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Macroeconomic consequences of international labour migration: Simulation experience from an econometric disequilibrium model

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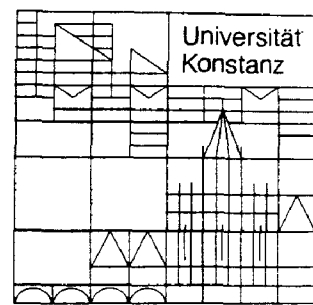
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Diskussionsbeiträge



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Werner Smolny

**Macroeconomic Consequences
of International Labour Migration**
Simulation Experience
from an Econometric Disequilibrium Model

MACROECONOMIC CONSEQUENCES OF INTERNATIONAL LABOUR MIGRATION

Simulation Experience from an Econometric Disequilibrium Model

Werner Smolny*

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Abstract: Recent experience on increasing labour supply coming from outside the FRG enhances interest in the economic effect of these supply shocks. This paper analyses the consequences of guest workers immigration in the sixties and seventies using a macroeconometric disequilibrium model. Within the rationing context the derivation of nonlinear multipliers is facilitated, which depend on the shares of demand and supply constrained regimes prevailing in the economy. The immediate impact stems from prevention of wage and price inflation by increasing labour supply. Effects on investment, the adjustment of the capital - labour ratio, and productivity have also to be discussed. In this context a shadow price of the labour supply constraint is derived. The model is estimated for the FRG and some simulations are performed. First, a restrictive immigration policy is modeled concerning guest workers coming from non EC - countries in the late sixties, i.e. a prosperous period, and these results are compared with simulations of a reduction of labour supply in the less prosperous period of the eighties.

1 Introduction

During the second half of the eighties the labour market situation in the Federal Republic of Germany was characterized by an enormous increase of labour supply. Increasingly important has become the immigration of people from Eastern Europe and especially from Poland, Rumania, and the Soviet Union. Further, high immigration is expected to persist, which is due also to the completion of freedom of movement of labour within the European Community and an expected increase of immigration from Southern Europe. The situation prevailing at the end of the eighties can be seen by inspection of figure 1. Net inflows amount to about 500000 people in 1988 coming from outside the FRG and are further increasing in 1989. On the other hand, immigrations exceed emigrations most of the time in the last thirty years and, on average, just compensate natural population development, which is negative from 1972 onwards.

This paper tries to evaluate the consequences of guest workers immigration at the end of the sixties and the beginning of the seventies within a macroeconomic disequilibrium model. Section 2 presents the general structure of the model and shows how migration influences the economic development. The main behavioral equations are derived in section 3. Output, employment, investment, and capital - labour substitution are derived from microeconomic optimization behavior of firms. Most emphasis is given on quantity constraints for output and employment determination. Further, expected constraints of goods demand and labour supply are the driving forces for investment and employment decisions. In the model an explicit aggregation procedure over firms is applied, which allows for heterogeneity of firms with respect to goods and labour market conditions. The underlying assumptions are discussed in section 4. In section 5 the main determinants of migration behaviour are analyzed. Section 6 presents the estimation results and in section 7 the results of two simulations are discussed. It is reasonable that the effects from migration differ with regard to the prevailing labour market situation. Therefore a first simulation starts during the period of excess demand for labour in 1968 and these results are compared with a simulation covering the years of high unemployment in the eighties. The paper is concluded by stating some implications for employment policy.

2 The structure of the model

The regime dependency of multipliers is a property of the business cycle models in the New Keynesian Macroeconomics. This is very explicit in the first models applying the minimum condition² to the aggregate goods and labour market: demand increases output and employment only in the Keynesian regime while immigration and a higher labour supply has positive effects on employment and output only in the regime of suppressed inflation. The model here, however, employs an explicit aggregation over micro markets, where the minimum condition holds only on these micro markets. Further, wage and price dynamics are introduced and the dynamics of output, employment, investment, and capital - labour substitution are derived within a microeconomic optimization model of the firm.

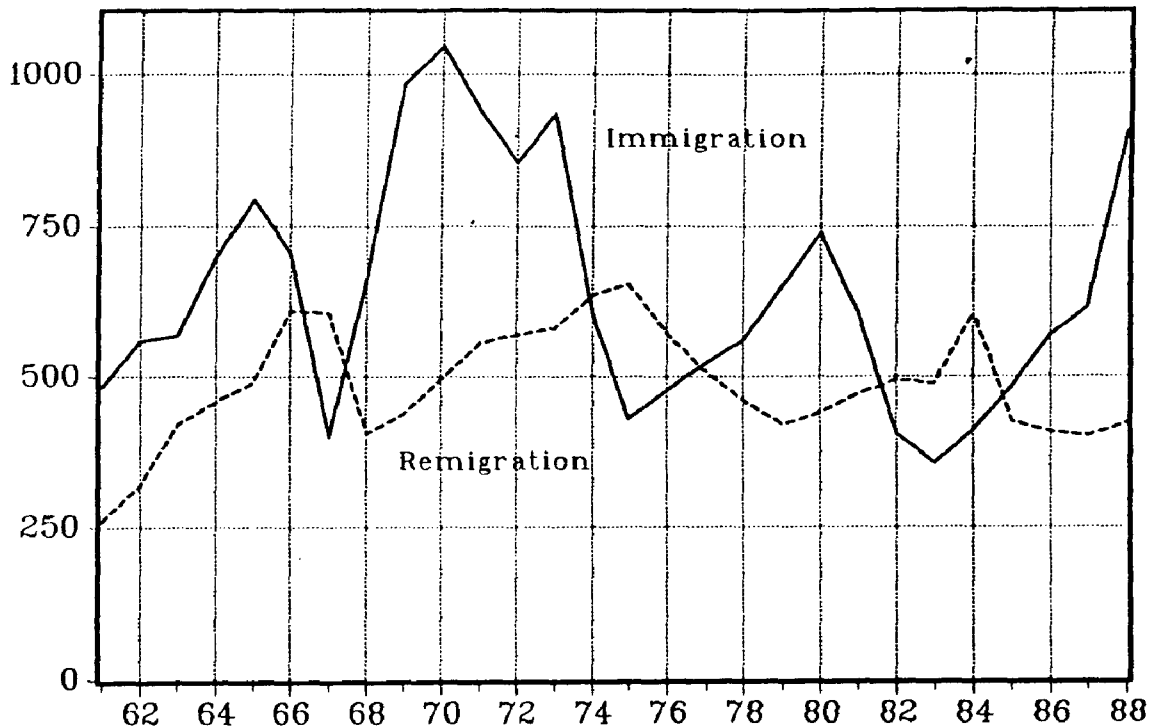
Effects from high immigration, as it pertained at the end of the sixties and the beginning of the seventies are expected first on employment and output. Higher labour supply will at least in the short run most likely increase employment and output. Another immediate effect is on wages and prices. Higher labour supply decreases demand pressure on the labour market and inhibits wage inflation.³ Wages are a substantial part of production cost and therefore also a dampening effect on prices is expected. Furthermore, there is also a direct effect from migration on prices. If labour supply and employment are the binding constraints for production, raising the bound reduces also demand pressure on the goods market. Changed relative factor prices do also influence capital - labour substitution. Lower real wages retard substitution of capital for labour and therefore increase capital productivity while reducing labour productivity growth. In addition, there is a direct effect from the labour supply constraint on the capital - labour ratio. In the presence of a bound on employment from labour supply the optimal capital - labour ratio will be higher and

²This condition says that transacted quantities are given by the minimum of supply and demand on the markets.

³These considerations hold only if the supply effects of higher immigration exceed the demand effects.

Figure 1: Migration in the Federal Republic of Germany

in 1000



increased immigration will dampen this effect. For investment three effects can be distinguished: first the negative effect from capital - labour substitution caused by lower real wages and the availability of labour discussed above. Second there is a positive effect from higher profitability. Lower wages increase profitability and increase the optimal capital stock. Finally, there is a direct effect from the availability of labour. Given the capital - labour ratio, the non - availability of labour may prevent a profitable use of the capital stock, therefore higher labour supply increases investment.

The effect of immigration on consumption is uncertain as well. While higher employment results in higher disposable income and consumption, there is also a dampening effect stemming from lower wages. Finally, there will be an effect on exports and imports. It seems plausible that supply constraints on the goods market encourage additional imports to bypass the constraint. Further, in the presence of supply constraints also foreign demand will be rationed on the German market.⁴ Higher labour supply will therefore have a positive effect on the trade balance.⁵ Additional to this there will be multiplier - accelerator effects. Moreover, there will be a feedback from the economic situation on immigration and remigration flows. Figure 1 shows clearly the dependence of these flows on the business conditions in the Federal Republic of Germany. The structure of the model and the expected effects from higher immigration are summarized in [table 1](#).

One caveat of the model is that it does not account for structural effects from labour migration.⁶ It seems plausible that immigrants have lower labour market qualifications on average, at least with respect to difficulties with the German language. On the other hand, mobility of the migrants will be higher which may partly offset their lower qualification. Immigration does probably increase a qualification mismatch while reducing a regional mismatch.

⁴ A more detailed analysis of these aspects with a disaggregated empirical application for the major trade partners of the FRG is contained in Franz, Heidbrink, Scheremet (1990).

⁵ The model does not include capital account effects from e.g. transfer payments of guest workers to their home countries.

⁶ Therefore, it cannot be distinguished between employment effects for Germans and foreigners.

