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Investment and employment adjustment after unification : some results from a macroeconometric disequilibrium model

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Discussion Paper No.99-56

Investment and Employment Adjustment after Unification:

Some Results from a Macroeconometric Disequilibrium Model

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JEL Classification: C51, E22, E24

Non-technical summary:
Unification had a fundamental impact on the macroeconomic development in East Germany. In 1990 output broke down dramatically and until 1992 about one third of the former jobs in East Germany were lost. In the following years, output slowly recovered, but employment hardly increased until 1999. Unemployment remained above 1 million since 1991.
In this paper, a model of the firm acting on a monopolistically competitive market leads to an aggregate model which can be used to classify developments on labour and goods market in Germany. Our estimates are based on this aggregate disequilibrium model formerly developed for West Germany. After unification it was updated to cover unified Germany. In this study we concentrate on the above mentioned macroeconomic shock and particularly focus on investment and employment adjustment.
The economic and monetary union resulted in a favourable exchange rate for labour incomes and monetary assets for the East German private households. At the same time, these conditions imposed on wages and debt deteriorated the competitiveness of East German products. Consequently, demand for East German products broke down and demand shifted to "imports" from West Germany. The effects of the resulting enormous demand increase in West Germany on the labour market are analysed. Employment is divided into demand determined employment and capacity determined employment. Demand employment rose significantly after unification while capacity employment fell short of labour supply. Hence, capacity constraints dominated the development of labour in the West. Recession in 1992/93 reduced demand employment. After this, demand employment was on a lower level, and capacity employment in unified Germany shrank because of the strong depreciation of the East German capital stock.
East Germany differs markedly from West Germany at least for the first years after unification. Prior to mid 1990, employment remained at its full employment level and fell much slower than output up to 1991 indicating labour hoarding. The fall in labour supply reflects intra-national labour mobility, early retirements and changes in individual labour supply decisions. Capacities influenced the level of employment to a much smaller extent in East Germany than in West Germany. Changes in the mismatch on the labour market and employment adjustment are less pronounced.
Investment behaviour after unification is different. The larger adjustment parameter in the East indicates that these differences mainly have to be attributed to the specifics of investment in East Germany. One reason is the fast replacement of the old capital stock by modern technology. Another reason is that investment was highly driven by governmental incentives.
To sum up, our results reveal that the adjustment of investment and employment can be analysed with the same theoretical model for West and East Germany.

Abstract:
The macroeconomic development in West Germany in the aftermath of unification was characterized by a boom period in 1990/1991, a deep recession in 1992/1993 and a slow recovery since then. In East Germany, in contrast, unification induced a breakdown of production and employment followed by a slow recovery starting in 1992.

In this paper, a macroeconometric model is used to assess this development. In particular, estimation results for investment and employment adjustment after unification are reported. The estimates are based on a disequilibrium model formerly developed for West Germany and extended in this paper to cover also unified Germany.

The results reveal that the adjustment of investment and employment can be analysed with the same theoretical model for West and East Germany. However, the adjustment speed for investment differs significantly at least in the early years after unification, while changes in the mismatch on the labour market and employment adjustment are less pronounced.

Zusammenfassung:
Die makroökonomischen Auswirkungen der Wiedervereinigung in Westdeutschland schlugen sich in einem exorbitanten Boom in den Jahren 1990/1991, einer tiefen Rezession in den Jahren 1992/1993 und einer darauffolgenden konjunkturellen Erholung nieder. In Ostdeutschland kam es dagegen zunächst zu einem Zusammenbruch der Produktion und einem rapiden Rückgang der Beschäftigung. Erst 1992 setzte dort der Prozess der wirtschaftlichen Erholung ein.
In diesem Beitrag wird ein makroökonometrisches Modell zur Analyse dieser Entwicklung verwendet. Der Schwerpunkt liegt dabei auf den Anpassungsvorgängen bei Investitionen und Beschäftigung. Die Schätzungen basieren auf einem Ungleichgewichtsmodell, das für Westdeutschland entwickelt und nach der Wiedervereinigung auf Gesamtdeutschland ausgeweitet wurde.
Als Ergebnis kann festgehalten werden, dass Investitionen und Beschäftigung für West- und Ostdeutschland auf der Grundlage des gleichen theoretischen Modells analysiert werden können. Während sich in den ersten Jahren nach der Wiedervereinigung in den Anpassungsgeschwindigkeiten der Investitionen signifikante Unterschiede zeigen, sind die Veränderungen beim Mismatch auf dem Arbeitsmarkt sowie die Anpassung der Beschäftigung weniger stark ausgeprägt.

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1 Introduction

Unification fundamentally changed the social and economic living conditions of the people in East Germany. In 1990, output broke down by about 40 percent, and until 1992, about one third of the former jobs in East Germany were lost. In the following years, output slowly recovered, but employment hardly increased until 1999. Unemployment figures remained above 1 million since 1991 which corresponds to unemployment rates of nearly 20 percent.

Unification also dominated the economic development in West Germany in the nineties. During the unification boom at the beginning of the nineties, economic growth amounted to about 6 percent per year; corresponding growth rates were formerly achieved only in the late sixties.[1] In addition, West German employment increased by about 2 millions from late 1989 until 1991. A corresponding increase of jobs was formerly achieved only in the fifties during post-war reconstruction. However, the West German unification boom was terminated by a deep recession late 1991 with output reductions until 1993. Employment declined by 1.5 millions and unemployment increased to more than 3 millions until 1998. Together with the still high unemployment in East Germany, the total unemployment figure is above 4 millions in the most recent past, corresponding to an unemployment rate of about 12 percent.

In this paper, it is argued that this development, to a large extent, can consistently be understood in terms of macroeconomic disequilibrium adjustment. In particular, the paper presents estimates for employment adjustment and investment based on a macroeconometric disequilibrium model formerly developed for West Germany and extended in this paper to cover also the unified Germany.

Unification hit the West German economy in a prosperous period with annual economic growth of about 4 percent in 1988/89. Employment had increased steadily since 1984 with a growth rate of about 1 percent in 1988/89. Industrial capacity utilization had achieved a level as high as in the early seventies, and private investment increased steadily. Growth perspectives were generally good; for instance, the business survey of the ifo institute reported that more firms expected an improvement of their business situation than expected a worsening since 1988. Unification further enhanced optimism, and the public opinion was that the opening of the Wall would initiate a catching-up process in East Germany corresponding to West German post-war reconstruction.

