Modeling German Unification in a Disequilibrium Framework

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Non-technical summary:
German unification fundamentally changed the terms for macroeconometric analysis. First, data availability poses a severe problem for econometric approaches. Second, unification may have led to structural changes in the behavioural equations.

In this paper we use a macroeconometric disequilibrium model to handle these problems. It is based on a microeconomic decision model of households and firms. Thus, under the assumption that utility and profit maximization do not differ substantially between East and West German households and firms, these behavioural equations seem to be capable to capture the transition process without dramatic changes. However, as a result of unification some parameters treated as exogeneous in the model have also changed, in particular parameters related to fiscal policy decisions. To measure the impact of these effects is one reason for the reestimation of the model for the time period 1960 to 1997, covering East Germany from 1991 onwards.

The main focus of our contribution is the modeling of investment behaviour and employment adjustment. The empirical estimations show that the disequilibrium model is able to analyze the changes induced by unification.

Most behavioural relationships remained fairly stable when switching from West Germany to unified Germany. On the other hand investment behaviour after unification was different from before. However, the adjustment speed differs at least in the early years after unification. These differences mainly have to be attributed to the specifics of investment in East Germany, where the willingness to invest was highly driven by fiscal incentives.

Two preliminary policy simulations analyse the impact of the demand shock in the West German economy in the aftermath of unification and the effects of the financial support by government for private investment. Both simulations depend on the prevailing regimes on goods and labour markets. In the first simulation we assume that exports to eastern Germany were reduced by 25% from 1990 on. During the capacity regime before 1992, the effect of the demand shock is much larger for goods demand than for output itself. However, to the extent that the demand regime gains importance in the recession 1992, the gap closes. On the labour market demand determined employment shrinks markedly, while capacity employment does not show any effect in the beginning and decreases only marginally from 1993 onwards. In the second simulation we assume that the financial incentives were halved. This reduction saves at least half of the expenditures for governmental investment subsidies in East Germany. We assume that this money is spent for governmental consumption. Our results reveal, that while output increases during demand regime, it decreases by 0.5% in 1997 during capacity regime. On the labour market employment also reduces by about 0.5%.

Abstract:
Unification fundamentally changed the terms of quantitative macroeconomic analysis for Germany. Two main areas concerned are data availability for the eastern part of Germany and structural changes within the behavioural equations after unification.

Our paper presents results from the estimation of a macroeconometric disequilibrium model formerly developed for West Germany. The challenge is to handle the structural break in the time series and the economic model by applying a SUR estimator for West Germany and the Federal Republic of Germany, respectively. The main focus here is the modeling of investment expenditures and employment adjustment. The empirical results are encouraging and show that the disequilibrium model is flexible enough to analyze the changes induced by unification.

In particular, our results reveal that most behavioural relationships remained fairly stable when switching from West Germany to the Federal Republic of Germany. One notable exception is investment behaviour which – during the first years after unification – was strongly affected by fiscal incentives in East Germany. Preliminary policy simulations show effects of these fiscal incentives and the demand shock to the West German economy. The simulated responses depend on the prevailing regimes on goods and labour markets.

Zusammenfassung:
Die deutsche Wiedervereinigung veränderte die Ausgangslage für makroökonometrische Analysen. Dies betrifft zum einen die Verfügbarkeit von Daten in Ostdeutschland, zum anderen die in Folge der Wiedervereinigung bedingten strukturellen Veränderungen in den Verhaltensgleichungen.

Diese Studie zeigt die Schätzergebnisse eines makroökonometrischen Ungleichgewichtsmodells, das für Westdeutschland entwickelt wurde. Zum einen bestand die Herausforderung darin, eine Lösung für den Strukturbruch in den Zeitreihen zu finden, zum anderen darin, die strukturellen Veränderungen in den Modellgleichungen mittels eines SUR-Ansatzes für West- und Gesamtdeutschland abzubilden. Den Schwerpunkt dieses Beitrags bildet die Modellierung der Investitionen und der Beschäftigungsanpassung. Die Ergebnisse zeigen, dass das Ungleichgewichtsmodell flexibel genug ist, um die Veränderungen infolge der deutschen Wiedervereinigung zu analysieren. Die meisten Verhaltensgleichungen bleiben bei dem Übergang von West- zu Gesamtdeutschland stabil. Eine Ausnahme bildet das durch die öffentlichen Fördermittel beeinflusste Investitionsverhalten.

Vorläufige Simulationen untersuchen die Wirkungen des vereinigungsbedingten Nachfrageschocks im Westen sowie der öffentlichen Fördermassnahmen im Osten. Die Simulationsergebnisse hängen von den jeweils vorherrschenden Regimen auf dem Arbeits- und Gütermarkt ab.

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1　Introduction

The transformation of the East European economies certainly is one of the most challenging episodes for economic policy makers. In most of these countries, we have seen a large number of advisors coming and going. Some of them spent useful advice while others failed to do so. Obviously, there was and still is no unanimity about the right answers to the economic problems faced by the transition countries. One reason for misleading advice may be seen in the missing experience with similar economic circumstances, the other in the failure to provide and use adequate models of the economic systems. Our contribution may be seen as a pleading for macroeconomic modeling in order to capture the relevant interactions within an economy which becomes even more crucial in a rapidly changing environment as for the transition countries. Furthermore, in order to be fruitful for an analysis of economic policy, such models have to be quantified, e.g. by econometric methods.

This is the approach followed in our contribution for the case of Germany. The case of Germany is special as the adjustment of a central planning economy to the mainly market driven West German economy did not come gradually, but occured within a few months in 1990. On July 1, 1990, the State Treaty between the Federal Republic of Germany and the German Democratic Republic established a monetary, economic and social union. It was a major step towards political unification of Germany which took place on October 3, 1990. Economic unification led to a free flow of goods, labour and capital across the former border. The transition to market economy confronted East Germany with deep-seated adjustment problems (see section 2). Three determinants were important for the further development:

- the sharp appreciation of the East Germany currency due to an exchange rate fixed at 1 DM per East German Mark,

- the massive transfers from West to East Germany (about $150 - 200$ billions DM per year),

- and the relative size and productivity of the West and East German economy.

East German output amounted to about 10 percent, employment to about 20 percent of West German figures. This corresponds to a 50 percent lower labour productivity in East Germany.