Table 1: The structure of the model

1. Technology
- Labour productivity (-)
- Capital productivity (+)
2. Demand
- Exports, Imports (+) (-)
- Investment (?)
- Consumption (?)
- Governmental expenditure, housing investment, exogenous
3. Output (+)
4. Employment (+)
5. Wages, prices (-) (-)
6. Labour supply
- Migration
- Labour force participation

Effect from increased immigration: (+): positive, (-): negative, (?): uncertain

3 The investment and employment decision of the firm

In this section the main results for the behaviour of the firms will be derived. One limitation of the analysis below is that wage and price behaviour is not derived within the microeconomic optimization context. Rather it is assumed that prices adjust only partially and with a delay to changes in costs and market disequilibria. Also, wages respond slowly to unemployment and income distribution aspects are important for wage behaviour. This is the usual assumption underlying the New Keynesian Macroeconomics and does not mean that wages or prices are exogenous or fixed, but only that the consequences of endogenous wage and price setting may be neglected for quantity adjustment. Therefore wages and prices are treated *as if* they were exogenous.⁷ This assumption is not without a thorough microeconomic foundation.⁸ There is an extensive literature on microeconomic models concerning wage stickiness. Supply oriented theories focus on union behaviour and insider pressure to explain slow adjustment of wages to market disequilibria. Also, models of efficiency wages, implicit contracts, and internal labour markets justify why it is not efficient for firms to adjust wages immediately to market disequilibria. In addition, theories of price behaviour emphasize imperfect competition, price adjustment costs and kinked demand curves to explain sluggish adjustment of prices. In the macroeconomic model, of course, wages and prices are endogenous. One may think of aggregate wages and prices adjusting slowly to equilibrium values, while individual firms have less incentives to diverge to much from average prices. In the microeconomic context firms have to choose output, employment, and investment given wages and prices, and given labour supply and goods demand constraints.

On the other hand the model differs from standard Keynesian models in that it allows also

⁷One should bear in mind that the concepts of perfect competition or the Walrasian auctioneer are also "as if" constructs.

⁸In addition, as Drèze (1987), p.16, notes, perfect flexible prices and permanent market clearing "... is not only unrealistic; it is very restrictive."

a delayed adjustment of quantities. There is a lot of theoretical and empirical evidence on the importance of adjustment costs and adjustment delays especially for capital. First, there is time necessary for decision making, then the time to produce capital goods and consequently delivery lags, and finally time and costs of installation. Also, if a new technique is embodied, workers have to be trained for working with the machine. The absence of a well organized market for second hand capital goods reveals that downward adjustment is even more costly.⁹ Most firms rely on depreciation to adjust the capital stock downward.

The costs and time lags in the adjustment process of employment are probably smaller. Even though they have to be considered. Again the process of information gathering and decision making takes time. New entrants have to be trained and decreasing returns for firm specific training are plausible. For downward adjustment of employment the firm has to pay attention to legal or contractual periods of notice and to consider possible reputation losses from dismissals.¹⁰ The loss of the firm's investment in specific human capital and of reputation may be as important that firms rely on normal fluctuations, i.e. quits and retirements, for downward adjustment of the labour force.¹¹

The main emphasis here is on the importance of adjustment *delays*.¹² Firms need some time to adjust employment and capital. When assuming for simplicity exogenous adjustment delays, say for capital about one or two years and for employment three to six month,¹³ one has a rather simple, three - step decision model:¹⁴

1. short run adjustment of output for given employment and capital stock,
2. medium run choice of employment for given capital stock, labour supply, and uncertain demand,
3. long run adjustment of the capital stock with uncertain output and employment.

Furthermore, a putty - clay technology is assumed, the capital - labour ratio can only be adjusted with investment and therefore with the same delay as the capital stock.¹⁵

1. **Output:** Optimal output can then be derived from

$$\max_{YT} P \cdot YT - W \cdot LT - UC \cdot K \quad (1)$$

$$\begin{aligned} YT &\leq YD \\ YT &\leq YS \end{aligned}$$

with:

P	:	price level
YT	:	output
YD	:	demand for goods
YS	:	output supply
W	:	wage rate
LT	:	employment
UC	:	user costs of capital
K	:	capital stock

This yields optimal output as the minimum of supply and demand:

$$YT = \min(YD, YS) \quad (2)$$

$$YS = \min \left[\left(\frac{Y}{L} \right)^* \cdot LT, \left(\frac{Y}{K} \right)^* \cdot K \right] \quad (3)$$

⁹The only remarkable exceptions are the markets for second hand cars and aeroplanes. Some forms of leasing does also allow rather quick downward adjustment.

¹⁰See e.g. Okun (1981).

¹¹A note: delayed factor input adjustment with completely flexible wages and prices does result in overshooting of wages and prices during the adjustment process.

¹²For a similar model only for capital see e.g. Nickell (1978) and Lambert, Mulkey (1987).

¹³Adjustment lags of about two years had already been estimated by Jorgenson, Stephenson (1967). A survey on empirical work about lags in employment adjustment is given by Palm, Pfann (1990).

¹⁴While this neglects the determinants of the optimal adjustment delay, it incorporates them in a consistent manner.

¹⁵It can be shown that without ex post fixed factor input proportions overshooting labour demand and employment, and anticyclical productivity of labour is implied.

with:

$$\begin{aligned} \left(\frac{Y}{L}\right)^* &: \text{productivity of labour} \\ \left(\frac{Y}{K}\right)^* &: \text{capital productivity} \end{aligned}$$

Output supply is given by the short run limitational production function as the minimum of the employment and capital constraint.

2. Employment: Employment has to be chosen *before* output realization from

$$\max_{LT} P \cdot E(YT) - W \cdot LT - UC \cdot K \quad (4)$$

$$\begin{aligned} LT &\leq LS \\ YT &\leq YD \\ YT &\leq YC \end{aligned}$$

with:

LS : labour supply

YC : capital constraint, $YC = \left(\frac{Y}{K}\right)^* \cdot K$

E is the expectation operator. Unconstrained employment L^* , i.e. employment in the presence of sufficient labour supply and a sufficient number of working places, follows from the first order condition¹⁶

$$\underbrace{P \cdot \text{prob}(YD > Y_{L\bullet}) \cdot \left(\frac{Y}{L}\right)^*}_{\text{expected marginal return}} = \underbrace{W}_{\text{marginal cost}} \quad (5)$$

$$\text{prob}(YD > Y_{L\bullet}) = \frac{W}{P} \cdot \left(\frac{L}{Y}\right)^* \quad (6)$$

with

$$Y_{L\bullet} = \left(\frac{Y}{L}\right)^* \cdot L^*$$

and states that expected marginal return should be equal to marginal costs. Expected return is given by the marginal product of labour weighted with the probability to achieve return and therefore to sell the product.

When assuming a lognormal distribution¹⁷ for goods demand YD and approximating the normal distribution of $\log YD$ by using a logistic curve this yields for optimal employment L^*

$$L^* = E(YD) \cdot \left(\frac{L}{Y}\right)^* \cdot \exp(-.5 \cdot \sigma_{yd}^2) \cdot \left(\frac{1 - sl}{sl}\right)^\alpha \quad (7)$$

with

$$\begin{aligned} \alpha &= \frac{\sqrt{3} \cdot \sigma_{yd}}{\pi} \\ sl &= \frac{W}{P} \cdot \left(\frac{L}{Y}\right)^* \end{aligned}$$

sl defines the share of wages in value added at full utilization of labour, i.e. in the absence of labour hoarding. Unconstrained employment is determined by expected goods demand, uncertainty of

¹⁶ The expected value of output is given by

$$E(YT) = \int_0^{YS} YD \cdot f_{YD} dYD + YS \cdot \int_{YS}^{\infty} f_{YD} dYD$$

with partial derivative

$$\frac{\partial E(YT)}{\partial YS} = \int_{YS}^{\infty} f_{YD} dYD = \text{prob}(YD > YS)$$

For a similar result see Nickell (1978), Benassy (1982), and Lambert, Mulkay (1987).

¹⁷ For the assumption of the lognormal distribution see the next section. The cumulative distribution function of the logistic curve is given by:

$$F(x) = \frac{1}{1 + \exp\left(-\frac{x - \mu}{\sigma}\right)}$$

For the quality of the logistic approximation of the normal distribution see Johnson, Kotz (1970), p.6.

demand¹⁸, productivity of labour, and sl as a measure of profitability. In the presence of constraints employment will be lower, i.e. employment follows from

$$LT = \min(LS, LD) \quad (8)$$

$$LD = \min(L_{YC}, L^*) \quad (9)$$

with:

LD : labour demand

$$L_{YC} = YC \cdot \left(\frac{L}{Y}\right)^*$$

Optimal labour demand will never be higher than the maximal number of workers that can be employed with the capital stock and, of course, employment cannot exceed labour supply.

3.1 Capital: The solution for the optimal capital stock is very similiar. It is assumed, that firms get all the investment goods they demand, i.e. if there are constraints on the domestic market they can always turn to the world market. Effective rationing of investment demand is only possible by simultaneous constraints on the domestic market and on the world market and seems to be negligible. Optimal capital stock can be derived from:

$$\max_{K, \left(\frac{K}{L}\right)} P \cdot E(YT) - W \cdot E(LT) - UC \cdot K \quad (10)$$

$$LT \leq LS$$

$$YT \leq YD$$

$$YT \leq YC$$

The first order condition can approximately be written as¹⁹

$$\left[P - W \cdot \left(\frac{L}{Y}\right)^* \right] \cdot \left(\frac{Y}{K}\right)^* \cdot \text{prob}(Y^m > YC) = UC \quad (11)$$

expected marginal return *marginal cost*

$$\text{prob}(Y^m > YC) = \frac{sk}{1 - sl} \quad (12)$$

with

$$Y^m = \min(Y_{L^*}, Y_{LS}, YD) \quad (13)$$

and:

$$sk = \frac{UC}{P} \cdot \left(\frac{K}{Y}\right)^*$$

$$Y_{L^*} = \left(\frac{Y}{L}\right)^* \cdot L^*$$

$$Y_{LS} = \left(\frac{Y}{L}\right)^* \cdot LS$$

sk defines the share of capital costs in value added at full utilization of capital. YD , Y_{L^*} , and Y_{LS} are the possible constraints which may prevent the firm from full utilization of capacities. Assuming again a lognormal distribution for Y^m and using the logistic approximation yields

$$YC = E(Y^m) \cdot \exp(-.5 \cdot \sigma_{Y^m}^2) \cdot \left(\frac{1 - sl - sk}{sk} \right)^\beta \quad (14)$$

¹⁸ σ_{YD}^2 is the variance of $\log YD$.