However, it soon became apparent that unification would impose severe costs especially in East Germany. The terms of the monetary union, especially the exchange rates for labour incomes, debts and property, implied a sharp appreciation of the East German currency. Unit labour costs and prices increased and deteriorated the competitiveness of East German products. Demand broke down

[1] Some historical data for East and West Germany are provided in figure 4 in the appendix.

rapidly and GDP was quite below the pre-unification level. Employment adjusted only slowly which, given the decrease in output, led to a further increase of unit labour costs. Demand in East Germany was stabilized mainly by public transfers from West Germany – public investment, income of public employees, unemployment benefits, increasing real retirement benefits – and heavily subsidized private investment, both for enterprises and for private housing. In the sequel, massive dismissals increased the utilization of employment and reduced unit labour costs. The high investment further contributed to the increase of labour productivity by capital deepening and technology transfers, and since 1993, East Germany is on a steady but painfully slow process of adjustment with respect to the West.

The most remarkable single aspect of the unification boom in West Germany is the increase of demand from East Germany since 1990. This demand increase – i.e. West German "exports" towards East Germany – was financed largely by public transfers and amounted to about 200 billions DM per year in the early years after unification. In 1990/91, West German output rose by about 6 percent and employment increased by about 3 percent per year. Since the West German economy was in a prosperous phase already in 1989, the demand increase led to a further increase of investment. However, the financing of the costs of unification increased interest rates as well as the tax burden and led to a slower increase of private spending later on. In addition, exports towards the "rest of the world" had become smaller since 1990. The unification boom had increased capacities, therefore the slowdown of demand reduced capacity utilization and led to a reduction of investment. The massive reduction of investment contributed to the slowdown of demand, and in 1992, the West German economy experienced a severe recession. The rather low growth rates of output of about 2 percent since 1994 were too small to stop the reduction of employment, and in 1997, the whole unification increase of employment was lost.

In this paper, it is analysed to what extent the specific development of East and West Germany after unification can be explained by macroeconomic reasoning based on an empirical macro model. In Section 2, the theoretical model is discussed. The model is characterized by imperfect competition on the product market, demand uncertainty and short-run capacity constraints. In particular, the model encompasses both Keynesian and classical mechanisms and the importance of demand and supply factors is determined endogenously. A special emphasis is placed on the medium-run employment adjustment and the long-run adjustment of investment and capacities. In Section 3, the estimation results are discussed, and Section 4 concludes.

2 Theoretical model

2.1 Assumptions

The macroeconomic disequilibrium model is built on a microeconomic model of firm behaviour. Within the microeconomic analysis, a market is defined by the supply of a single firm and the demand for the firm's product. In the sequel, an aggregation procedure is discussed to derive implications for macroeconomic relations.

In the theoretical model, it is assumed that firms adjust capacities and the production technology only with a delay with respect to demand and cost changes, thus under uncertainty about demand. This assumption reduces the dynamic decision problem of the firm to a sequence of static decision models which can be solved stepwise:

- The determination of output, prices and employment takes place in the short run, with predetermined capacities and production technology.
- Capacities and the production technology are determined in the long run; therefore both variables can be treated as predetermined for the short- and medium-run adjustment. The investment decision takes the expected optimal adjustment of output, prices and employment into account.

The theoretical analysis is carried out within a framework of imperfect competition on the product market.[2] In order to distinguish demand shifts, the price elasticity of demand and demand uncertainty, a log-linear demand curve is assumed,

$$\ln YD = \eta \cdot \ln p + \ln Z + \varepsilon, \quad \eta < -1, \mathrm{E}(\varepsilon) = 0, \mathrm{Var}(\varepsilon) = \sigma^2. \tag{1}$$

The time and firm indices are omitted to simplify the notation. Demand YD depends on the price p with elasticity η, on exogenous demand shifts Z and on a demand shock ε which is not known at the time of the investment decision. Supply YS is determined by a short-run limitational production function with capital K and labour L as inputs,

$$YS = \min(YC, YL) = \min(\pi_k \cdot K, \pi_l \cdot L), \quad \pi_l = \pi_l(k, \theta), \pi_k = \pi_k(k, \theta). \tag{2}$$

YC are capacities, YL is the employment constraint and π_l, π_k are the productivities of labour and capital. The factor productivities are determined by the capital-labour ratio k and production efficiency θ. The factor prices are assumed to be exogenous at the firm level. These assumptions imply constant marginal costs within the capacity limit in the short run.

[2] See e.g. Barro (1972) and Dixit, Stiglitz (1977). The model is basically a variant of the model of Hall (1986).

2.2 Output, prices and employment

The short-run optimization problem of the firm can be written as

$$\max_{\rightarrow p,Y,L} \; p \cdot Y - w \cdot L - c \cdot K \quad \text{s.t.} \quad Y \leq \{YC, YL, YD\}. \tag{3}$$

In this notation, w are wages and c are the user costs of capital. For the optimal solution, two cases can be distinguished:

1. In case of sufficient capacities, the optimal price is determined by unit labour costs and the price elasticity of demand. Output results from introducing this price into the demand function, and employment is the labour input required to produce this output.

$$p(w) = \frac{w}{\pi_l \cdot (1 + 1/\eta)}, \tag{4}$$

$$\ln Y(w) = \eta \cdot \ln p(w) + \ln Z + \varepsilon \quad \text{and} \quad L(w) = Y(w)/\pi_l. \tag{5}$$

2. In case of capacity shortages, optimal output is equal to the capacity constraint. Employment is again given as the corresponding labour requirement, and the optimal price results from solving the demand function for p at $YD = YC$.

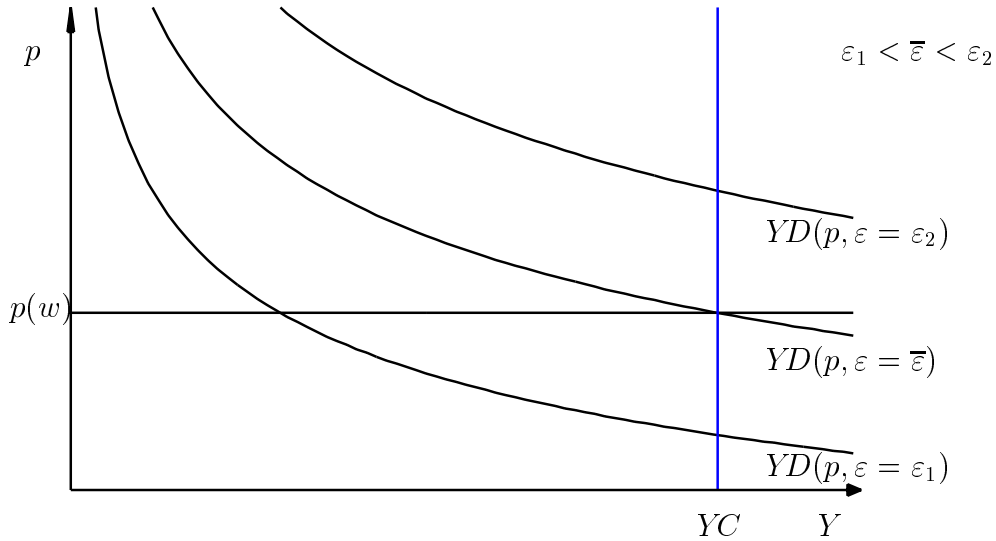
$$Y = YC, \quad L(YC) = YC/\pi_l, \tag{6}$$