Obviously, macroeconomic modeling is more demanding in such a context, in particular when quantitative estimates are required. The problems can be summarized under two separate headings. First, data availability poses a severe problem for econometric approaches. Second, German unification may have lead

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to structural changes in the behavioural equations. This setting requires specific estimation techniques. Let us now turn to these aspects in some more detail.

Data availability is a problem for East Germany prior to unification, because official statistics are based on a fundamentally different accounting system. Thus, these data cannot be compared with national account data for West Germany or Germany after unification. Furthermore, the introduction of the West German national accounting system to East Germany took some time. Therefore, observations for 1990 and 1991 are subject to a larger degree of uncertainty than during the period afterwards. Further difficulties arise because detailed national accounting for West Germany lasted only until 1994. Only a few key figures for West Germany from the Federal Statistics Office are available until the recent past. Therefore, we have to work with West German data for the time period 1960 to 1994, and with data for the unified Germany from 1991 to 1997. The whole model was estimated with quarterly data.

The macroeconometric disequilibrium model used for the analysis is based on a microeconomic decision model of households and firms, which is introduced in section 3. Thus, under the assumption that utility and profit maximization do not differ substantially between East and West German households and firms, these behavioural equations should be capable to capture the transition process without dramatic changes. However, as a result of unification some parameters treated as exogeneous in the model may have also changed, in particular parameters related to fiscal and monetary policy decisions or the activities of the privatisation agency "Treuhandanstalt". To measure the impact of these effects is one of the goals of the reestimation of the model for the time period 1960 to 1997, covering East Germany from 1991 onwards.

In order to exploit as much information as possible from the available data, a two equation system is estimated for most econometric equations of the model. The first equation covers the West German sample 1960–1994, while the second employs the German data 1991–1997. Then, structural stability is tested by imposing cross equation restrictions. Due to the limited number of available observations for Germany, however, this testing is still limited to subsets of the parameters.

The paper is organized as follows. In section 2, the development of the macroeconomic situation in West and East Germany and the impact of unification is discussed. Section 3 introduces the theoretical approach of the macroeconomic disequilibrium framework which is the basis of the econometric model. The structure of the model and the modeling of German unification within the macroeconometric model is the topic of section 4 which also provides some estimation results. The performance of the model for policy analysis is demonstrated by two policy simulations in section 5. Section 6 summarizes the main findings and provides an outlook to ongoing research.

2   German Unification: Some Stylized Facts

Unification hit the West German economy in a prosperous period. After the second oil price shock in 1979/1980, the economic situation had slowly recovered, and in 1988/89, annual economic growth amounted to about 4 percent. Employment had increased steadily since 1984 with an annual 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.

The historical development was different. 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 rapidly, and in 1991, GDP was quite below the pre-unification level. Employment adjusted only slowly which implied a further increase of unit labour costs. To exemplify this development with two figures: In 1990, output broke down by about 40 percent, and until 1992, about one third of the former jobs in East Germany were lost (see figure 1, left panels).[1]

East German demand was stabilized mainly through public transfers from West Germany. First, public investment increased e.g. through the building of the streets which should integrate the eastern part of Germany into the transport system. Second, private consumption and private housing investment were stabilized through rather generous unemployment benefits, increasing real retirement benefits, high incomes of public employees and increasing real values of monetary assets. Note the favourable currency conversion rate for income and monetary assets. Third, private investment was heavily subsidized, both for enterprises and for private housing.
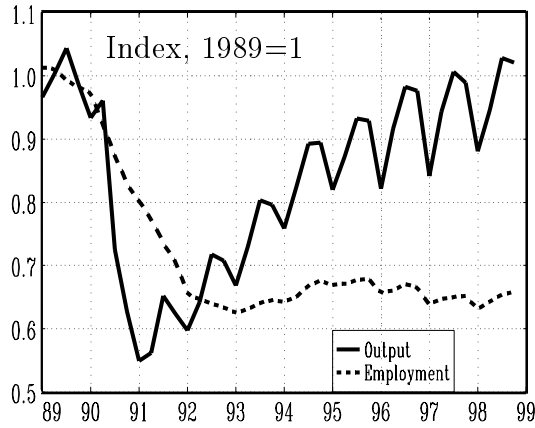
In the sequel, massive dismissals increased the utilization of employment and reduced unit labour costs. The high investment further contributed to the increase of labour productivity by capital deepening and technology transfers, and since 1993, East Germany is on a steady but painfully slow process of adjustment with respect to the West. Remarkable are especially the extraordinary high investment rates. The share of investment in output amounts to about 40 percent, and investment per employee is well above the West German level (see the bottom panels in
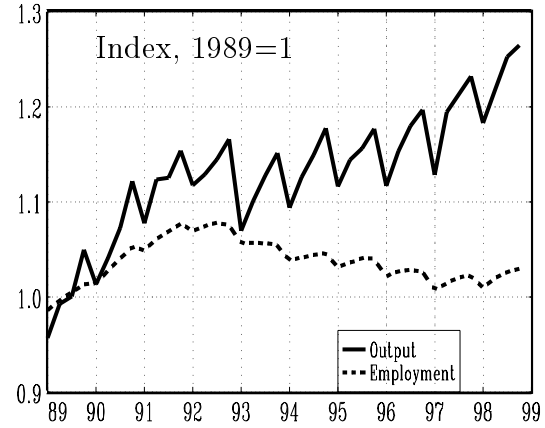
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[1]The data for 1989 are national accounts estimates of the DIW, Berlin.

Figure 1: Output, employment and investment

Output and employment, East
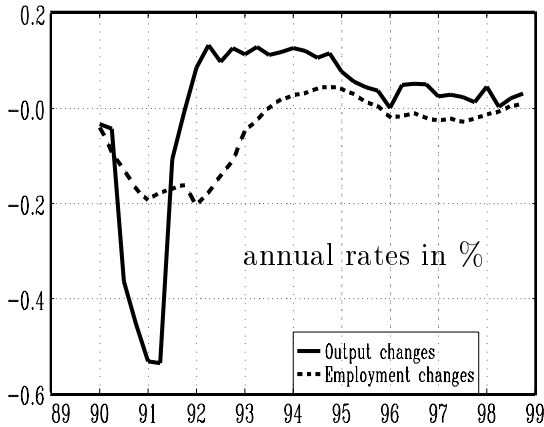
Index, 1989=1