¹⁹ One can use the result that $\frac{\partial E(YT)}{\partial YC} = \text{prob}[\min(Y_{L^*}, Y_{LS}, YD) > YC]$.

For the derivation see Smolny (1991).

with:

$$\beta = \frac{\sqrt{3} \cdot \sigma_{ym}}{\pi}$$

Capacities are chosen proportionally to the expected minimum of goods demand YD and goods supply determined by employment, Y_L and Y_{LS} . Further determinants are a measure of profitability and the variance of $\log Y^m$.

3.2 Capital - labour substitution: Optimal factor productivities follow from the derivation of equation 10 with respect to the capital - labour ratio. For a CES - technology with constant returns to scale, the optimal labour and capital productivities are given by²⁰

$$(y - l)^* = \text{const.} + \sigma \cdot [(w - p) - \log[E(DUL)] + (1 - \sigma) \cdot \gamma_l \cdot t + \lambda_{LS} \quad (15)$$

$$(y - k)^* = \text{const.} + \sigma \cdot [(uc - p) - \log[E(DUC)] + (1 - \sigma) \cdot \gamma_k \cdot t - \lambda_{LS} \quad (16)$$

with γ_l , γ_k denoting the rates of labour / capital saving technical progress and

DUL : degree of utilization of labour,

DUC : degree of utilization of capital.

The slope of the transformation curve is equal to relative prices, corrected for the expected degrees of utilization of labour and capital, and the shadow price of the labour supply constraint. A lower expected utilization has the same effect on factor substitution as higher factor prices, and non - availability of labour increases labour productivity: capital - labour substitution does not only depend on relative prices, but also on possible constraints on the labour market and the degree of uncertainty of demand. Then optimal capital stock follows from:

$$K = \left(\frac{K}{Y} \right)^* \cdot YC \quad (17)$$

There are four channels how immigration and labour supply can influence output. First, insufficient labour supply restricts employment and thus also output, second, investment depends on $E(Y^*)$ and therefore also on LS . Third, substitution and optimal productivities depend on the shadow price of the labour supply constraint, and finally, if higher labour supply influences relative prices this determines also the respective shares of labour and capital.

So far, only adjustment delays have been considered. Additionally, nonlinear adjustment costs are approximated by extended dynamic structures. One way to incorporate the above considerations about employment adjustment is to restrict dismissals to some percentage of employment, i.e.

$$LD_t \geq (1 - \delta^d) \cdot LT_{t-1} \quad (18)$$

and further restricting hires by

$$LD_t \leq (1 + \delta^h) \cdot LT_{t-1} \quad (19)$$

with:

δ^d : rate of dismissals and quits

δ^h : hiring rate

Labour demand depends on past employment. Optimal labour demand may not be lower than $(1 - \delta^d) \cdot LT_{t-1}$ and should not exceed $(1 + \delta^h) \cdot LT_{t-1}$. Then optimal labour demand follows from

$$\begin{aligned} LD &= \max \{ LD^*, (1 - \delta^d) \cdot LT_{t-1} \} \\ &= \max \left\{ \min \left[L^*, L_{YC}, (1 + \delta^h) \cdot LT_{t-1} \right], (1 - \delta^d) \cdot LT_{t-1} \right\} \end{aligned} \quad (20)$$

The parameters δ^d , δ^h can be estimated by using aggregate data. The parameter δ^d especially reveals to be important in the empirical analysis, see equation A.28 in the appendix. δ^d is about 4 percent and highly significant while δ^h amounts to about 10 percent.

²⁰ Small case letters denote logs.

Further, for investment an extended error correction dynamic is introduced to allow for nonlinear adjustment costs of capital while the dynamic adjustment of labour and capital productivity is approximated by a usual partial adjustment mechanism.

4 The aggregation of micro markets

The above equations describe the behaviour of *one* firm, but, of course, firms differ for instance with respect to demand expectations, demand realizations and labour supply.²¹ Further, it is reasonable to allow for mobility between micro markets,²² workers who get no job change to other firms while firms facing a demand constraint for their goods try to open new markets. Of course, similar considerations hold for the supply side. If mobility processes are assumed to be *proportional* to firm size and the rate of excess demand or supply on the market, the aggregate distribution of micro markets can be approximated by a lognormal distribution,²³ i.e. LS_i , LD_i , YS_i , and YD_i are lognormally distributed with²⁴

$$\begin{pmatrix} ls \\ ld \end{pmatrix} \sim N \left[\begin{pmatrix} E(ls) \\ E(ld) \end{pmatrix}, \begin{pmatrix} \sigma_{ls}^2 & \rho \sigma_{ls} \sigma_{ld} \\ \rho \sigma_{ls} \sigma_{ld} & \sigma_{ld}^2 \end{pmatrix} \right] \quad (21)$$

and similar considerations hold for the goods market. Transacted quantities on the micro markets are given by the minimum of supply and demand:

$$LT_i = \min(LS_i, LD_i) \quad (22)$$

$$YT_i = \min(YS_i, YD_i) \quad (23)$$

Then the density for transacted quantities on the labour market can be written as

$$f_{lt} = \int_{lt}^{\infty} f_{s,d}(ls = lt) dld + \int_{lt}^{\infty} f_{s,d}(ld = lt) dls \quad (24)$$

with expected value of employment LT_i :

$$\begin{aligned} E(LT_i) &= L_1 + L_2 \\ &= \int_{-\infty}^{\infty} \int_{ls}^{\infty} LS_i \cdot f_{s,d} dld dls + \int_{-\infty}^{\infty} \int_{ld}^{\infty} LD_i \cdot f_{s,d} dls dld \end{aligned} \quad (25)$$

Aggregate employment is given by $E(LT_i)$ multiplied by the number of micro markets (= firms):

$$LT = N \cdot E(LT_i) \quad (26)$$

When approximating the weighted shares of micro markets in each regime, i.e. $L_1/E(LT_i)$, $L_2/E(LT_i)$ and the respective regimes on the good market by a logistic curve, one can derive simple expressions for aggregate transacted quantities depending only on aggregate supply, aggregate demand, and a parameter ρ^* .²⁵

$$LT = \left\{ LS^{-\rho_i^*} + LD^{-\rho_i^*} \right\}^{-1/\rho_i^*} \quad (27)$$

$$YT = \left\{ YS^{-\rho_y^*} + YD^{-\rho_y^*} \right\}^{-1/\rho_y^*} \quad (28)$$

Aggregate employment and output can be written as CES - functions of aggregate supply and demand. The parameter ρ^* indicates a mismatch between supply and demand on the micro

²¹ Also consistent with the aggregation procedure are differences in the production technology, wages, prices, etc..

²² Micro markets may be defined in relation to firms. Each firm's demand and supply of labour defines one micro labour market and respectively for the goods market. See Kooiman (1984) for the advantages of this approach.

²³ For a similar approach see Lambert (1988).

²⁴ Small case letters denote logs.

²⁵ For this derivation see Lambert (1988).

markets and is determined by the uncertainty of demand for the firm's product and by the amount of mobility processes between micro markets. ρ^* depends on the variance of the logarithmic difference between supply and demand.

$$\text{var}(ls_i - ld_i) = \sigma_i^{*2} = \sigma_{ls}^2 + \sigma_{ld}^2 - 2\rho\sigma_{ls}\sigma_{ld}$$

For illustration purposes, a value of this variance for the labour market of say $\sigma_i^{*2} = 0.01$ implies a structural unemployment rate at equilibrium, i.e. for $LS = LD$,

$$\text{sure} = \frac{LS - LT}{LT} \approx 0.04$$

It can be shown by numerical evaluations of equation 25 that the approximation error of equation 27 is less than 0.075 percent in the relevant range.²⁶ Further, the minimum of two lognormally distributed random variables is also approximately lognormally distributed,²⁷ thus it is possible to construct a nested CES - function to model the complicated structure of aggregate employment in equation 20 above.²⁸

5 Migration and participation

Migration flows are analyzed for the five most important immigration countries for the Federal Republic of Germany. While in the sixties most immigrants (Z) came from Italy this situation has changed at the beginning of the seventies with now most of the migrants being from Turkey. The three other important migration countries for the FRG are Greece, Spain, and Yugoslavia. Inflows from these five countries account for about 70 percent of total inflows in the last 30 years. While there was also a large amount of remigration (F), in most years there was a net inflow to the FRG.

This paper deals mainly with the economic sources of labour migration.²⁹ The main economic determinants driving migration decisions are wage differences and the different employment situation in Germany compared to the home country of the guest workers. This is especially true for the years until 1973, where apart from the short recession in 1967 the German labour market was extremely tight and firms supported immigration of guest workers to remove labour shortages.

In addition, institutional regulations have to be considered. Confronted with the recession and high unemployment rates in 1973 the German government enacted a law that inhibited immigration from non EC - countries. Since 1974 only family members of foreigners living here have been allowed to live and work in the FRG, which has reduced inflows from Greece, Spain, and Yugoslavia down to a small fraction. On the other hand, due to freedom of movement of labour within the Common Market this did not apply to e.g. inflows from Italy. In addition, in the sixties mainly male workers came to Germany, and immigration of family members from Turkey in the seventies resulted in nearly as high immigration flows as before.