$$\ln p(YC) = (\ln YC - \ln Z - \varepsilon)/\eta. \tag{7}$$

Figure 1 provides a visual impression of the model. For a negative demand shock $\varepsilon_1 < \overline{\varepsilon}$, the price is determined by unit labour costs; the mark-up is determined by the price elasticity of demand. The firm suffers from underutilization of capacities. For a positive demand shock $\varepsilon_2 > \overline{\varepsilon}$, insufficient capacities restrain output, and the firm increases the price. $\varepsilon = \overline{\varepsilon} = \ln YC - \eta \cdot \ln p(w) - \ln Z$ is the borderline case which distinguishes these cases. The most important characteristics of the model are the minimum price $p(w)$ and the capacity limit YC. The supply curve of the firm is horizontal within the borders of capacity and vertical at the capacity limit. The optimal price is determined either by unit labour costs and the degree of competition on the market or by the relation of the levels of demand and capacity; optimal output and employment are determined either by unit labour costs and the level of demand or by capacities.

Note the implied asymmetry of the price and quantity adjustment. For demand increases, the adjustment of output and employment is bounded by capacities, and the price rises instead. For demand reductions, the price adjustment is bounded

Figure 1: Price and quantity adjustment



by marginal costs and the price elasticity of demand, and output and employment are reduced instead. A similar asymmetry results for cost changes.

The model can be extended by introducing a delayed adjustment of prices and employment. In this case, the firm sets prices and employment under uncertainty about demand, i.e. the firm chooses one point in the $\{p, Y\}$-diagram. Relevant for prices and employment are still the capacity limit $YS = YL \leq YC$ and the minimum price $p(w)$ which is determined by unit labour costs, the price elasticity of demand and the degree of demand uncertainty σ.[3] In this model, rationing of demand or underutilization of employment can occur. For a positive demand shock, the firm cannot satisfy all customers (delivery lags), for a negative demand shock, underutilization of capacities and labour hoarding occur. These short-run demand shocks can be identified from the utilization of labour and capital.

The model also provides a framework for the analysis of the price and quantity adjustment during the business cycle. Suppose the stochastic process generating the demand shocks is autocorrelated. The firm exploits this autocorrelation when forming demand expectations for the future. Then, a short-run demand shock affects output and the utilization of labour and capital today. The adjustment of the firm depends on the availability of capacities: In case of capacity constraints (in boom periods), the firm adjusts the price, and employment remains unchanged;

[3]See Smolny (1998a,b) for a detailed discussion. Uncertainty increases the optimal price and reduces employment through the costs of underutilization of employment.

with sufficient capacities (in recession periods), the price remains unchanged, and the firm adjusts employment.

2.3 Aggregation

The microeconomic model of the firm also provides a consistent basis for aggregation. If firms differ with respect to the realization of the demand shocks ε, the microeconomic minimum condition of supply and demand of the firms can be explicitely translated into a macroeconomic relation between the aggregates. If the distribution of ε is approximated by the normal distribution, the aggregate counterpart of the microeconomic minimum condition can accurately be approximated by a CES-type function of aggregate output $n \cdot \mathrm{E}(Y)$ in terms of aggregate capacities $n \cdot \mathrm{E}(YC)$ and aggregate demand $n \cdot \mathrm{E}(YD)$,[4]

$$\mathrm{E}(Y)^\rho \approx \mathrm{E}(YD)^\rho + \mathrm{E}(YC)^\rho, \quad \rho < 0. \tag{8}$$

E is the expectation operator, and n is the number of firms. ρ can be interpreted as a mismatch parameter (mismatch between demand and capacities). The aggregate multipliers, i.e. the elasticities of aggregate output with respect to capacities and demand can be calculated from eq. (8) as

$$\frac{\partial \mathrm{E}(Y)}{\partial \mathrm{E}(YD)} \cdot \frac{\mathrm{E}(YD)}{\mathrm{E}(Y)} = \left\{ \frac{\mathrm{E}(YD)}{\mathrm{E}(Y)} \right\}^\rho = \mathrm{prob}(YD < YC) \tag{9}$$

$$\frac{\partial \mathrm{E}(Y)}{\partial \mathrm{E}(YC)} \cdot \frac{\mathrm{E}(YC)}{\mathrm{E}(Y)} = \left\{ \frac{\mathrm{E}(YC)}{\mathrm{E}(Y)} \right\}^\rho = \mathrm{prob}(YD > YC) \tag{10}$$

These elasticities correspond to the regime probabilites, i.e. the shares of firms within the respective regime. The aggregate model implies that the demand and cost multipliers depend on the business cycle. In recession periods with a large share of firms with sufficient capacities, quantities (output and employment) adjust with respect to demand and cost changes, and prices adjust only with respect to costs. In boom situations with a high capacity utilization and a large share of firms with capacity constraints, prices adjust with respect to demand with only small output and employment effects and only small effects from cost changes. The microeconomic case dependency of cost and demand effects corresponds to demand and cost multipliers depending on the regime shares at the macro level; the share of firms exhibiting capacity constraints is determined by aggregate capacity utilization. If in addition aggregate demand depends on employment, the model yields the usual Keynesian multiplier but only within the borders of capacities, i.e. the model exhibits both classical and Keynesian features.

[4] The approximation holds also, if capacities, costs, prices and demand shifts differ between firms.

The model can be extended by introducing labour supply constraints. The availability of sufficient workers can limit the adjustment of employment at the micro level, correspondingly to capacity constraints. In this case, aggregate employment $n \cdot \mathrm{E}(L)$ depends on aggregate labour demand $\mathrm{E}(LD)$ and aggregate labour supply $n \cdot \mathrm{E}(LS)$ also,

$$\mathrm{E}(L)^\rho \approx \mathrm{E}(LD)^\rho + \mathrm{E}(LS)^\rho, \tag{11}$$

$$\mathrm{E}(LD)^\rho \approx (\mathrm{E}(YD)/\pi_l)^\rho + (\mathrm{E}(YC)/\pi_l)^\rho. \tag{12}$$

The adjustment of employment can be interpreted in terms of a matching model; it depends on expected demand, capacity utilization and implicitly the unemployment rate.