— Output
···· Employment

Output and employment, West

Index, 1989=1

— Output
···· Employment

Output and employment changes, East

annual rates in %

— Output changes
···· Employment changes

Output and employment changes, West

annual rates in %

— Output changes
···· Employment changes

Investment/output ratio

— West
···· East

Investment per employee

1000 DM

— West
···· East

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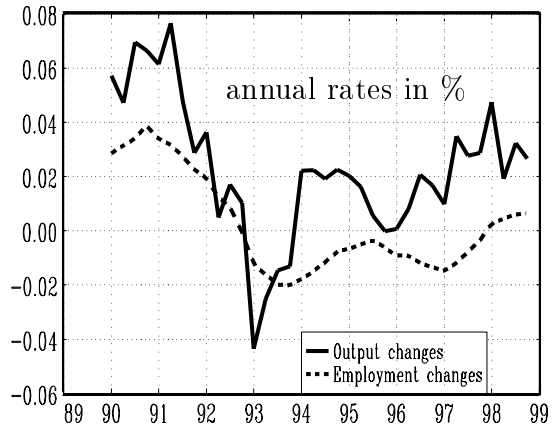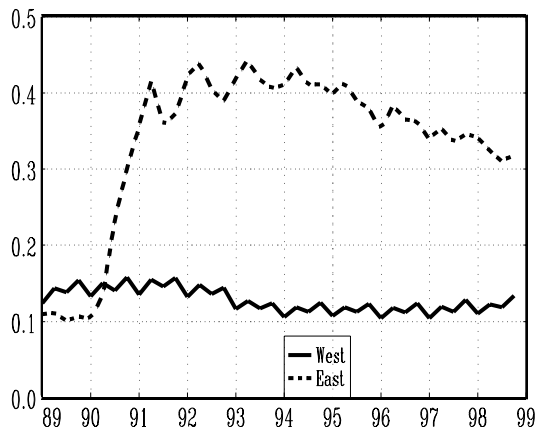
figure 1).[2] In the following years, output slowly recovered, but employment hardly increased until 1999. Unemployment figures remained above 1 million since 1991 which corresponds to unemployment rates of nearly 20 percent.

Unification also dominated the economic development in West Germany in the nineties. In 1990/1991, West Germany experienced a remarkable unification boom with annual economic growth of about 6 percent (see figure 1, right panels); corresponding g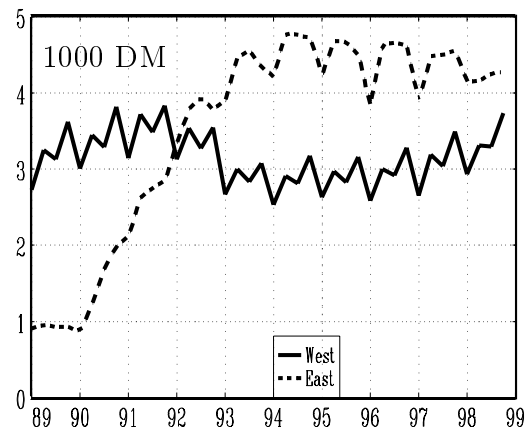rowth rates were formerly achieved only in the late sixties. In addition, West German employment increased by nearly 2 millions (about 3 percent per year) from late 1989 until 1991. A corresponding increase of jobs was formerly achieved only in the fifties during post-war reconstruction.

The most remarkable single aspect of the unification boom in West Germany was 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 150-200 billions DM per year (about 6-8 percent of GDP) in the early years after unification. Since the West German economy was in a prosperous phase already in 1989, the demand increase led to a further increase of private investment.

However, the West German unification boom was sharply terminated by a deep recession 1992 with output reductions until 1993. First, 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. Second, exports towards the "rest of the world" had become smaller since 1990. Third, 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. The rather low growth rates of output of about 2 percent since 1994 were to small to stop the reduction of employment, and in 1997, the whole unification increase of employment was lost. 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 the following figures, some key aspects of the productivity development of East Germany relative to West Germany are reported. Figure 2 depicts the ratios of East vs. West Germany.[3] The upper left panel shows the development of relative labour productivity per employee. Labour productivity in the former GDR (1989) was much lower than the respective figure for West Germany. It amounts to less than 40 percent of the West level, corresponding to about the West German level

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[2]The figures refer to construction (excluding housing) and equipment investment of firms, i.e. they exclude inventories, private housing and the public sector.

[3]In figure 6 in the appendix, the corresponding data for West and East Germany, respectively, are depicted.

in 1960. The breakdown of production after unification further worsened the situation, but since 1991 a steady adjustment path with respect to the West German level began (unconditional convergence). However, the adjustment process was painfully slow: It took two years (1991/1992), before the pre-unification productivity level was re-established, and since 1993, the progress was small. Remember also that this process was accompanied by massive employment reductions, and real East German output today is still hardly above the pre-unification level of 1989 (see figure 1).

Two main aspects can account for this development. First, the loss of competitiveness reduced demand and capacity utilization (see the upper right panels of figures 2 and 6).[4] Since employment adjusted only slowly, labour productivity decreased. The increase of labour productivity 1991/1992 is related to output increases but also to the massive dismissals in this period (convergence of the business cycle situation).[5] Second, prior to unification, the East German capital intensity of production was well below the West German level.[6] The massive investment since late 1990 increased the capital intensity and contributed to the adjustment of labour productivity (neoclassical convergence through adjustment of the capital/labour ratio).

On the base of these data, the development of total factor productivity was calculated.[7] The figures reveal that East German total factor productivity (1989) was also well below the West German level, but increased since 1991. However, the adjustment with respect to the West level between 1991 and 1995 was only about one percentage point per year, on average. In addition, the process of total factor productivity convergence stopped in 1996. On the base of these trends, one cannot be very optimistic about the future development of income and wealth in East Germany.

Finally, the bottom panels in figures 2 and 6 depict the development of real wages and real unit labour costs (real wages relative to real labour productivity) in East and West Germany. It can be seen that prior to unification, real wages in East Germany were below 40 percent of the West German level and increased to about 60 percent until today. This development, together with the corresponding development of labour productivity, implies real unit labour costs well above the West German level not only in the early nineties but still in 1998. Again, these figures

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[4]Capacity utilization is an estimate from the econometric model. The estimate is based on the data of the business survey of the ifo Institute, München.

[5]See figure 1 above.

[6]The capital stock data for East Germany 1989 are based on the rather conservative estimate of the Federal Statistics Office.