For remigration mainly the same aspects as for immigration are important. Also important is the number of foreigners living in the FRG. An additional determinant for remigration are the immigrations of the recent past. Many immigrants plan to stay only for a short period in Germany and leave then. Also, the immigration decision has to be made under uncertainty about the living conditions in the guest country and disappointment about the situation here leads to remigration. An institutional aspect is a law about subsidies for remigration, which was in effect in 1984. The subsidies have been claimed by about 150000 people especially from Turkey and Portugal.³⁰ The general structure of the migration equations can be outlined by:

$$Z_t = Z[UR_t, UR_t^a, (w - w^a)_t, Pop_{t-1}^a, D_{7488}] \quad (29)$$

²⁶ For observed aggregate data $0.9 \leq \frac{LS}{LD} \leq 1.1$.

²⁷ For $\sigma_{ls} = \sigma_{ld} = 0.5$ and $\rho = 0.98$, this implies $\text{sure} \approx 0.04$, the approximation error for the cumulative density function of LT is always less than $0.025 \cdot 10^{-3}$.

²⁸ The maximum of two lognormally distributed random variables can equally be approximated by a CES - function:
 $E[\max(S, D)] = \{E(S)^\rho + E(D)^\rho\}^{1/\rho}$

²⁹ For a more detailed analysis refer to Franz (1981) and Franz, Smolny (1990).

³⁰ See Hönckopp (1987).

$$F_t = F[UR_t, UR_t^a, (w - w^a)_t, Z_{t-1}, D_{84}, Pop_{t-1}^a] \quad (30)$$

$$Pop_t^a = \alpha_1 \cdot (Z - F)_t + (1 - \alpha_1) \cdot (Z - F)_{t-1} + (1 + \alpha_2) \cdot Pop_{t-1}^a \quad (31)$$

The difference in the economic situation is captured by the respective unemployment rates, while wage differences are only available for Italy. On the other hand, the absolute wage difference for the other countries is high that *changes* in the difference during the sample period may be not very important. The institutional factors are captured by dummy variables, while the lagged number of foreigners is related to migration of family members in equation 29 and to the scale effect in equation 30. In addition, equation 31 accounts for natural population growth. One may criticize the limitation on this small set of explanatory economic variables, but equations 29 and 30 account for about 90 percent of the variance of migration flows.

Migration is one component of labour supply, the other is labour market participation. For this purpose standard specifications from labour supply theory have been estimated, with participation depending on real wages and the unemployment rate. Structural factors are a time trend for increased participation of women and the share of males in foreign population accounting for the higher participation of men.

$$EQ^a = EQ^a \left[UR, (wn - p), \left(\frac{Pop^m}{Pop^a} \right) \right] \quad (32)$$

$$EQ^d = EQ^d \left[UR, (wn - p), t \right] \quad (33)$$

6 Results of estimation

Only the main results of the estimations can be presented here. A complete representation of all the behavioural equations and the goodness of fit measures of the simulations is contained in Entorf, Franz, König, and Smolny (1988).³¹ The main emphasis is put on the migration equations³² and on those results which concern the main assumptions of the microeconomic model of the firm. Necessary conditions for the derivations of the output and employment equations are delayed price, wage, and quantity adjustments.

A main implication of delayed factor input adjustment and ex post fixed factor proportions are *procyclical* factor productivities and significant underutilizations of labour and capital. For these productivities the first order conditions, equations 15 and 16 are estimated, where possible underutilizations are captured by specific indicators. Observed productivities differ from optimal productivities by the degrees of utilization of factor inputs:

$$(y - l) = (y - l)^* + dul \quad (34)$$

$$(y - k) = (y - k)^* + duc \quad (35)$$

For the utilization of capital the respective series from the business survey of the Ifo - institute, Munich, is taken, while underutilization of labour in the firm³³ is approximated by the amount of short time working and trend deviations of overtime working. Both indicators are highly significant and the implied degrees of utilization are shown in figure 2. As expected, the utilization of labour is always higher than the utilization of capital, indicating faster adjustment of employment to demand than capital. However, labour hoarding amounts to about 2 percent or 500000 workers on average.

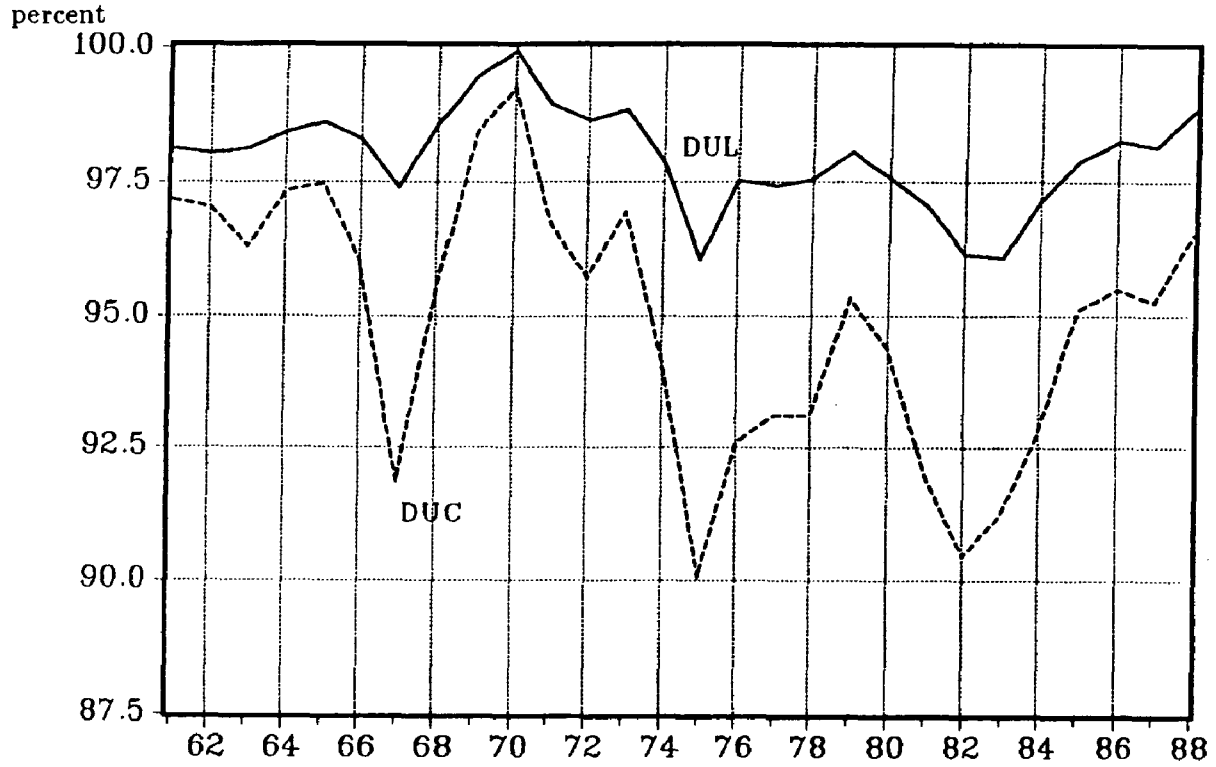
An interesting feature of the model is that it allows to calculate the weighted share of firms in the supply and demand constrained regime, which are equal to the elasticities of output to demand

³¹ The output and employment equations differ from those here, but these results are discussed here in detail. A similar model is estimated for most European countries for the conference on European unemployment, see Drèze, Bean (1990). The initial paper in this context is Sneessens, Drèze (1986).

³² A more detailed discussion of the migration equations is presented in Franz, Smolny (1990).

³³ It should be emphasized that this concerns underutilization within the firm. This differs considerably from underutilization of labour in the economy, which can be measured by the aggregate unemployment rate.

Figure 2: Utilization of labour (DUL) and capital (DUC)



and supply.

$$\frac{\partial Y_T}{\partial Y_S} \cdot \frac{Y_S}{Y_T} = \pi_{YS} = \left(\frac{Y_{LT}}{Y_T} \right)^{-\rho_Y} \quad (36)$$

$$\frac{\partial Y_T}{\partial Y_D} \cdot \frac{Y_D}{Y_T} = \pi_{YD} = \left(\frac{Y_D}{Y_T} \right)^{-\rho_Y} \quad (37)$$

π_{YS} denotes the share of supply constrained firms and π_{YD} denotes the share of demand constrained firms on the goods market. The results are contained in [figure 3](#).

The variance of these shares is rather low and indicates a rather quick adjustment of employment to demand. However, it should be noted that even these small variations imply changes in utilization of labour as shown in [figure 2](#). Further, the model is estimated using annual data and employment adjustment can be assumed to be completed to a great extent within a year.