2.4 Capacities and capital-labour substitution

In the long run, the firm adjusts capacities and the production technology. Since there is uncertainty about the demand shock ε, the realized future values of output, prices and employment are not known at the time of the investment decision. However, the firm knows the decision rule for those variables: They are given by the solution of the short-run optimization problem above. For the capacity decision, the following properties can be derived:[5]

- The optimal probability of demand constraints $\mathrm{prob}(YD < YC)$ and the optimal expected utilization of capacities $U := \mathrm{E}(Y)/YC$ depend only on the price elasticity of demand η, the variance of demand shocks σ^2 and relative factor costs $\frac{c}{\pi_k}/\frac{w}{\pi_l}$. The choice of capacities can be understood as the optimal choice of capacity utilization and regime probability.

- The average price is determined as mark-up over labour and capital costs, but depends also on the expected utilization of capacities,

$$\frac{\mathrm{E}(p \cdot Y)}{\mathrm{E}(Y)} = \left(\frac{w}{\pi_l} + \frac{c}{U \cdot \pi_k}\right) / (1 + 1/\eta). \tag{13}$$

- Optimal capacities depend loglinear on wage costs w and the demand shift Z,

$$\ln YC = \eta \cdot \ln p(w) + \ln Z + \overline{\varepsilon}\left(\eta, \sigma, \frac{c}{\pi_k}\frac{\pi_l}{w}\right). \tag{14}$$

[5] See Smolny (1999) for a detailed discussion.

Expected demand shifts increase all quantities proportionally and do not affect prices or relative quantities. This implies an accelerator mechanism for the capacity adjustment. Depending on the adjustment speed of capacities with respect to demand expectations, this introduces a source of instability into the aggregate adjustment. Higher relative capital costs reduce capacities through optimal utilization. A proportional increase in c and w leaves the regime probabilities and capacity utilization unchanged, but increases the price proportionally. Capacities decrease with elasticity $|\eta|$, i.e. the model exhibits linear homogeneity both in prices and quantities. Less competition reduces capacities through higher prices and through a lower optimal utilization, and more uncertainty reduces optimal capacities through a lower utilization. Demand uncertainty exhibits the same effect on capacities and average prices as higher capital costs.

The second component of the investment decision concerns the choice of the optimal capital-labour ratio k. The capital-labour ratio, in turn, determines the productivities of labour and capital π_l, π_k. It can be shown that the optimal relation between the elasticities of the factor productivities of labour and capital with respect to the capital-labour ratio is chosen equal to the ratio of the corrected factor shares,

$$-\frac{\frac{\partial \pi_k}{\partial k} \cdot \frac{k}{\pi_k}}{\frac{\partial \pi_l}{\partial k} \cdot \frac{k}{\pi_l}} = \frac{w \cdot U}{c} \frac{\pi_k}{\pi_l}. \tag{15}$$

The inefficiency caused by uncertainty and a delayed adjustment exhibits the same effects as higher capital costs and favours substitution of labour against capital; the model without uncertainty is contained for $U \to 1$.

The assumption of a delayed adjustment of capacities and capital-labour substitution extends the deterministic model by introducing uncertainty and permits to analyse the resulting inefficiencies.

- Ex ante, the firm chooses capacities and the factor productivities under uncertainty about demand. With uncertainty, optimal capacities and expected output are lower due to the costs of stochastic underutilization of capacities.

- Ex post, different regimes on the goods market and underutilization of capacities are possible. Since the demand multiplier depends on the share of firms with capacity constraints, the instability associated with the capacity adjustment is reduced. Firms exhibiting capacity constraints cannot increase output and employment in case of demand increases, and prices rise instead.

The model also provides a framework to analyse the price and quantity adjustment during the business cycle. Consider a positive demand shock. The short-run

effects depend on capacity utilization: Firms with sufficient capacities increase output and employment, and capacity utilization increases; firms with capacity constraints increase only the price. If positive demand expectations persist, firms will, with a delay, increase capacities. The model can be understood as an error correction model for investment: Capacities adjust, if capacity utilization differs from the optimum. With higher capacities, output and employment increase further, while capacity utilization and prices should decrease. That means, demand shocks should exhibit an effect on prices, capacity utilization and regime proportions only in the short run.

3 Employment adjustment and investment

The macroeconomic model introduced in the previous section can be matched with aggregate data in terms of a macroeconometric disequilibrium model. Applications to the West German economy are documented e.g. in Entorf, Franz, König and Smolny (1990), Smolny (1993) and Franz, Göggelmann and Winker (1998). The latter paper extends the estimation period to 1994 requiring the analysis of structural breaks within the West German model. The current attempt to incorporate the East German economy is more demanding. Thus, it is not yet possible to present the complete macroeconometric model in this paper. Instead, we concentrate on two central aspects, namely employment adjustment and investment.

3.1 Unification as a macroeconomic shock for West Germany

The economic situation in West Germany prior to unification was characterized by a period of high output and employment growth. Furthermore, industrial capacity utilization has reached a level as high as in the early seventies, i.e. a historical maximum. Nevertheless, unemployment remained high and persistent.

It is difficult to assess the economic situation in East Germany prior to unification. Immediately afterwards the labour market was characterized by almost full employment in terms of jobs. However, the strong decline in output and capacity utilization indicates that an increasing share of labour was subject to underutilization up to the so-called short-time work zero, i.e. jobs without any productive activities, which is not modeled in this framework explicitly.

The economic and monetary union in the third quarter 1990 resulted in a favourable exchange rate for labour incomes and monetary assets from the East German private households perspective. At the same time, these conditions imposed on wages and debt deteriorated the competitiveness of the East German

economy. Consequently, demand for East German products broke down and demand shifted to "imports" from West Germany, which were financed by monetary assets of East German private households and transfer payments from West Germany.