[7]Total factor productivity tfp is calculated from $\ln \text{tfp} = \ln(Y/L) - \alpha \cdot \ln(K/L) - \beta \cdot \ln Q$. Y/L is labour productivity, K/L is the capital/labour ratio and Q is capacity utilization. The production elasticity of physical capital α is chosen as 0.3, β is an estimate of the econometric model.

Figure 2: Adjustment: East to west

Relative labour productivity

Relative capacity utilization

Relative capital/labour ratio

Relative total factor productivity

Relative real wages

Relative real unit labour costs
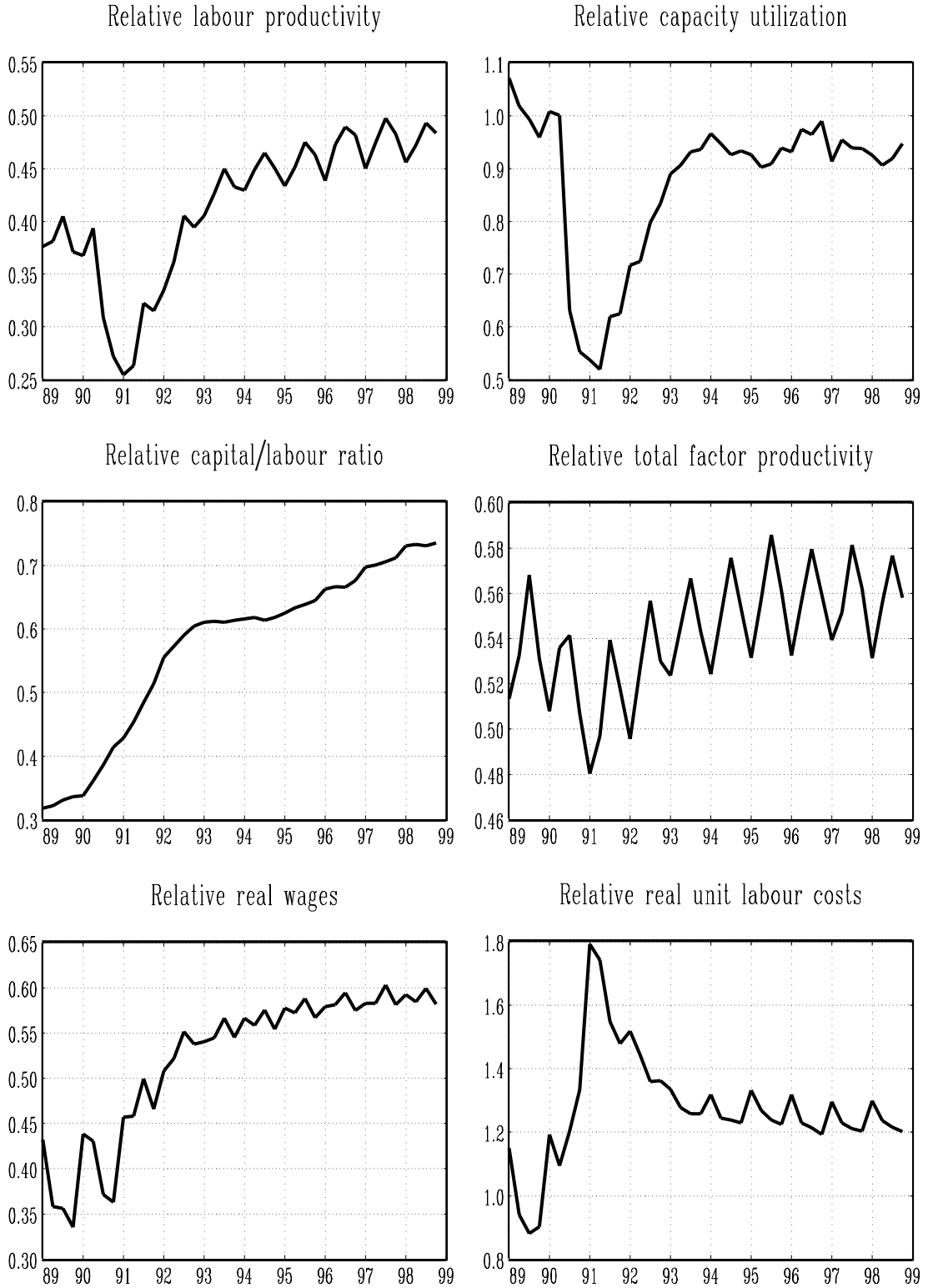
do not enhance the optimism about the future development of the employment situation in East Germany.

3   Theoretical Model

The economic effects of German unification described in the previous section are analyzed in a macroeconometric disequilibrium model in section 4. The theoretical framework of the empirical model is provided in this section.[8] The macroeconomic disequilibrium model is built on a microeconomic model of firm behaviour. In the sequel, an aggregation procedure is discussed to derive implications for the macroeconomic relations.

In the microeconomic 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. Output, prices and employment are determined in the short run with predetermined capacities and production technology. Firm level demand YD_i is determined by the price p_i, exogenous demand shifts Z_i and a demand shock ε_i which is not known at the time of the investment decision. For simplicity, a log-linear demand curve is assumed

$$\ln YD_i = \eta_i \cdot \ln p_i + \ln Z_i + \varepsilon_i. \tag{1}$$

implies a framework of imperfect competition on the product market. Supply YS_i is determined by a short-run limitational production function with capital K_i and labour L_i as inputs,

$$YS_i = \min(YC_i, YL_i) = \min(\pi_{ki} \cdot K_i, \pi_{li} \cdot L_i). \tag{2}$$

YC_i are capacities, YL_i is the employment constraint and $\pi_{li} = \pi_l(k_i, \theta_i)$ and $\pi_{ki} = \pi_k(k_i, \theta_i)$ are the productivities of labour and capital. The factor productivities are determined by the capital-labour ratio k_i and production efficiency θ_i. The factor prices are assumed to be exogenous at the firm level. These assumptions imply constant marginal costs within the capacity limit. <u>Figure 3</u> provides a visual impression of the model. For the short-run adjustment, two cases can be distinguished:

1. In recession periods with sufficient capacities (negative demand shocks, $\varepsilon_1 < \overline{\varepsilon}_i$), the optimal price $p(w_i)$ is determined by unit labour costs w_i/π_{li} and the price elasticity of demand η_i. Output results from introducing this price into the demand function, and employment is the labour input required to produce this output. The firm suffers from underutilization of capacities.

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[8]For a more detailed discussion of the model, see Smolny (1998a,b,1999).

