemployment rate which corresponds to the equality of labour supply, demand determined employment, and capacity employment, of about 2.5 percent in the sixties which increases to nearly 6 percent in 1986. The increasing importance of mismatch for unemployment in Germany was confirmed by the analysis of Franz, König (1990), König, Entorf (1990), and Entorf, König, Pohlmeier (1992).

The theoretical model as presented above allows to distinguish different kinds of mismatch. First, adjustment constraints of employment and price rigidities lead to mismatch between goods supplied and goods demanded. The observable outcome is the considerable amount of labour hoarding and the procyclical productivity of labour. A measure of this kind of mismatch is the ρ_y -parameter of the output equation. Second, a measure of mismatch on the labour market, as for instance a difference in the regional or occupational structure of labour demanded and supplied, is given by the ρ_m -parameter in the CES-function with labour demand and supply. Third, the slow adjustment of capacities leads to a mismatch between capacity employment and demand determined employment. Examples are the effects of the oil price shocks which rendered part of the capital stock obsolete, or the capacities of steel and ship-building which do not match with the demand for electronic data processing machines. Again, this can be measured by the ρ_f -parameter of the respective CES-function. Finally, the dynamic adjustment of employment implies an inefficiency during the business cycle which is again caused by the limited mobility of workers and firms.

The estimates of the disequilibrium model revealed the following results for Germany:³⁶ first, the goods market mismatch was only slightly increasing

³⁵ See the country papers in Drèze, Bean (1990).

³⁶ See Smolny (1993a,b).

during the observation period. Second, the mismatch between labour supply and demand in the traditional sense was of minor importance for the high unemployment in the seventies and eighties. The excess supply of labour since the second half of the seventies limited the effects of this kind of mismatch.³⁷ More important was the mismatch between goods demand and capacities. This result is confirmed by Heidbrink (1994).

The most important source of labour market inefficiencies is associated with the dynamic adjustment of employment. This does not mean that the adjustment of employment has become slower. However, the variability of the target level of employment is higher in the seventies and eighties, and therefore the adjustment constraints were more important in this period. This kind of inefficiency differs considerably from the traditional concept of mismatch. In terms of a traditional u-v-curve, it refers to the difference between shift of the curve and loops around a long-run stable curve.³⁸ A higher mobility of workers and firms would reduce both kinds of mismatch, but policy recommendations would focus also on measures to stabilize labour demand. In addition, a continuous period of sufficient growth would reduce this inefficiency.

4.6 Simulation studies

The disequilibrium model has been used for simulation in several contexts. These simulation studies can serve different purposes. First, they can be used to forecast the development of the endogenous variables. A second use is to compare actual developments with the forecasts given by the model and to learn something about structural changes within the economy. Finally, one can use a simulation model to evaluate the effects of a change in the exogenous variables on the endogenous variables.

The last issue has been the subject of a number of investigations.³⁹ Entorf, Franz, König, Smolny (1990) estimated the impact of monetary and fiscal policy measures, Heidbrink (1994) simulated the effects of exchange rate changes and coordinated policy measures within a link model with Germany and 4 EC-countries, and Franz, Smolny (1990), Smolny (1992), and Franz, Oser, Winker (1994) analyzed the impact of migratory movements on labour supply and employment in Germany. Finally, Franz, Heidbrink, Smolny (1994) estimated the effects of unification. The most important feature for the simulation properties of the disequilibrium model are the regime dependent policy multipliers. Demand policy affects output and employment only for periods of sufficient labour supply and capacities, and an increasing labour supply affects employment only, if the labour supply is binding for employment.

Heidbrink (1994), Schellhorn, Winker (1994), and Franz, Heidbrink, Smolny (1994) investigated the dynamic stability of the model. For instance, in Franz,

³⁷ See also Franz (1989).

³⁸ A similar result was achieved by Franz, Smolny (1994) with a model of a dynamic u-v-curve and vacancy data.

³⁹ For a more detailed overview, see Schellhorn, Winker (1994).