More interesting results concern the shares of supply and demand constrained firms on the labour market.

$$\frac{\partial L_T}{\partial L_S} \cdot \frac{L_S}{L_T} = \pi_{LS} = \left(\frac{L_S}{L_T} \right)^{-\rho_L} \quad (38)$$

$$\frac{\partial L_T}{\partial L_D} \cdot \frac{L_D}{L_T} = \pi_{LD} = \left(\frac{L_D}{L_T} \right)^{-\rho_L} \quad (39)$$

Within the demand constrained regime it can be distinguished whether the existing capital stock is the binding constraint for employment or profitability aspects combined with goods demand expectations confine employment.

$$\pi_{L^*} = \left(\frac{L^*}{L_D} \right)^{-\rho_L} \cdot \pi_{LD} \quad (40)$$

Figure 3: Regime shares on the goods market

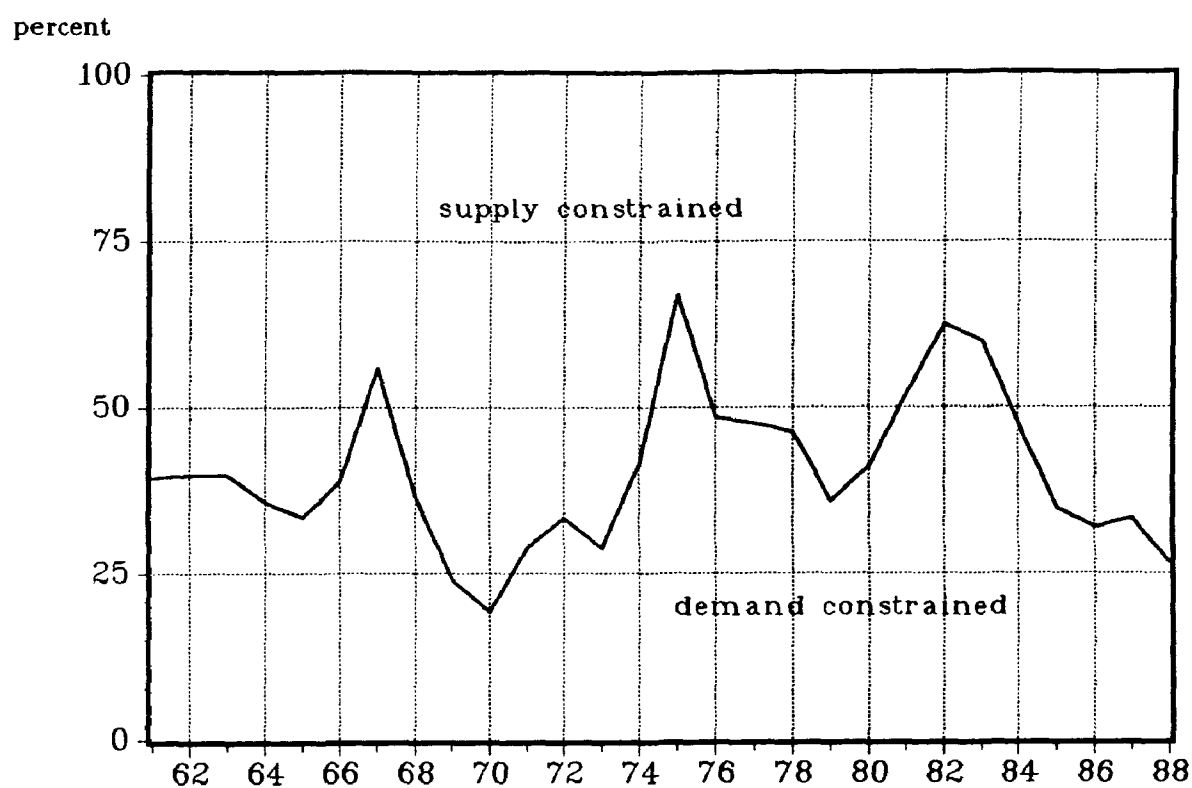
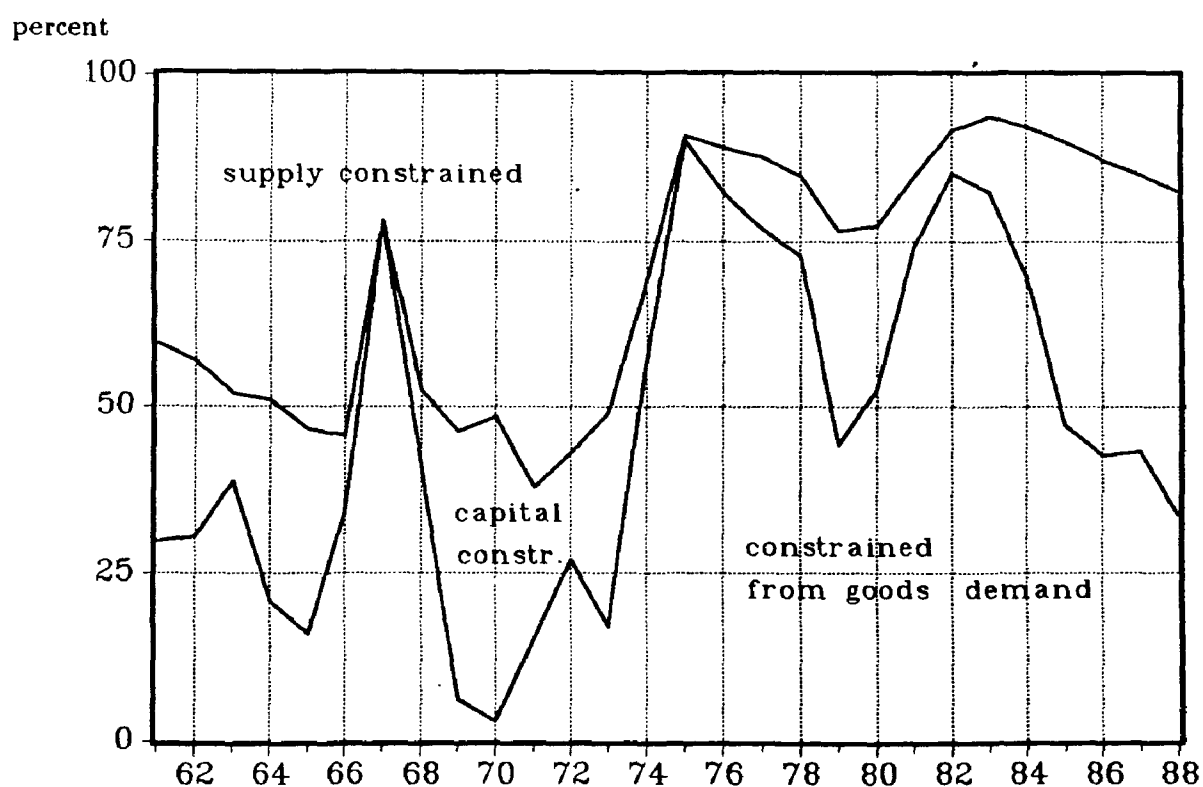


Figure 4: Regime shares on the labour market



$$\pi_{LYC} = \left(\frac{LYC}{LD} \right)^{-\rho_1} \cdot \pi_{LD} \quad (41)$$

The results are shown in figure 4.

While firms can adjust employment rather quickly to changes in goods demand, the labour market regimes are more persistent. This gives also a first indication to wage and price rigidities. In the years up to 1973, apart from the short recession 1967, the shortage of labour supply was *not* removed by wage increases, whereas since 1974 the demand constrained regime has dominated and unemployment remained high. Similiar arguments are applicable for the Keynesian situation of too low expected goods demand³⁴ since 1974, which has not been removed by price adjustment.

The figure gives a plausible impression of the economic situation prevailing in the FRG for the last 30 years: while until 1973 employment was constrained mainly by labour supply,³⁵ the low demand for goods is the main determinant for high unemployment since then. Further, a long lasting deficiency of demand leads to a reduction in capacities by lower investment, which is visible very clearly in the years 1975 until 1979 and 1982 until 1988. Also, high values of demand and utilization of capital cause a higher rate of investment which is apparent for 1970 and in the investment boom today.

The low influence of demand on prices is also evident in equation A.38, which explains the inflation rate in dependence of cost and demand factors. While a decrease in demand has a short run impact on inflation, there is no significant long run influence from the level of demand. Moreover, demand variations account only for a small fraction of price changes, while the most important contribution comes from product wages. Another remarkable result is that wages are more influenced by market pressure than prices, at least in the long run. Real wages are weakly procyclical indicating more price rigidity than wage rigidity.³⁶

Now the analysis is turned to the migration equations. The general structure of the equations has been outlined above. For the empirical application a dynamic specification has been introduced to allow for slow adjustment of migration flows to the economic determinants. For all equations a general error correction specification has been used and insignificant coefficients have been eliminated for the final versions.

A very important variable in all equations is the unemployment rate. The coefficient of the German unemployment rate is significantly different from zero in all 10 equations. Also, unemployment in the home country of the migrants contributes significantly to the explanation of the migration flows in 5 equations, but the coefficients are mostly much smaller. Further, the labour market situation is more important for immigration than for remigration. A structural break for the immigration equation accounting for the immigration stop 1974 is found for Greece, Spain, and Yugoslavia and is not evident for inflows from Turkey. Surprisingly high is the coefficient of lagged immigrations on remigration. The respective coefficients imply that 20 to 50 percent of immigrants leave the FRG in the following year.³⁷

After describing the determinants of migration decisions, the analysis now focusses on the consequences of migration for the economic development in the FRG. Direct effects of migration and labour supply are mostly visible on wages and prices. A direct effect on the factor productivities is not revealed, there is only the indirect effect via the influence on relative factor prices. Finally, there is a weak positive effect of higher inflows of guest workers on investment.

7 Simulation results

So far only the direct effects on macroeconomic variables have been considered. The total effect, however, can be determined by simulating the model. Here the results of two simulations will be presented. The first is a reduction of immigration flows during a situation of labour shortages at

³⁴ Profitability is not important for the determination of L^* , i.e. the coefficient of the share of labour s_l was not significantly different from zero.

³⁵ Again with the exception of the short recession 1967.

³⁶ This result is not specific for Germany, but has also been found for the United States, see e.g. Blanchard (1987).

³⁷ This interpretation of the coefficient is not clear, because we do not know whether this are the same persons who leave the FRG.