Figure 3: Price and quantity adjustment
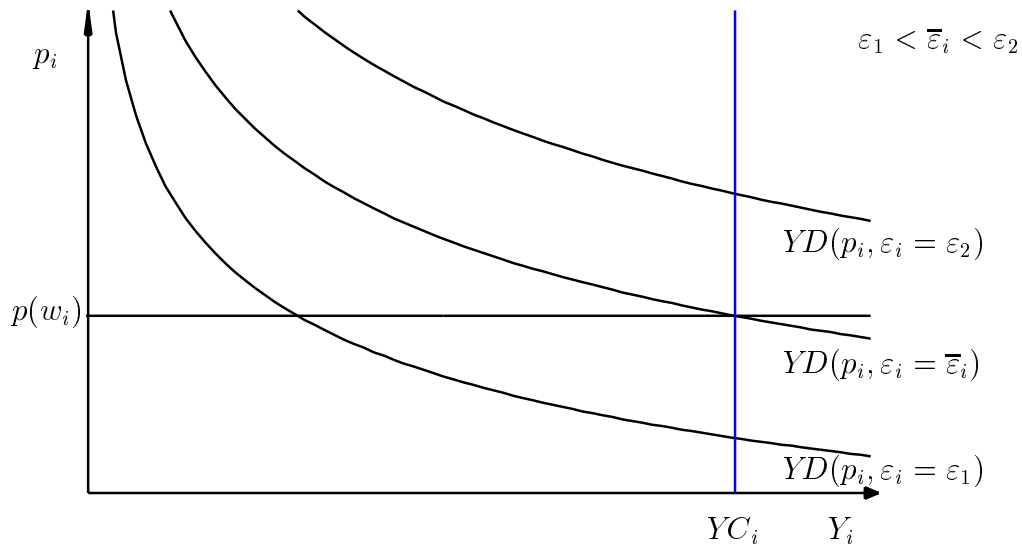
2. In boom periods with capacity shortages (positive demand shocks, $\varepsilon_2 > \overline{\varepsilon}_i$), output is determined by the capacity constraint YC_i. Employment is again given as the corresponding labour requirement, and the optimal price is determined by the ratio of the demand level and capacities. Insufficient capacities restrain output and employment, and the firm increases the price.

The most important characteristics of the short-run model are the minimum price $p(w_i)$ and the capacity limit YC_i. The supply curve of the firm is horizontal within the borders of capacity and vertical at the capacity limit. This provides a first hint towards the macroeconomic adjustment. The adjustment with respect to demand changes depends on the availability of capacities, i.e. aggregate capacity utilization:

– Firms with sufficient capacities adjust output and employment, the price remains unchanged. This corresponds to the Keynesian multiplier model which is relevant in recession periods.

– Firms with capacity constraints adjust the price, and output and employment remain unchanged. This corresponds to the classical model which is relevant in boom periods.

Finally, the implied price setting corresponds to a kind of Phillips-curve model for the aggregate adjustment: Prices are determined by unit labour costs and capacity utilization. Note also the implied asymmetry of the price and quantity

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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 by marginal costs and the price elasticity of demand, and output and employment are reduced instead.[9] A similar asymmetry results for cost changes.

In the long run, the firm decides on capacities and the production technology. For the investment decision, the following properties can be derived:

- Expected demand shifts Z_i affect the capital stock, expected output and expected employment proportionally; investment can be understood as an adjustment of the capital stock with respect to demand. This implies an accelerator mechanism for aggregate investment which introduces a source of instability into the aggregate adjustment.

- Higher costs increase prices proportionally and reduce optimal capacities. The average price is determined as mark-up over labour and capital costs; it is not affected by the level of demand. The mark-up is determined by competition η_i and uncertainty $\text{var}(\varepsilon_i)$.

- The probability of (short-run) capacity constraints is determined by relative capital costs, uncertainty and competition, i.e. not by expected demand shifts.

- Capital-labour substitution is determined by relative factor costs, but uncertainty favours the flexible factor, i.e. employment.

This yields another hint towards the macroeconomic adjustment. The long-run supply curve is horizontal, average prices are determined by production costs, and demand shifts increase all quantities proportionally.

For estimation purposes, the microeconomic minimum condition of supply and demand of the firms can be explicitly translated into a macroeconomic relation between the aggregates. Aggregate output Y can accurately be approximated by a CES-type function in terms of aggregate capacities YC and aggregate demand YD,

$$Y^\rho \approx YD^\rho + YC^\rho, \quad \rho < 0. \tag{3}$$

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. (3) as

$$\frac{\partial Y}{\partial YD} \cdot \frac{YD}{Y} = \left\{ \frac{YD}{Y} \right\}^\rho = \text{prob}(YD_i < YC_i) \tag{4}$$

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[9]In case of a delayed adjustment of prices and employment also, rationing of demand (delivery lags) or underutilization of employment (labour hoarding) occur.

$$\frac{\partial Y}{\partial YC} \cdot \frac{YC}{Y} = \left\{ \frac{YC}{Y} \right\}^{\rho} = \text{prob}(YD_i > YC_i) \qquad (5)$$

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 share of firms exhibiting capacity constraints is determined by aggregate capacity utilization. If 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.

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, corresponding to capacity constraints. In this case, aggregate employment L depends on aggregate labour supply LS as well,

$$L^{\rho} \approx LD^{\rho} + LS^{\rho}, \qquad (6)$$

$$LD^{\rho} \approx (YD/\pi_l)^{\rho} + (YC/\pi_l)^{\rho}. \qquad (7)$$

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

The assumption of a delayed adjustment of capacities and capital-labour substitution extends the standard model by introducing demand uncertainty and permits to analyse the resulting inefficiencies. Ex ante, the firms choose capacities and the production technology under uncertainty about demand. Ex post, different regimes on the goods market and underutilization of capacities are possible. The short-run demand multiplier depends on the share of firms with capacity constraints, or aggregate capacity utilization. In the long run, firms with capacity constraints adjust 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 exhibit an effect on prices, capacity utilization and regime proportions only in the short run.

4 Empirical Assessment

4.1 Structure of the Model

The macroeconomic model introduced in the previous section can be matched with aggregate data in terms of a macroeconometric disequilibrium model, the so-called Konstanz Mannheim Disequilibrium Model. It is a medium-sized macroeconometric model which was developed to classify unemployment in different states of rationing on an empirical basis. Previous versions were constructed for the West German economy including goods and labor market as the main building blocks. In this sense it is primarily developed to analyse the real activities of a medium size open economy.