Heidbrink, Smolny (1994) it is tested, to what extent the disequilibrium model is able to account for the effects of unification on West Germany's goods and labour market. The model was estimated for West Germany for the period until 1989, and an ex-post forecast was made with the actual values of the exogenous variables until 1993. The most important effects from unification within the framework of the disequilibrium model were the sharply increasing labour supply from 1989–1992 and the East German demand for West German products.⁴⁰ The latter mirrors the outcome of a Keynesian expenditure program on a great scale: East German “imports” from West Germany accounted to more than 150 bill. DM per year since 1991. The observed outcome for employment and labour supply is depicted in figures 11 and 12.⁴¹ However, the results also revealed a structural break: the actual employment dynamics exceeded the simulated employment growth remarkably for 1990–1991. It is not clear, whether this simulation error is due to a serious shortcoming of the dynamic model of employment determination, or whether German unification must be regarded as a “cosmic shock” which is very difficult to forecast in its economic consequences. It can be seen from figure 12 that the employment increases at the beginning of the nineties were about twice as large as those in previous boom periods and were unprecedented in the thirty years before.

5 Conclusions

If prices do not adjust instantaneously and clear the market at each moment of time, rationing occurs. The slow adjustment of quantities increases the inefficiencies associated with the business cycle and probably also the persistence of the disequilibria. A dynamic model of the firm is presented which pays special attention to the slow adjustment of employment, investment, and the production technology. Of course, the model is only one interpretation of reality. It describes mainly the short- and medium-run economic situation on the goods and labour market.

Excess supply on the goods market, which is not immediately removed by price or quantity adjustments implies underutilization of labour and capital; excess demand creates a spillover to the international markets; excess supply on the labour market is unemployment. The regime shares on the goods market give an impression of the short-run constraints and can be helpful for the prediction of medium-run employment changes.

The medium-run supply conditions are determined by the labour supply constrained output level and capacities. On the labour market, “Keynesian” labour demand and capacity employment can be identified in addition to the labour supply. The employment series and the share of firms in the different regimes on the labour market provide a picture of the medium-run employment

⁴⁰It should be noted that monetary effects and effects from the increasing public debt were treated only cursory.

⁴¹The data refer to the whole economy.