Figure 5: Simulation I: labour supply and employment

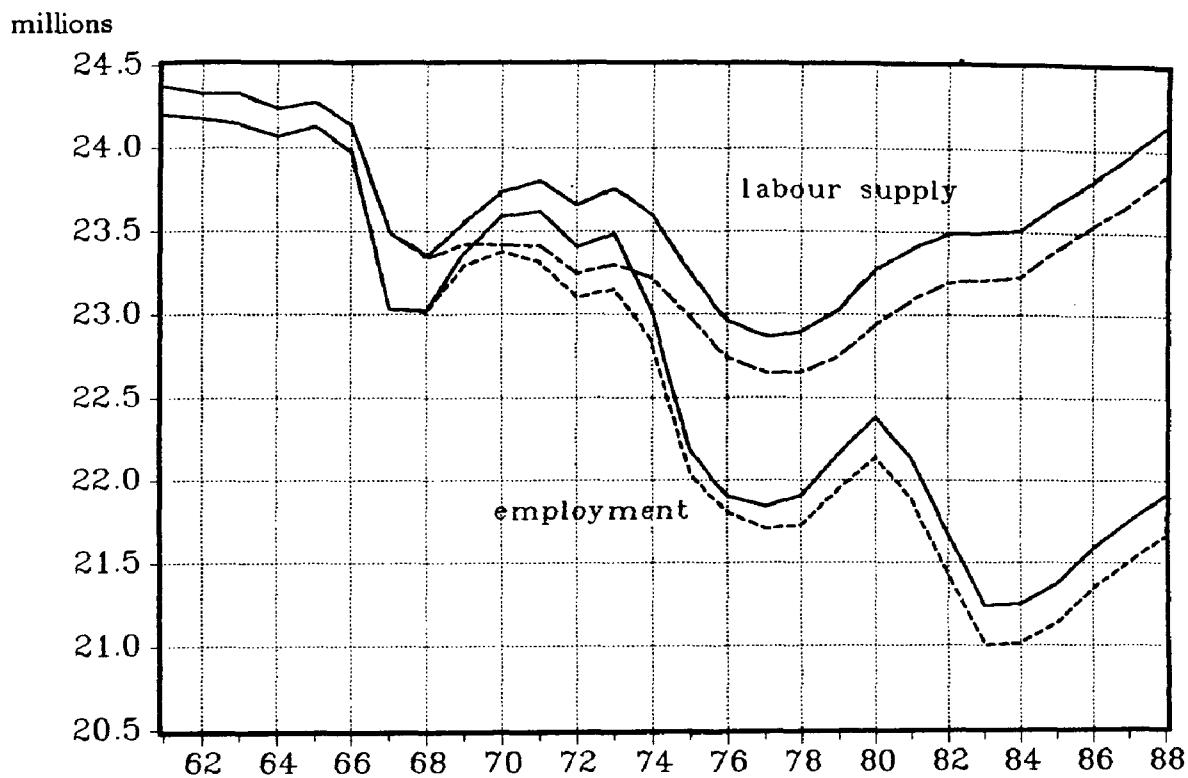


Figure 6: Simulation I: regime shares on the labour market

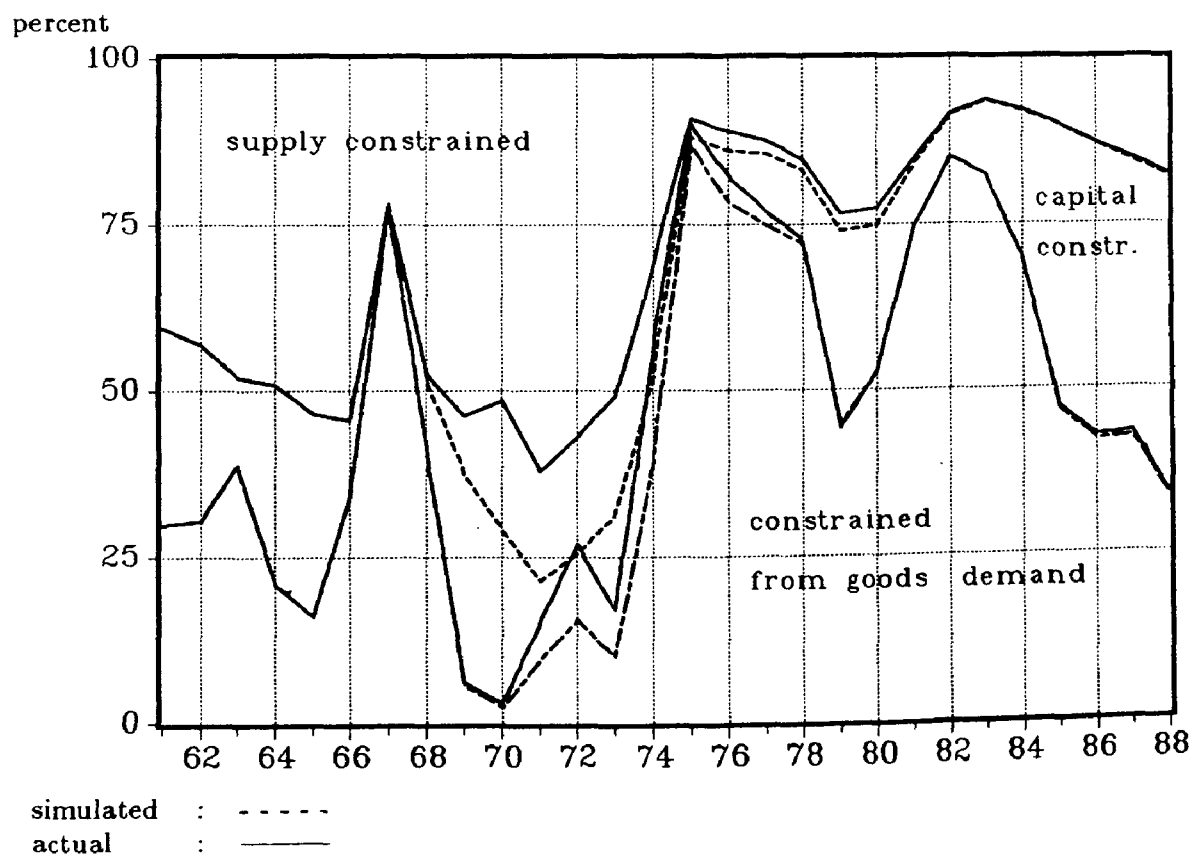
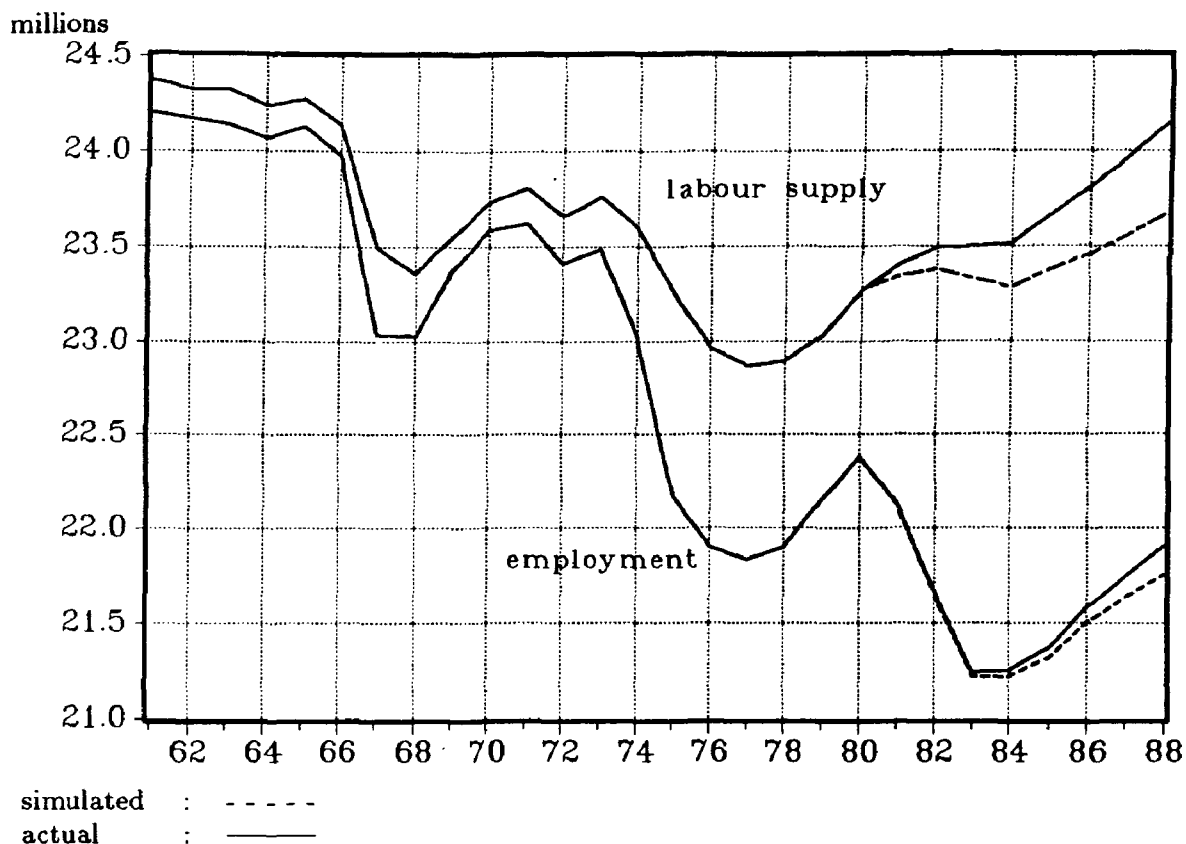


Figure 7: Simulation II: labour supply and employment



the end of the sixties and the beginning of the seventies, i.e. the effects of a immigration stop for non EC - migrants starting already in 1968 (instead of 1973) have been calculated. Immigration flows are limited to the average level from 1962 - 1966. The consequences can be demonstrated by the following two figures. Figure 5 shows the effect of reduced immigration on labour supply and employment. One can see very clearly the enforced reduction in employment at the beginning of the seventies. Also impressive is the lower level of employment even after 1974, since then labour supply was no longer the binding constraint for employment.