The model determines regime shares and corresponding levels of employment for each point in time. Regime shares are defined as the shares of firms facing capacity, demand and labor supply constraints. The model's most notable feature is the capability to allow for different rationing constellations at the same time on the aggregate level.

Almost all equations are estimated in an error-correction specification, which mirrors short-term deviations from long-term relationships. The time horizon of simulations with this model ranges between three to ten years to cover both short-run dynamics and the tendency towards the long-run solution.

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. First, we have to deal with some statistical problems.

4.2 Modeling German Unification

The most important problem of modeling German unification is the structural break in most time series. As an example, the GDP for the Federal Republic of Germany rose by about 50 billion DM by unification, which meant a growth rate of 7.9% at one point of time. On the labour market labour supply increased from 27 million to 33 million in a single step. Moreover, employment suddenly increased about 30% and remained above the former level. Another problem is the timespan of data available for unified Germany. Since unification occurred in October 1990, we have only about 30 observations so far; for some series, the West German data last only until 1994.

Our first approach of modeling time series changing dramatically was merging

the data for West Germany and unified Germany from the first quarter of 1993 onwards. As mentioned above, it is quite difficult to model the transition process in East Germany, particularly within the first years. We had to assume that economic adjustment had made considerable progress. An error correction form was chosen to model the dynamic adjustment processes. We estimated the whole model and our approach seemed to be successful at first glance. In order to handle the structural change in 1993.1 we used two kinds of dummies: shift dummies were chosen for the jump on a higher level; a single dummy was taken for the period 1993.1 to consider the bias in the growth rates. International transactions differ from this and were merged earlier. Although the results seemed to be promising, there were some critical problems:

- The West German and German Systems of National Accounts were mixed together at two different points of time. This implied an estimation bias.

- The dynamics of the adjustment process were not modeled correctly.

- The estimates were not robust and highly depended on the chosen dummies.

In order to avoid these shortcomings, we chose, as an alternative, Zellner's (1962) Seemingly Unrelated Regressor (SUR). SUR estimates are obtained by estimating a set of linear equations by imposing cross-equation constraints. In the SUR method, the residual covariance matrix has a particular structure. Only the disturbance terms of each equation are correlated with each other. A gain in efficiency occurs because in estimating the coefficients of a single equation, the SUR procedure takes account of zero restrictions on coefficients occurring in other equations. The idea for solving our problem is to estimate two equations simultaneously by SUR: One equation for West Germany, the other equation for unified Germany. In the first step, a robust single equation for West German data is developed. In a second step, we assume to have a similar behaviour of the agents in unified Germany. Therefore we use the same specification by imposing the cross equation restrictions, except for the constant. This two-equation-system is estimated simultaneously by applying Aitken's estimator. In order to extract a maximum of information from the available data, the West German data covering the time span from 1960 to 1994 and the data for unified Germany from 1991 to 1997 are employed. The benefits of this method are obvious:

- We operate with two consistent Systems of National Accounts.

- The efficiency of the estimator is increased and a maximum of information from the available data is exploited.

- Dynamics can be modeled correctly, because artificial growth rates are avoided.

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– The estimates depend less on the chosen dummies. In most cases dummies can be avoided.

The imposed coefficient restrictions can be tested using Wald tests and other model specification tests. However, due to the limited number of available observations for unified Germany, only restrictions on subsets of the parameters are tested in the current version.

The theoretical model suggests to use error correction approaches for the estimation of the empirical model. The estimation procedure involves the following steps. First, the time series properties of the data are tested by means of unit root tests. Second, an error correction model was estimated for the West German data in one step with the methods of ordinary least squares. This model serves as a starting point for the two-equation-system. The two-equation-system for West Germany and unified Germany is estimated by SUR imposing the cross equation restriction with the West German equation. These restrictions are tested step by step for subsets of the parameters, i.e. dynamics and the long–run solution.

4.3   Estimation Results

Investment

The conditions of the economic and monetary union and the consequences for demand, output and employment in East Germany were already discussed in section 2. Under these severe circumstances, East German firms had to strive for survival. New jobs could be generated only by new investments. Given the financial conditions of most East German firms, the implied wage push and the breakdown of demand for East German products, governmental reactions seemed necessary. The German government reacted by providing large sums of financial means to rebuild the industrial base in East Germany and to foster long-term growth and employment. Governmental policy preferred to concentrate financial support on the factor capital. It rejected the alternative strategy of subsidizing labour because of the danger of conserving uncompetitive labour-intensive production structures. Furthermore, employment subsidies could have encouraged trade unions to enhance their wage claims.

The most important instruments of governmental support were investment bonuses (Investitionszulagen), investment grants for the improvement of regional economic structures (Gemeinschaftsaufgabe "Verbesserung der Wirtschaftsstruktur"), extra depreciation allowances (Sonderabschreibungen) and subsidized loans. While investment bonuses were available only for new equipment, investment grants were also given for buildings. The investment bonus was not subject to taxation, but the investment grant was. Besides the normal depreciation practice - which is limited by 30 percent in a degressive scheme on equipment and much

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smaller in a linear scheme on buildings - firms in East Germany had access to an extra depreciation allowance of up to 50 percent in the first year, combined with a complete linear depreciation in the first five years. German government banking institutions launched several credit programs to support smaller firms in East Germany by granting them loans at reduced interest rates. Conditions varied widely over these programs. From mid 1990 to mid 1998 firms received investment bonus and grants in the amount of 69 billion DM. Financial support for equity capital and the establishment of firms totaled about 22 billion DM. Granting favourable loans and other programs to get outside capital amounted to about 66 billion DM [10].

Moreover, an office to privatize the former state-owned companies, the "Treuhandanstalt" (THA), was founded by the government. The THA had to find potential purchasers for transfers of firms into private ownership, to oblige them to create new jobs, to invest a specific volume, and to control keeping the contracts. In order to keep the location of the firms, it was very interested to find as much buyers as possible and therefore was willing to grant generous financial means to the contractual partners. Many economic agents were motivated to buy state-owned companies to receive these financial means which were mainly invested in eastern Germany but often used for other purposes also.