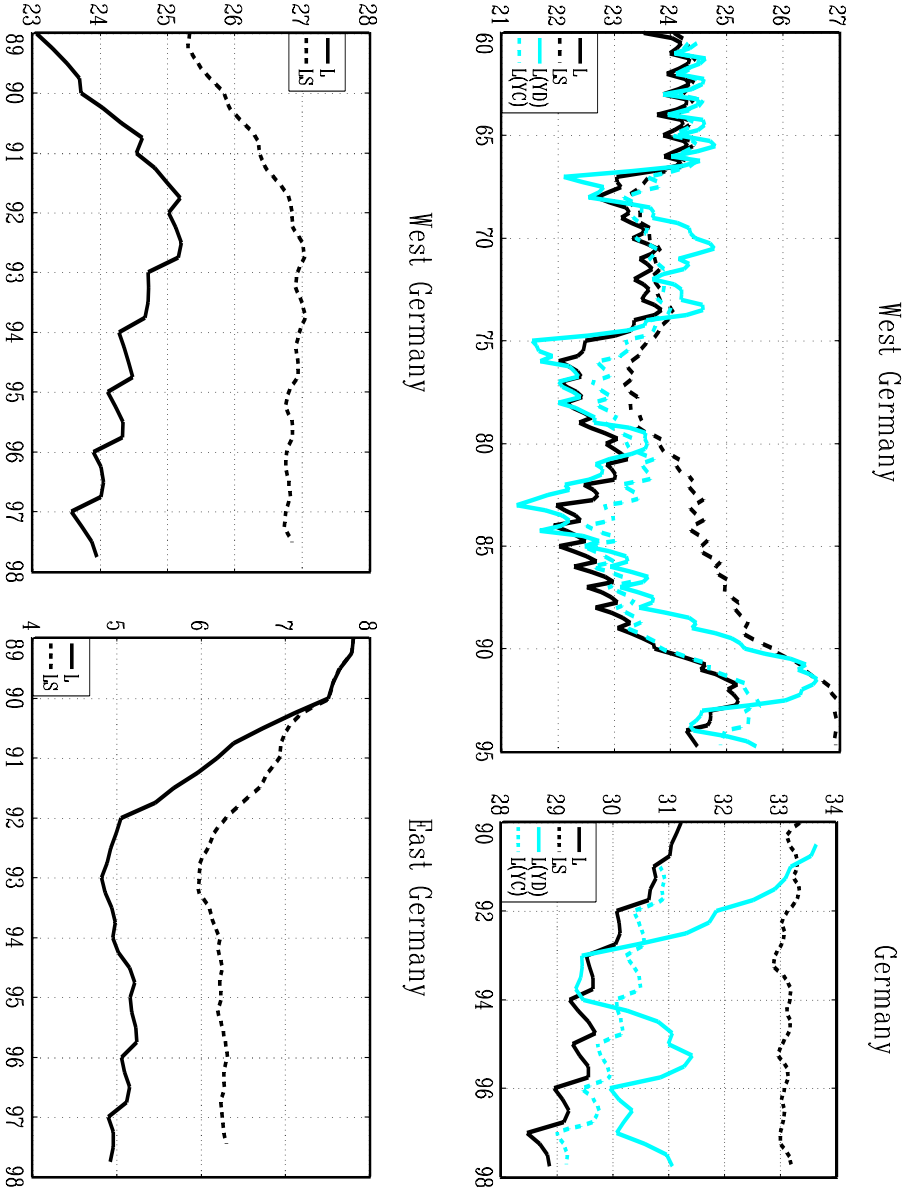
3.2 Employment

The effects of the resulting enormous demand increase in West Germany can be analysed within the macroeconometric model. Figure 2 provides some results for the employment series.

First, the two plots in the upper part of the figure show the developments of the different employment series derived from the theoretical model for West Germany up to 1994, and for Germany from 1990 onwards. From the left hand plot, the tremendous increase in labour supply `LS` during the 1980s can be clearly detected. It accelerated after unification up to 1992. A part of this further increase of almost 2 million people can be attributed to intra-national labour mobility (see lower panel). Although starting prior to unification, demand determined employment `L(YD)` in West Germany received a major boost by the enormous demand increase from East Germany. In the peak period 1991 it almost reached labour supply. By contrast, capacity employment `L(YC)` falls short of labour supply by more than 1.5 millions. Although growing faster than labour supply since the mid 80s, capacities in West Germany failed to catch up with labour supply and increased goods demand in the aftermath of unification. Hence, capacities have become the major limiting factor to employment in West Germany `L` in the aftermath of unification.

The recession in 1992/93 is marked by a strong decrease of demand determined employment, which finally strengthens the restrictions imposed by capacities. Data availability does not allow to extend the estimation of `L(YD)` beyond 1994. Therefore, the analysis continues with the right hand plot showing estimates for unified Germany. Labour supply in Germany `LS` remained fairly stable from 1989 onwards. However, this corresponds to an increase of the labour supply in West Germany by about 2 million and a similar decrease in East Germany, which can be detected from the two plots in the lower part of the figure. Furthermore, capacity employment `L(YC)` shrinks in Germany mirroring both a slight decrease for West Germany and the increase in labour productivity in East Germany.
Demand side effects are almost irrelevant in West Germany during the early years of unification when repressed consumption in East Germany could finally be realized out of savings and public transfers. As capacities were still growing when this unification shock settled down, the resulting lack of demand contributed significantly to the bad labour market performance in the 1992/93 recession. However this temporary intertemporal shift of demand seems to loose importance for the

Figure 2: Employment series



labour market performance in the late 1990s. Now, again the capacity constraint dominates employment.

Finally, the picture for East Germany in the lower right hand plot differs markedly from West Germany at least for the first years after unification. Prior to mid 1990, employment `L` remained at its full employment level and fell much slower than output up to 1991 indicating a significant amount of labour hoarding, e.g. in form of short-time work zero. The fall in labour supply (`LS`) reflects intra-national labour mobility, early retirements and changes in individual labour supply decisions.

The next step of modeling the labour market consists in linking demand determined employment, capacity employment and labour supply by the aggregate employment function. This provides an estimate of the mismatch on the labour market both for West Germany prior to 1992 and for Germany from 1992 onwards. In both cases the mismatch parameter ρ for the labour market is modeled by a deterministic time trend. The estimates indicate an increasing mismatch from 1960 onwards.[6] Estimates of ρ for West Germany and Germany are very similar indicating a slightly higher degree of mismatch for unified Germany. The difference, however, is not significant. Using these estimates, our model determines regime shares and corresponding levels of employment for each point of time according to equations (9) and (10). The regime shares are defined as the shares of firms facing a particular constraint relative to the total number of firms. In Figure 3 the shares of firms constrained by expected goods demand (demand regime), existing capacities (capacity regime) and labour supply (labour supply regime) are plotted.