A further impression of the model is given by figure 6. At the beginning of the seventies the supply constrained regime was dominating for the labour market with important consequences for wages and prices. Simulated wage increases are higher from 1971 to 1974 by about 1.5 percentage points and caused price inflation by a somewhat lower amount, implying a higher real wage. This induced capital - labour substitution and increased the productivity of labour. This gives a partial explanation of the lasting employment effect. Further, the direct negative impact on investment and the indirect multiplier - accelerator effects have reduced demand as well as capacities. The economy embarked on a lower growth path: from 1970 to 1972 output has been lower by about one percentage point. In the long run output increases nearly to the actual level. However, it should be noted that in this model long run consequences concerning output, employment and productivity are much more uncertain than short run impacts. Technical progress is assumed to be exogenous and no effects of e.g. investment on productivity are taken into account.

These results, of course, are not comparable to the current situation with high unemployment and excess supply on the labour market. Therefore a second simulation with *hypothetical* reduction of labour supply for the beginning of the eighties is analyzed. The size of the supply shock has been chosen comparable with the first simulation. The results can be seen in figure 7.

The consequences for employment are much more smaller. Even the simulated reduction of labour supply of 500000 (1988) has caused a reduction of employment of only 150000 workers

(1988). There was virtually no change in wages and prices and output losses are negligible. Formulated differently, an increase of labour supply during a situation of high unemployment does hardly affect employment.

8 Conclusions

A macroeconomic disequilibrium model has been estimated and the results imply that short run wage/price rigidities and quantity adjustments are important features of the economic development in the Federal Republic of Germany. The period until 1973 can be characterized by the importance of supply shortages on the labour market, while since 1974 expected goods demand is the main determinant of employment. Long lasting deficiencies of demand have also caused a downward adjustment of the capital stock. Despite the preliminary nature of these results some policy implications of the analysis can be drawn. First, high immigration flows to the FRG at the end of the sixties and the beginning of the seventies have increased output and employment while decreasing demand pressure and thus wage and price inflation. On the other hand, a sole increase of the supply of labour in a situation of high unemployment hardly affects output and employment. However, it has been shown elsewhere³⁸ that the existence of wage and price rigidities leaves room for fiscal and monetary policy to reduce unemployment. Especially a policy focussing on stimulating investment will have positive effects via its short run impacts on demand and via the long run creation of capacities. Further, in a situation of deficient demand on the goods and labour market the effect on price and wage inflation is small.

It should be noted, however, that investment and the creation of capacities react only slowly to policy measures due to long adjustment delays for capital stock adjustment. While labour supply is quickly increasing and correspondingly unemployment persists, at the end of the eighties capital utilization is high and the capital constrained regime has become increasingly important.

Further, one has to hesitate in drawing strong policy conclusions in the current situation with its apparently significant structural changes in the economy. The economic consequences of the reunification of East and West Germany are uncertain. Neither the outcome of the policy measures already implemented like the monetary union, nor the way the remaining important questions will be addressed, like the necessary amount of public investment in East Germany due to the deficiencies of the infrastructure there and the process of merging the social security systems, can be predicted with accuracy. Therefore no credible policy advice for the current situation in the FRG can be derived from the analysis.

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³⁸ Confer Entorf, Franz, König, Smolny (1988)

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APPENDIX

Variable list

Y	: output, real, private sector
L	: employment, private sector
K	: capital stock, real, private sector
K_v	: stock of inventories
YD	: demand for goods
LS	: labour supply
DUL	: utilization of labour
DUC	: utilization of capital
H^o	: indicator for labour hoarding, based on overtime working
H^s	: indicator for labour hoarding, based on short time working
Q_{ifo}	: utilization of capital for industry, business survey, Ifo-Institut, Munich
Q_a	: indicator of demand pressure on the world market, weighted sum of utilization of main competitors
I	: investment, real, private sector
V	: inventory investment, real
C	: private consumption, real
DI	: disposable income, real
M	: imports, excluding materials, real
M_r	: imports of materials, real
X	: exports, real
UR^i	: unemployment rate in country i , no index for Germany
W	: wage costs
W_n	: net wage rate
P	: output price
P_i	: price of investment goods
P_m	: price of imports excluding materials
P_{mr}	: price of imported materials
P_{mt}	: price of total imports
P_a	: export price of main competitors
SK	: share of capital in value added at full utilization of capacities $SK = (R - \Delta p + \delta) \cdot \frac{P_i}{P} \cdot \left(\frac{K}{Y}\right)^*$
R	: long run interest rate
Z^i	: immigration from county i
F^i	: remigration to country i
Pop^i	: foreigners in the FRG, from country i
EQ^a	: labour force participation, foreigners
EQ^d	: labour force participation for Germans

A Results of estimation

A.1 Technology

A.1.1 Productivity of labour and capital

$$(y - l)_t^* = 0.37^* \cdot [1.99^* + 0.28 \cdot (w - p)_t + 0.05^* \cdot t - 0.001^* \cdot t^2] + (1 - 0.37^*) \cdot (y - l)_{t-1}^* \quad (\text{A.1})$$

$$(y - k)_t^* = 0.37^* \cdot [-3.02 + 0.28 \cdot (p_t - p)_t - 0.008 \cdot t - 0.0001 \cdot t^2] + (1 - 0.37^*) \cdot (y - k)_{t-1}^* \quad (\text{A.2})$$

t : trend

A.1.2 Utilization of labour and capital

$$(y - l) = (y - l)^* + dul \quad (\text{A.3})$$

$$(y - k) = (y - k)^* + duc \quad (\text{A.4})$$

$$dul = 0.49^* \cdot h^s + 0.66 \cdot (h^o - h^{o^{max}}) \quad (\text{A.5})$$

$$duc = 0.54^* \cdot (q_{ifo} - q_{ifo}^{max}) \quad (\text{A.6})$$

A.1.3 Capacity

$$K_t = (1 - \delta) \cdot K_{t-1} + I_t \quad (\text{A.7})$$

$$YC = K \cdot \left(\frac{Y}{K} \right)^* \quad (\text{A.8})$$

δ : depreciation rate

Small case letters denote logs.

Coefficients with a star indicate significance at the five percent level.

Annual data from 1960 - 1988

A.2 Demand

$$YD = C + I + V + XD - MD - MR + G + \text{housing investment} \quad (\text{A.9})$$

G : governmental expenditure

A.2.1 Investment

$$\begin{aligned} \left(\frac{I_t}{K_{t-1}} \right) = & 1.30^* + 0.11^* \cdot \Delta y_t^m - 0.01^* \cdot \Delta sk_t + 0.01^* \cdot t - 0.0001 \cdot t^2 \\ & - 0.18^* \cdot [k - 0.28 \cdot y^m - 0.03 \cdot sk]_{t-1} + 0.71^* \cdot \left(\frac{I_t}{K_{t-1}} \right)_{t-1} \end{aligned} \quad (\text{A.10})$$

$$Y^m = \left\{ YD^{-\rho} + Y_{LS}^{-\rho} + Y_{L^*}^{-\rho} \right\}^{-1/\rho} \quad (\text{A.11})$$

A.2.2 Inventory investment

$$\begin{aligned} \left(\frac{V_t}{K_{vt-1}} \right) = & -0.38 + 1.15^* \cdot \Delta y_{vt} + 0.008 \cdot t - 0.0002 \cdot t^2 \\ & - 0.26^* \cdot [k_v - 1.01^* \cdot y_{vt}]_{t-1} + 0.25^* \cdot \left(\frac{V_t}{K_{vt-1}} \right)_{t-1} \end{aligned} \quad (\text{A.12})$$

A.2.3 Consumption

$$C_t = 0.59^* \cdot (69.90^* + .87^* \cdot DI_t - 6.73^* \cdot r_t + 2.85^* \cdot \Delta lt_t) + (1 - 0.59^*) \cdot C_{t-1} \quad (\text{A.13})$$

$$DI_t = \alpha_t \cdot YT_t \quad (\text{A.14})$$

A.2.4 Trade

Imports excluding materials

$$\begin{aligned} md_t = & 0.60^* \cdot [-11.10^* + 2.00^* \cdot y_{vt} + 0.78^* \cdot (p - p_m)_t] - 0.04^* \cdot q_{a,t} \\ & + (1 - 0.60^*) \cdot (md - 0.04^* \cdot q_a)_{t-1} \end{aligned} \quad (\text{A.15})$$

$$m = md + 0.56^* \cdot (q_{ifo} - q_{ifo}^{min}) \quad (\text{A.16})$$

Imports of materials

$$\begin{aligned} \Delta mr_t = & -4.13 + 2.01^* \cdot \Delta y_{vt} + 0.02 \cdot \Delta (p - p_{mr})_t \\ & - 0.10 \cdot [mr - 1.19^* \cdot y_{vt} - 0.32 \cdot (p - p_{mr})]_{t-1} \end{aligned} \quad (\text{A.17})$$