Figure 11: Employment and labour supply 1960-1993

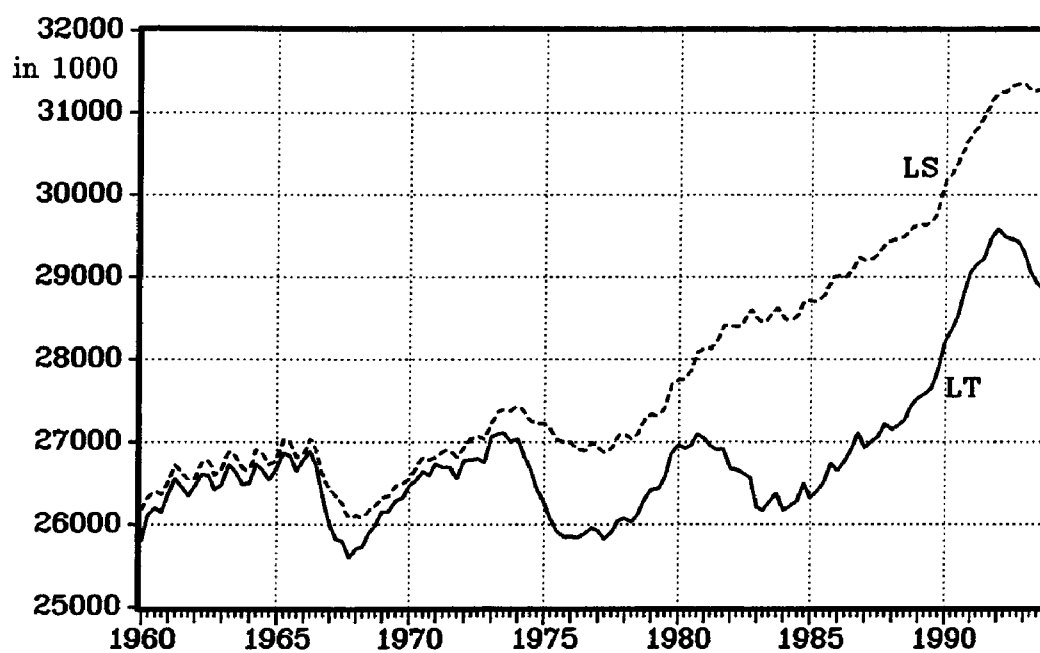
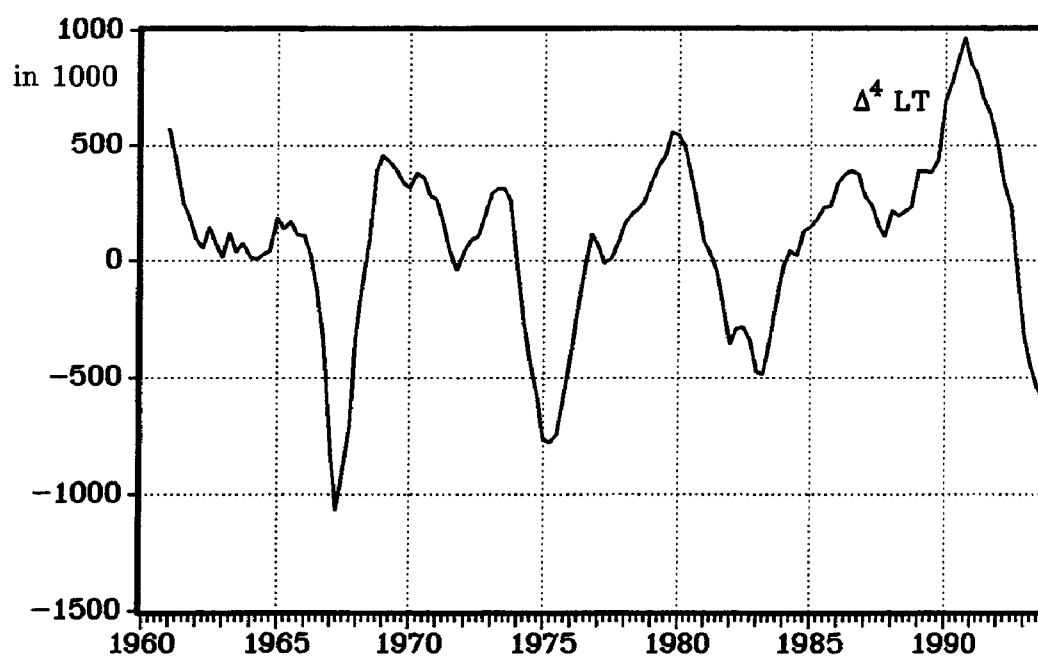


Figure 12: Annual changes of employment



Annual changes.

situation during the business cycle. The labour supply was binding in Germany only until 1973. The driving force of employment adjustment was the demand for goods, with capacity employment adjusting slowly with respect to demand.

In the short run, employment growth can be limited by adjustment constraints. Together with the increasing labour supply, this provides a partial explanation for the persistence of high unemployment in Germany in the eighties. At the beginning of the eighties, the demand breakdown in course of the second oil price shock reduced employment. After the recovery of demand in 1984, the employment growth was mainly impeded by adjustment constraints for employment until the end of the eighties, when the slow adjustment of capacities constrained employment.

An important increase of structural unemployment in the usual static sense is not revealed. The only kind of mismatch which had increased over the observation period were the adjustment constraints that are more important in periods of rapid changes of demand than in "equilibrium" situations like the sixties.

Appendix

Table 3: Variable list

YT :	output
YD :	goods demand
YS :	goods supply
Y_{LT} :	employment constraint
YC :	capacities
LT :	employment
LS :	labour supply
LD :	labour demand
L_{YC} :	capacity employment
L_{YD} :	demand determined employment
L_{YT} :	employment necessary to produce output
DUL :	utilization of labour, $DUL = L_{YT}/LT$
DUC :	utilization of capital $DUC = YT/YC$
q :	utilization of capital, ifo institute
K :	capital stock
w :	wages
p :	prices
c :	user cost of capital
π_L :	optimal labour productivity
π_K :	optimal capital productivity
I :	investment
C :	consumption
G :	residual demand components, housing, net governmental demand
X :	exports
XD :	export demand
M :	imports
MD :	structural imports

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