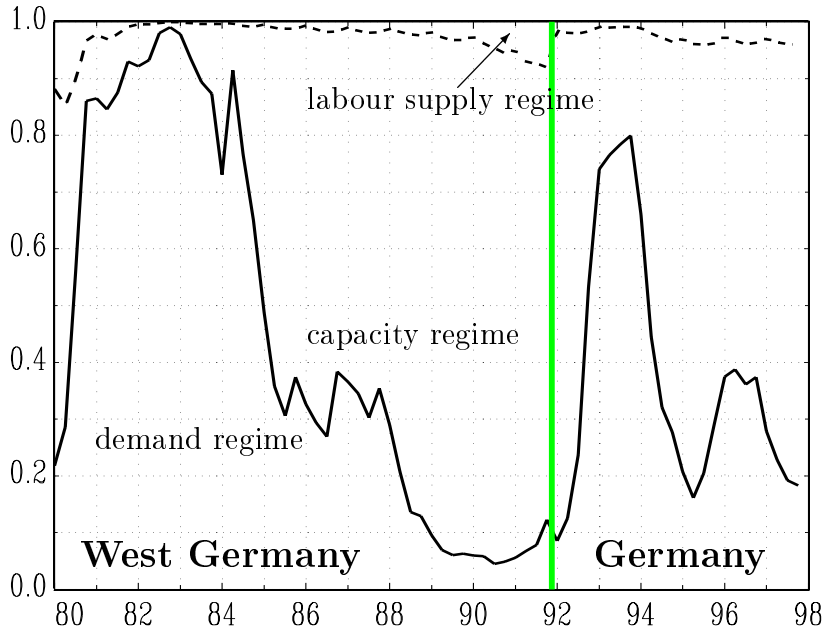
Since estimates of German capital stock prior to 1992 are subject to a larger degree of uncertainty, regime shares for West Germany are plotted up to the last quarter 1991 and regime shares for Germany from 1992 onwards. As expected from the employment series in figure 2, labour supply is hardly a limiting factor prior to unification and even less important afterwards, mirrored by the small share at the top of the plot. The high degree of capacity utilization in West Germany prior to and immediately after unification is mirrored by the capacity constrained regime from the mid 1980s to the beginning of 1992. Only after the breakdown of the unification demand boom 1992/93, a large share of firms faced demand constraints. Consequently, capacity employment decreased and capacities became prevalent again since 1994.

The long-run relation between labour supply, capacity employment and demand determined employment is estimated by a static CES function.[7] This static relationship does not differ significantly between West Germany and Germany after unification. However, the dynamic adjustment of employment towards this

[6] Note that the results shown in Figure 3 are based on estimates for the period 1960 to 1997.

[7] See equation(11) and equation(12).

Figure 3: Regime shares



static relationship may differ. Dynamic adjustment is modeled in an error correction framework, where L is the endogenous variable. The value of the exogenous variable L^* was fitted in the above mentioned static CES function. Results of our error correction model are summarized in Table 1 below. The estimates for West Germany and the two samples 1960–1988 and 1960–1994 indicate a slightly higher persistence of short term changes when the post unification period is included. However, at the same time the error correction term becomes smaller resulting in a lower overall adjustment. This tendency is confirmed by the SUR estimates for West Germany and Germany in columns (3) and (4).

Zellner's Seemingly Unrelated Regressor (SUR)[8] estimation is used in order to extract a maximum of information from the available data, in particular with regard to the dynamic adjustment in West Germany and unified Germany. Therefore, we use a two equations approach based on equations for West Germany covering the time span 1960 to 1994 and for Germany from 1991 to 1997, which are estimated simultaneously. Since the number of degrees of freedom is too small for the German data, cross-equation restrictions are imposed on almost all parameters. It is argued that behaviour of economic subjects in East Germany in the early years after unification may differ substantially from their behaviour, when unification specific shocks already settled down and a learning process concerning

[8]See Zellner (1962).

Table 1: Error Correction Models for Employment

Dependent variable: $\Delta \ln L_t$				
	(1)	(2)	(3)	(4)
	West Germany	West Germany	West Germany	Unified Germany
c	0.127	0.069	0.075	0.079
	(3.16)	(2.18)	(2.69)	(2.63)
$\Delta \ln L_{t-1}$	0.426	0.543	0.531	0.251
	(5.02)	(7.03)	(7.30)	(1.82)
$\Delta \ln L_{t-2}$	−0.147	−0.159	−0.062	−0.113
	(-2.15)	(-2.38)	(-1.15)	(-1.29)
$\Delta \ln L_{t-3}$	−0.198	−0.110	−0.059	−0.142
	(-3.09)	(-1.75)	(-1.11)	(-1.59)
$\Delta \ln L_{t-4}$	0.657	0.708	0.657	0.667
	(10.03)	(11.30)	(12.12)	(7.09)
$\Delta \ln L_{t-5}$	−0.490	−0.516	−0.481	−0.307
	(-6.31)	(-6.91)	(-6.93)	(-2.35)
$\ln L_{t-1}$	−0.205	−0.117	−0.092	−0.092
	(-4.07)	(-2.69)	(-2.46)	(-2.46)
$\ln L^*{}_{t-1}$	0.801	0.811	0.740	0.740
	(3.71)	(2.38)	(2.00)	(2.00)
$\bar{R}^2$	0.899	0.878	0.877	0.886
SEE $\cdot$ 1000	0.339	0.360	0.363	0.298
Sample	61:3-88:4	61:3-94:4	61:3-94:4	90:3-97:4

t-values in parentheses

market economies is terminated. This provides another motivation for imposing the cross-equation constraints given the limited number of observations. Eventually, the behaviour might resemble closely the estimated equations for West Germany. Nevertheless, the restrictions on the estimated parameters can be tested econometrically in this framework. They are loosened step by step on the basis of Wald tests. The coefficient restrictions on the dynamics for unified Germany could be rejected clearly indicating differences in the dynamic adjustment of employment in West and East Germany.

An alternative approach for handling the structural break in times series resulting from the combination of data for West Germany prior to 1990 and Germany from 1991 onwards consists in merging together the time series either in 1991 or – to avoid the uncertainty of measuring investment and capital stock data for East Germany in 1991 and 1992 – in 1993. Using several kinds of dummies for the break in 1991 or 1993, respectively, an error correction model can be fitted to the data from 1960 to 1997. Although the results seem promising at first glance, some problems of this approach are noteworthy. First, in a comprehensive macroeconometric model, this estimation strategy would result in the mixing of the West German and German systems of National Accounts. Second, the dynamics of the adjustment process cannot be modeled adequately for the periods immediately after the merge point. Third, this estimation approach assumes parameter stability in the period before and after unification, which cannot be tested in this framework. Finally, the estimates depend on the chosen set of dummies.