Exports

$$\begin{aligned} xd_t = & 0.36^* \cdot [7.00^* + 1.007^* \cdot wt_t - 0.81^* \cdot (p - p_a)_t] + 0.03 \cdot q_{a,t} \\ & + (1 - 0.36^*) \cdot (xd - 0.03 \cdot q_a)_{t-1} \end{aligned} \quad (\text{A.18})$$

$$x = xd - 0.53^* \cdot (q_{ifo} - q_{ifo}^{min}) \quad (\text{A.19})$$

A.3 Output, Utilization and Regime Shares on the Goods Market

A.3.1 Output

$$YT = \left\{ Y_{LT}^{-\rho_y} + (1.008^* \cdot YD)^{-\rho_y} \right\}^{-1/\rho_y} \quad (\text{A.20})$$

$$\rho_y = 32.78^* - 0.44 \cdot t + 0.0015 \cdot t^2 \quad (\text{A.21})$$

$$Y_{LT} = \left(\frac{Y}{L} \right)^* \cdot LT \quad (\text{A.22})$$

A.3.2 Utilization

$$DUL = \frac{YT}{Y_{LT}} \quad (\text{A.23})$$

$$DUC = \frac{YT}{YC} \quad (\text{A.24})$$

A.3.3 Regime shares

$$\pi_{YS} = \left(\frac{Y_{LT}}{YT} \right)^{-\rho_y} \quad (\text{A.25})$$

$$\pi_{YD} = \left(\frac{1.008^* \cdot YD}{YT} \right)^{-\rho_y} \quad (\text{A.26})$$

A.4 Employment, Labour Market Regimes

A.4.1 Employment

$$LT = \left\{ LS^{-\rho_l} + LD^{-\rho_l} \right\}^{-1/\rho_l} \quad (\text{A.27})$$

$$LD_t = \left\{ \left[LD_t^{*- \rho_l} + (1.10^* \cdot LT_{t-1})^{-\rho_l} \right]^{-1} + (0.962^* \cdot LT_{t-1})^{\rho_l} \right\}^{\rho_l} \quad (\text{A.28})$$

$$LD^* = \left\{ (1.004^* \cdot L_{YD})^{-\rho_l} + L_{YC}^{-\rho_l} \right\}^{-1/\rho_l} \quad (\text{A.29})$$

$$\rho_l = -126.3^* + 5.96^* \cdot t - 0.08^* \cdot t^2 \quad (\text{A.30})$$

$$L_{YC} = YC \cdot \left(\frac{L}{Y} \right)^* \quad (\text{A.31})$$

$$L_{YD} = YD \cdot \left(\frac{L}{Y} \right)^* \quad (\text{A.32})$$

A.4.2 Regime shares

$$\pi_{LS} = \left(\frac{LS}{LT} \right)^{-\rho_l} \quad (\text{A.33})$$

$$\pi_{LD} = \left(\frac{LD}{LT} \right)^{-\rho_l} \quad (\text{A.34})$$

$$\pi_{LYD} = \left(\frac{1.004^* \cdot L_{YD}}{LD} \right)^{-\rho_l} \cdot \pi_{LD} \quad (\text{A.35})$$

$$\pi_{LYC} = \left(\frac{L_{YC}}{LD} \right)^{-\rho_l} \cdot \pi_{LD} \quad (\text{A.36})$$

A.5 Wages and Prices

$$\Delta w_t = -0.04^* + 1.10^* \cdot \Delta p_t + 0.72^* \cdot \Delta(y-l)_t^* + 0.07^* \cdot \Delta(p_{mt} - p)_t + 0.04^* \cdot D_{70} \quad (A.37)$$

$$+ 0.06^* \cdot \Delta \pi_{LS_t} + 0.06^* \cdot \pi_{LS_{t-1}} + 0.18^* \cdot \Delta w_{t-1}$$

$$\Delta p_t = 0.007^* + 0.44^* \cdot \Delta(w - (y - l))_t + 0.50^* \cdot \Delta tax + 0.05^* \cdot \Delta(p_{mt} - p)_{t-1} \quad (A.38)$$

$$- 0.02^* \cdot \Delta \pi_{LYD_t} + 0.40^* \cdot \Delta p_{t-1}$$

D_{70} : dummy, 1970 = 1

tax : value added tax rate

A.6 Labour supply

A.6.1 Migration

Immigration

$$Z_t^I = 115.9^* - 31.52^* \cdot \Delta UR_t + 27.5^* \cdot UR_t^I + 2.5 \cdot \Delta W_t^{diff} \quad (A.39)$$

$$+ 0.53^* \cdot Z_{t-1}^I + 3.3^* \cdot W_{t-1}^{diff} - 8.13^* \cdot UR_{t-1}$$

$$Z_t^E = (53.9^* - 43.67^* \cdot \Delta UR_t + 7.3^* \cdot \Delta UR_t^E + 0.38^* \cdot Z_{t-1} - 24.13^* \cdot UR_{t-1}) \quad (A.40)$$

$$\cdot (1 - D_{7486}) + (-5.3^* + 0.05 \cdot Pop_{t-1}^E) \cdot D_{7486}$$

$$Z_t^{Gr} = (-5.0 - 36.70^* \cdot \Delta UR_t + 0.78^* \cdot Z_{t-1}^{Gr} + 4.3 \cdot UR_t^{Gr}) \cdot (1 - D_{7486}) \quad (A.41)$$

$$+ (-0.7 + 0.05 \cdot Pop_{t-1}^{Gr}) \cdot D_{7486}$$

$$Z_t^T = 23.1^* - 41.40^* \cdot \Delta UR_t + 13.1 \cdot \Delta UR_t^T + 72.9^* \cdot D_{73} + 0.83^* \cdot Z_{t-1}^T \quad (A.42)$$

$$Z_t^{YU} = (-259.7^* - 71.54^* \cdot UR_t + 53.6^* \cdot UR_t^{YU} + 0.52^* \cdot Z_{t-1}^{YU}) \cdot (1 - D_{7486}) \quad (A.43)$$

$$+ (-88.6 + 0.20 \cdot Pop_{t-1}^{YU}) \cdot D_{7486}$$

W^{diff} : relative wage difference, Italy and FRG

D_{7488} : dummy (1974-1988) = 1

Indices: I : Italy, E : Spain, Gr : Greece, T : Turkey, YU : Yugoslavia

Remigration

$$F_t^I = 47.1^* + 5.77^* \cdot UR_t - 7.3^* \cdot UR_t^I + 0.28^* \cdot F_{t-1}^I + 0.52^* \cdot Z_{t-1}^I \quad (A.44)$$

$$F_t^E = -5.1 + 3.81^* \cdot UR_t - 1.1^* \cdot UR_t^E + 0.54^* \cdot F_{t-1}^E + 0.46^* \cdot Z_{t-1}^E \quad (A.45)$$

$$F_t^{Gr} = -0.3 + 9.09^* \cdot \Delta UR_t - 4.2 \cdot \Delta UR_t^{Gr} + 0.71^* \cdot F_{t-1}^{Gr} + 0.22^* \cdot Z_{t-1}^{Gr} \quad (A.46)$$

$$F_t^T = -9.9 + 17.06^* \cdot \Delta UR_t - 9.4 \cdot \Delta UR_t^T + 0.44^* \cdot F_{t-1}^T + 0.22^* \cdot Z_{t-1}^T + 153.2^* \cdot D_{84} \quad (A.47)$$

$$F_t^{YU} = 4.6^* + 2.67^* \cdot \Delta UR_t + 0.61^* \cdot F_{t-1}^{YU} + 0.22^* \cdot Z_{t-1}^{YU} \quad (A.48)$$

D_{84} : dummy, 1984 = 1

A.6.2 Population

$$Pop^A = Pop^I + Pop^E + Pop^{Gr} + Pop^T + Pop^{YU} + Pop^{const} \quad (A.49)$$

$$Pop_t^I = 0.750^* \cdot (Z^I - F^I)_t + (1 - 0.750^*) \cdot (Z^I - F^I)_{t-1} + 1.012^* \cdot Pop_{t-1}^I \quad (A.50)$$

$$Pop_t^E = 0.699^* \cdot (Z^E - F^E)_t + (1 - 0.699^*) \cdot (Z^E - F^E)_{t-1} + 1.018^* \cdot Pop_{t-1}^E \quad (A.51)$$

$$Pop_t^{GR} = 0.660^* \cdot (Z^{GR} - F^{GR})_t + (1 - 0.660^*) \cdot (Z^{GR} - F^{GR})_{t-1} + 1.027^* \cdot Pop_{t-1}^{GR} \quad (A.52)$$

$$Pop_t^T = 0.693^* \cdot (Z^T - F^T)_t + (1 - 0.693^*) \cdot (Z^T - F^T)_{t-1} + 1.030^* \cdot Pop_{t-1}^T \quad (A.53)$$

$$Pop_t^{YU} = 0.759^* \cdot (Z^{YU} - F^{YU})_t + (1 - 0.759^*) \cdot (Z^{YU} - F^{YU})_{t-1} + 1.015^* \cdot Pop_{t-1}^{YU} \quad (A.54)$$

A.6.3 Labour force participation

$$LS = LS^a + LS^d \quad (A.55)$$

$$LS^a = EQ^a \cdot Pop_{1565}^a \quad (A.56)$$

$$LS^d = EQ^d \cdot Pop_{1565}^d \quad (A.57)$$

$$Pop_{1565}^a = \beta_t^a \cdot Pop^a \quad (A.58)$$

$$Pop_{1565}^d = \beta_t^d \cdot Pop^d \quad (A.59)$$

$$EQ_t^a = -5.88^* - 1.1 \cdot UR_t + 0.5^* \cdot (wn - p)_t + 2.11^* \cdot \left(\frac{Pop^m}{Pop^a} \right)_t + 0.42^* \cdot EQ_{t-1}^a \quad (A.60)$$

$$\Delta EQ_t^d = 0.87^* - 0.22^* \cdot UR_t - 0.07^* \cdot (wn - p)_t + 0.17^* \cdot t - 0.27^* \cdot EQ_{t-1}^d + 0.33 \cdot \Delta EQ_{t-1}^d \quad (A.61)$$

Pop_{1565} : population aged 15 - 65, a: foreigners, g : Germans

Pop^m / Pop^a : share of males in foreign population