All these public incentives for private investment have to be considered in the empirical specification of the investment equation. Therefore, we construct a single variable *sub* which is calculated as a rate by dividing the total investment grants given for East Germany through the private investment volume. Since data were only available on an annual basis, the values of *sub* are on a constant level each quarter within a year. Moreover, we have to find a solution for the capital stock problem. Capital stock data for East Germany are subject to a large degree of uncertainty in 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 Statistics 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, which was induced by the public investment programs and generous tax relief. Data on the capital stock of unified Germany are available from 1991 on an annual basis. Using the perpetual inventory method

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[10]Kiel Institute of World Economics (1999), p. 29.

proposed by the Federal Statistics Office, we obtain quarterly data and a total of 28 observations.

The empirical implementation of the investment function from the theoretical model (see section 3) is also an error correction specification. The error correction term defines the long-run relationship between capital stock, real economic activity, the relevant prices and governmental support programs.

In order to assess the robustness of our investment specification for West Germany and unified Germany, estimation was performed for different samples. The results are summarized in <u>table 1</u>. 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 report 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 an error correction term of the capital stock, expected production activity $(E(\ln y^a))$[11] and the real user costs of capital (uc). User costs are defined as the rate of depreciation plus the real interest rate multiplied with relative prices for investment goods. The specification for unified Germany also considers the variable sub, which includes the governmental support for private investment.

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 five lags. The long–run relationship indicates an elasticity of the capital stock with regard to expected production 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 lag $t-6$ for modeling expectations about future output is based on a procedure selecting the optimal lag length resulting in the smallest standard error of estimation[12].

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). Again, the estimates for West Germany are almost identical to those obtained in column (2).

Wald tests were chosen to examine restrictions on the dynamics in a first step

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

[12]The procedure is described and motivated in more detail in Smolny (1993) and Franz, Göggelmann and Winker (1998).

Table 1: 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	0.020 (4.42)	0.014 (4.48)	0.015 (5.00)	0.137 (5.68)
$\Delta \ln K_{t-1}$	0.764 (9.61)	0.823 (11.46)	0.844 (15.30)	0.252 (3.14)
$\Delta \ln K_{t-2}$	0.094 (1.06)	0.112 (1.32)	0.034 (0.58)	0.254 (3.13)
$\Delta \ln K_{t-4}$	0.461 (5.25)	0.483 (5.69)	0.608 (9.33)	-0.109 (-1.43)
$\Delta \ln K_{t-5}$	-0.547 (-7.10)	-0.588 (-8.23)	-0.670 (-12.10)	0.044 (-0.61)
$\ln K_{t-1}$	-0.005 (-3.17)	-0.005 (-3.04)	-0.005 (-3.95)	-0.037 (-10.85)
$E_{t-6}(\ln y_t^a)$	0.004 (2.06)	0.004 (2.28)	0.005 (3.13)	0.029 (10.20)
uc_{t-1}	-0.006 (-1.56)	-0.001 (-0.25)	-0.0001 (-0.06)	-0.0001 (-0.06)
sub_{t-1}	$-$	$-$	$-$	0.022 (5.18)
$\bar{R}^2$	0.983	0.982	0.982	0.992
SEE $\cdot$ 1000	0.535	0.545	0.551	0.165
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

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and restrictions on the long-run coefficients in a second step.[13] All coefficient restrictions for unified Germany had to be clearly rejected.[14] 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 etc.). Return on investment before taxes was extraordinarily high, firms were highly motivated and investments were realized within impressively short time. Therefore, the dynamic part of the investment process was less different. 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 (3.7% versus 0.5%). The variable mirroring fiscal incentives, *sub*, is also highly significant and clearly shows the impact of generous governmental support on investment in East Germany. This effect is the base of our policy simulation in section 5 where we analysed the effect of financial support by halving its volume.

To sum up, investment behaviour after unification was different from before. Since the changes are small for West German investment, the differences mainly have to be attributed to the specifics of investment in 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 willingness to invest was highly driven by governmental incentives.

Employment

Let us now turn to the employment effects of unification. As discussed in section 2, the breakdown of demand for East German products was accompanied by a shift towards West Germany. The effects of the resulting enormous demand increase in West Germany are mirrored in our macroeconometric model.[15] Here, a few central estimation results are reported. Figure 4 provides estimates of the employment series. Besides employment L and labour supply LS, capacity employment L(YC) and demand determined employment L(YD) are depicted as derived in equations (6) and (7) in the theoretical model. L(YC) describes the capacity constraints for employment, while L(YD) gives the employment level necessary to produce goods demand.

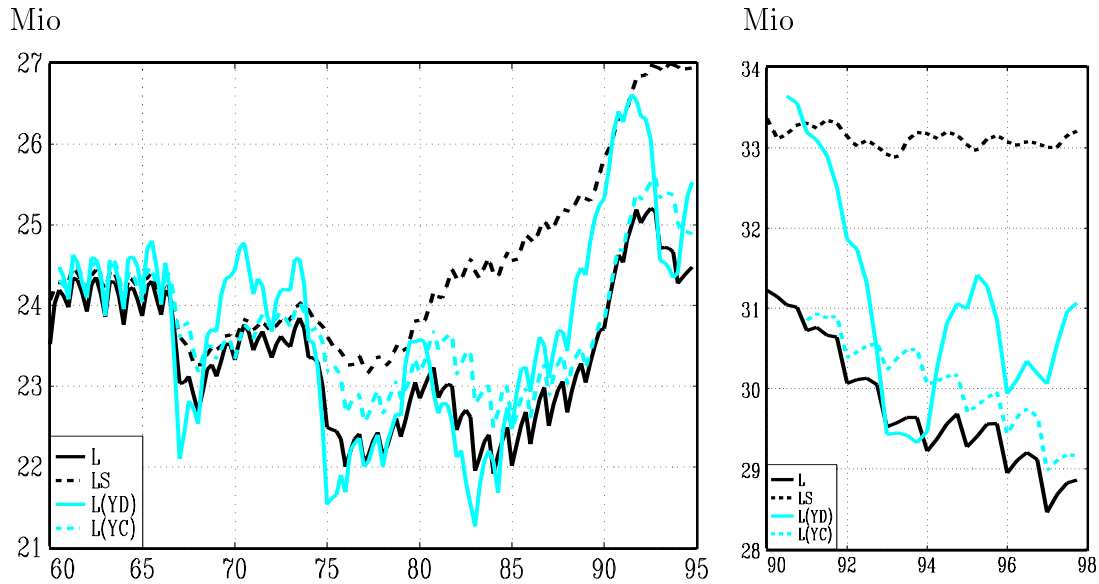The left hand plot shows firstly the tremendous increase in labour supply in

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

[14]see table 3.