3.3 Investment

The capacity adjustment is modeled by an econometric investment equation in error correction specification. The error correction term defines the long-run relationship between capital stock, expected demand and the relevant prices. Using this framework for German data after unification imposes at least two problems.

First, capital stock data for East Germany are subject to a large degree of uncertainty at least for the early years after unification, since the collapse of manufacturing in East Germany made a large fraction of the existing capital stock obsolete. In order to take this effect into account we follow the approach of the federal statistical office which aims at providing a rather conservative estimate of available capacities: For example, equipment which went out of use before the end of 1992 due to the changing economic conditions was given a value of zero already in 1991. Further reductions were made for shut-downs in the period 1993 to 1995. Finally, remaining old equipment was valued at 60% of the GDR book value with an assumed exchange rate of 0.75 DM for one East German mark. Despite of the resulting large write-offs, real capital stock of East Germany did not decrease in absolute terms due to the unprecedented high rates of investment

in the post unification period.

Second, as for the employment equation the length of the time period after unification is still small given the large uncertainty in the data for the first few years. Hence, it is not possible yet to estimate a highly dynamic investment equation solely for East Germany or Germany after 1991. Instead, the SUR system approach is used.

For the econometric analysis, investment was subdivided into construction (excluding housing), inventories, equipment, housing, and public sector investment. In this section, we concentrate on private investment in construction (excluding housing) and equipment, which determines capacities. Most of the arguments carry over to housing and inventory investment. However, some additional effects have to be taken into account there. Their discussion is left for future research.

In order to assess the robustness of our investment specification for West Germany and unified Germany, the estimation was repeated for different samples. The results are summarized in Table 2.

The first two columns provide the results of single equation estimation for West Germany covering the period 1960/1 to 1989/4, i.e. prior to unification, in column (1), and the period 1960/1 to 1994/4 in column (2). The last two columns show the results of the SUR estimation for West Germany 1960/1 to 1994/4 in column (3) and for unified Germany from 1991/1 to 1997/4 in column (4).

The dependent variable is the growth rate of the capital stock (equipment and construction excluding housing)) $\Delta \ln K$. Besides the autoregressive dynamic structure, investment is determined by the error correction term of capital stock, expected production activity ($E(\ln y^a)$)[9] and the user costs of capital (uc).

For the period prior to unification the estimation results for West Germany in column (1) are consistent with the theoretical model. Investment follows a marked autoregressive process up to lag five. The long-run relationship indicates an elasticity of the capital stock with regard to expected activity of almost one and a negative impact of the user costs of capital. However, the adjustment of the capital stock towards this long-run relationship is rather small (0.5% per quarter). The choice of the lag $t-6$ is the result of a data based procedure selecting the lag length resulting in the smallest standard error of estimation.[10]

Including West German data for the post unification period up to 1994 in column (2) does not change the results substantially. Solely, the effect of user costs does not show up significantly. This finding is confirmed by the system estimates provided in columns (3) and (4).

[9] $E(\ln y^a)$ is the expected minimum of those constraints which may prevent firms from full utilization of capacities.

[10] See Smolny (1993) and Franz, Göggelmann and Winker (1998) for details.

Table 2: Error Correction Models for Equipment and Construction[a]

Dependent variable: $\Delta \ln K_t$				
	(1)	(2)	(3)	(4)
	West Germany	West Germany	West Germany	Unified Germany
c	0.021	0.016	0.016	0.131
	(4.51)	(4.78)	(4.99)	(3.52)
$\Delta \ln K_{t-1}$	0.755	0.808	0.841	0.246
	(9.48)	(11.30)	(13.57)	(1.79)
$\Delta \ln K_{t-2}$	0.091	0.108	0.068	0.227
	(1.03)	(1.30)	(0.97)	(1.95)
$\Delta \ln K_{t-4}$	0.460	0.476	0.469	−0.049
	(5.27)	(5.68)	(6.49)	(-0.41)
$\Delta \ln K_{t-5}$	−0.539	−0.580	−0.566	0.147
	(-7.02)	(-8.26)	(-9.28)	(1.09)
$\ln K_{t-1}$	−0.005	−0.005	−0.005	−0.029
	(-3.42)	(-3.52)	(-3.62)	(-5.37)
$E_{t-6}(\ln y_t^a)$	0.004	0.004	0.004	0.019
	(2.23)	(2.73)	(2.75)	(5.23)
uc_{t-1}	−0.006	−0.001	−0.001	−0.001
	(-1.53)	(-0.38)	(-0.20)	(-0.20)
$\bar{R}^2$	0.983	0.982	0.982	0.972
SEE · 1000	0.533	0.538	0.540	0.295
Sample	61:3-89:4	61:3-94:4	61:3-94:4	92:3-97:4

t-values in parentheses

[a] construction excluding housing

Wald tests were chosen to examine restrictions on the dynamic in a first step and restrictions on the long-run coefficients in a second step. All coefficient restrictions for unified Germany had to be clearly rejected.[11] This is in contrast to most other equations of the macroeconometric model highlighting the particularity of investment in East Germany. The significant higher constant in the investment equation for unified Germany is attributed to the enormous volume of governmental support for private investment (right of way for private investors, "Gemeinschaftswerk Aufschwung Ost" etc.). Return on investment before taxes

[11] Since the user costs were insignificant, we did not consider this variable in the Wald test.

was extraordinarily high, firms were highly motivated and investments were realized within impressively short time. Therefore, the dynamic part of the investment process is different. In particular, the estimates for lag order 4 and 5 become insignificant. The long-run relationship is highly significant implying an elasticity of the optimum capital stock with regard to expected production activity somewhat smaller than for West Germany. First period adjustment towards this long-run relationship is much higher than for West Germany (2.9% versus 0.5%).

To sum up, investment behaviour after unification was different from before. Since the changes are small for West Germany, the differences mainly have to be attributed to the specifics of East Germany. Besides the arguments already listed above, the replacement of the old capital stock by modern technology in an extraordinary short period of time contributed to these differences. The ifo institute, Munich, estimates that the amount of investment in equipment and construction (excluding housing) in the industry from 1991 to 1998 was about 753 billion DM.[12] The willingness to invest was highly driven by governmental incentives, which included investment grants, several credit programs, extra depreciation allowance ("Sonderabschreibungen"), tax relief, guarantees, subsidies, special subsidies for innovations, regional support and some other instruments.[13]

[12]See Jahresgutachten 1998/99 des Sachverständigenrates zur Begutachtung der gesamtwirtschaftlichen Entwicklung, p. 104, paragraph 150.

[13]Preliminary estimation results indicate that the investment equations can be improved by taking explicitely into account these high investment subsidies.

4 Conclusions

In this paper a microeconomically founded macroeconometric disequilibrium model was used to assess the employment adjustment and investment after German unification.

It is shown that a model of the firm acting on a monopolistically competitive market leads to an aggregate model which can be used to classify the developments in Germany after unification. Of course, such a model does not take into account all unification effects, in particular, effects stemming from particular policy measures such as short-term work zero leading to excessive labour hoarding in the early years after unification. Nevertheless, under the caveat that the number of available observations for the post unification period is still small, a tentative conclusion seems to be that the structural model originally derived for West Germany can also successfully be applied to unified Germany.

In particular, it is possible to quantify different regimes on the labour market, which allow for a clear identification of the sources of the recession in 1992/93. Furthermore, it seems reasonable to use the empirical investment function derived from the theoretical model also for Germany. However, the substantial use of fiscal policy measures has to be integrated, which is part of our current research.

Our future research will also include the econometric assessment of the potential structural break in 1990 for all other stochastic equations of the model. Then, the impact of policy measures can be simulated, e.g. effects on prices and wages, user costs of capital taking into account the public support, and the international spillover of this shock. Furthermore, the model will be completed by integrating capital market, public sector and a more refined treatment of the trade relations to the major trading partners of Germany. Finally, the availability of more data for East Germany and unified Germany may allow for the explicit modeling of the East German economy. In particular, productivity adjustment through capital deepening and technology transfers, as well as wage and price adjustments are on our research agenda.

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A Appendix: Output and Employment in East and West Germany

Figure 4 provides some data on the development of output and employment in East and West Germany after unification.

The top panels show the development of output and employment in East and West Germany relative to the level in 1989. The plots in the second part of the figure exhibit the corresponding yearly growth rates. Both plots highlight the delayed adjustment of employment in East Germany to the break in output after unification. While employment in East Germany declined from 9.3 million to 6.2 million in 1993, GDP reached its minimum in 1991. Afterwards economy recovers steadily, but growth rates of GDP were lower since 1994. The West German growth rates were positive and high immediately after unification. Economic growth amounted to about 5% p.a. until it declined to negative values in 1993. Unification boom increased employment by about 2 millions within three years, more than ever observed in German post-war history. Corresponding to this prosperity, the unemployment rate for West Germany decreased as can be seen in the left bottom panel. In the recession 1992/93 there was a sharp decrease of employment which led to the historically highest rate of unemployment.

Finally, the right plot in the bottom panel provides information on investment per employee in East and West Germany. It highlights the catching up of East German investment rates until 1992 and the much higher investment rates from 1992 onwards.
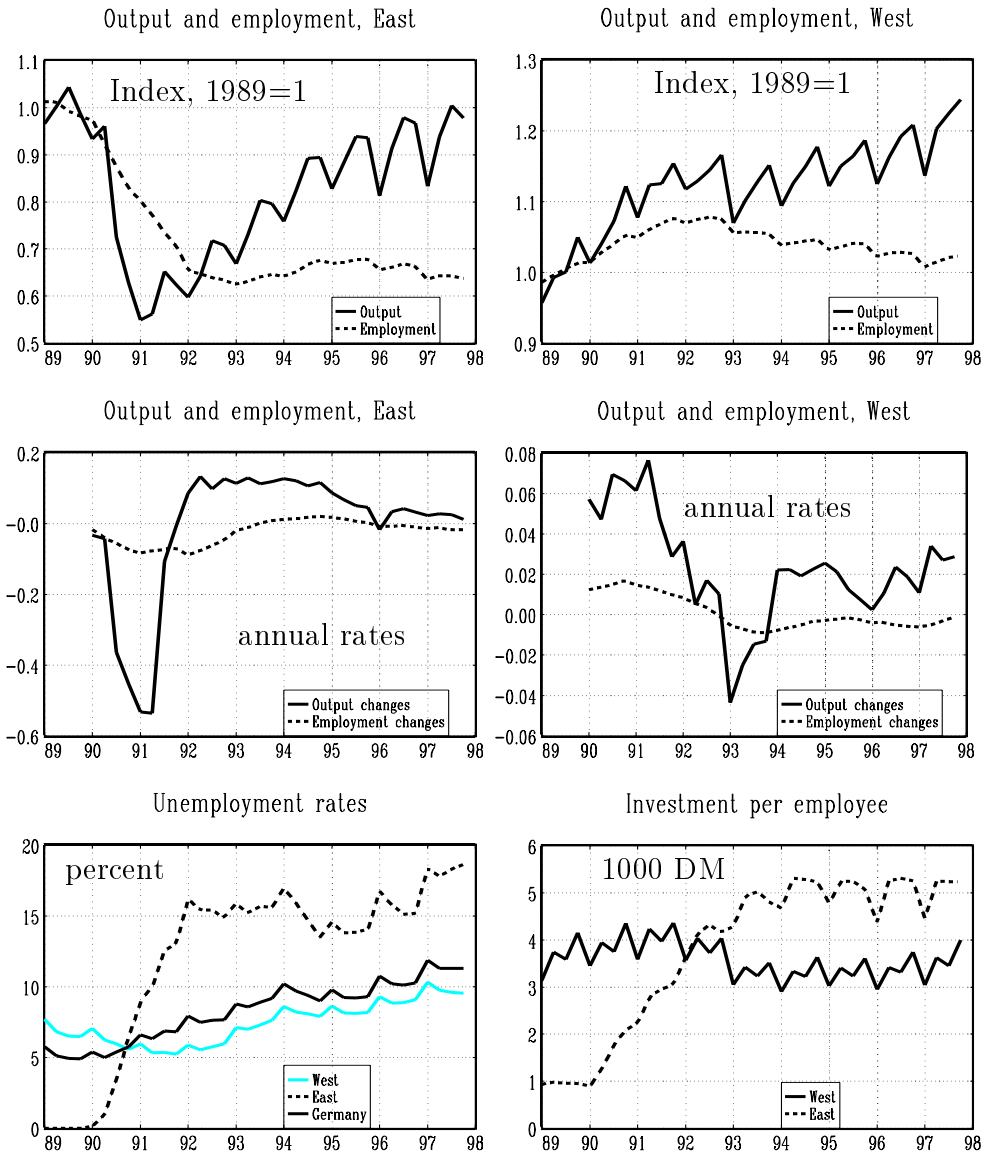
Figure 4: Output and employment series