[15]A simulation of these effects is undertaken in section 5.

Figure 4: Employment series

West Germany LS during the 1980s. It continued after unification up to 1992. A part of this further increase of almost 2 million people can be attributed to intra-national labour mobility. Although increasing 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 exceeded labour supply. By contrast, capacity employment L(YC) falls short of labour supply by more than 1.5 million. Although growing faster than labour supply from the mid 80s, capacities in West Germany failed to catch up with labour supply and increased goods demand in the aftermath of unification. Hence, existing capacities have become the major limiting factor to employment in West Germany.

The recession in 1992/93 is marked by a sharp decrease of demand determined employment, which led to less investment and finally strengthened 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 of the figure 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. Furthermore, capacity employment L(YC) shrinks in Germany mirroring both a slight decrease for West Germany and the economic depreciation of the East German capital stock.

Demand side effects were almost irrelevant in West Germany during the early

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years of unification when repressed consumption could finally be realized out of savings and 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 labour market performance in the late 1990s. Now, again the capacity constraint dominates employment.

The next step of modeling the labour market consists in linking the estimates for demand determined employment, capacity employment and labour supply with actual employment by the aggregate labour market function. This provides an estimate of the mismatch on the labour market. The mismatch parameter for the labour market is modeled by a deterministic time trend both for West Germany and unified Germany. The estimates indicate an increasing mismatch from 1960 onwards and a slightly higher degree of mismatch for unified Germany. The difference, however, is not significant.

The long-run relation between labour supply, capacity employment and demand determined employment is estimated by a static CES function derived from the theoretical model.[16] This static relationship does not differ significantly between West Germany and Germany after unification. However, the dynamic adjustment of employment towards this static relationship may differ. Dynamic adjustment is modeled in an error correction framework. Unfortunately, the limited number of observations for unified Germany (1992–1997) does not yet permit the serious estimation of this approach. Nevertheless, it is possible to analyse adjustment in West Germany prior and after unification, respectively. Dynamic behaviour on the labour market is modeled in a further error correction model, 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 <u>Table 2</u> below. The estimates for West Germany for 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. The system estimates are provided in columns (3) and (4) again. Since the dynamic part of employment was quite similar, coefficients were restricted. In the long term of the error correction model adjustment parameter did not differ significantly.[17]

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[16]see equation(6) and equation(7).

[17]see table 3.

Table 2: Error Correction Models for Employment

Dependent variable: $\Delta \ln L_t$				
	(1)	(2)	(3)	(4)
	West Germany	West Germany	West Germany	Unified Germany
c	0.083 (2.60)	0.059 (2.55)	0.065 (3.19)	0.069 (3.14)
$\Delta \ln L_{t-1}$	0.257 (3.03)	0.258 (3.23)	0.244 (3.62)	0.244 (3.62)
$\Delta \ln L_{t-4}$	0.590 (9.27)	0.611 (10.40)	0.562 (10.75)	0.562 (10.75)
$\Delta \ln L_{t-5}$	−0.380 (-6.00)	−0.335 (-5.66)	−0.287 (-5.85)	−0.287 (-5.85)
$\Delta \ln L^*_t$	0.275 (9.10)	0.298 (10.23)	0.306 (11.41)	0.306 (11.41)
$\Delta \ln L^*_{t-1}$	0.030 (0.64)	0.032 (0.74)	0.009 (0.23)	0.009 (0.23)
$\Delta \ln L^*_{t-2}$	−0.072 (-1.83)	−0.050 (-1.40)	−0.043 (-1.44)	−0.043 (-1.44)
$\Delta \ln L^*_{t-4}$	−0.081 (-2.11)	−0.082 (-2.15)	−0.088 (-2.52)	−0.088 (-2.52)
$\ln L_{t-1}$	−0.168 (-3.63)	−0.139 (-3.66)	−0.154 (-4.63)	−0.154 (-4.63)
$\ln L^*_{t-1}$	0.142 (3.49)	0.122 (3.44)	0.133 (4.34)	0.133 (4.34)
$\bar{R}^2$	0.945	0.938	0.938	0.910
SEE · 1000	0.251	0.254	0.258	0.264
Sample	61:3-88:4	61:3-94:4	61:3-94:4	90:3-97:4

t−values in parentheses

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5 Policy Simulations

Two policy simulations are carried out in order to assess the empirical content of our macroeconometric disequilibrium model in the context of German unification. The first simulation analyses the impact of the demand shock on the West German economy in the aftermath of unification. The second simulation is concerned with the effects of the generous financial support by the government for private investment in East Germany. Some key results of both simulations are reported in figure 5 (left panels for the first and right panels for the second simulation).

Export Shock

Our first simulation concentrated on the enormous demand increase in West Germany after the opening of the wall. The upper left panel of figure 5 shows the share of West German "exports" towards East Germany Xw-X as share of West German gross domestic product Yw. This demand push amounted to 9 percent in 1992-1994. What would have happened when this extraordinary demand stemming from East Germany would have been smaller? For this purpose, we assume that exports to eastern Germany were reduced by 25% from the third quarter of 1990 on. This negative demand shock totals 4.9 billion DM in 1990.3 and reaches 16.7 billion DM in 1994.4. The simulation period is 1990.3 to 1994.4. For the period after 1994, West German national accounting are not available from the Federal Statistical Office. This simulation period includes both a regime dominated by capacity constraints in 1990.3-1992.1 and a demand constrained regime in 1992.2-1994.2.

The second left panel exhibits the relative differences of output Y and goods demand YD. Reported are the relative differences of shock vs. control simulation. During the capacity regime before 1992, the effect of the demand shock is much larger for goods demand than for output itself. However, to the extent that the demand regime gains importance in the recession 1992, the gap closes. Output would have been smaller by almost 2 percent, i.e. 10 billion DM per quarter, by the end of 1993 given a smaller demand increase from East Germany, which could have resulted, e.g. from a less favourable exchange rate for private monetary assets.

The main focus of our macroeconometric model is the labour market. Therefore, the bottom left panel of figure 5 provides figures for the relative differences in the employment series. The effect on demand determined employment L(YD) corresponds closely to the effect on demand itself, since effects on technology, which might blur this relation, are relevant only in a longer horizon. Demand determined employment shrinks by up to 600,000 employees in 1993.1, i.e. by more than 2 percent of the West German labour force. In contrast, capacity employment L(YC) does not show any effect in the beginning and decreases only marginally from

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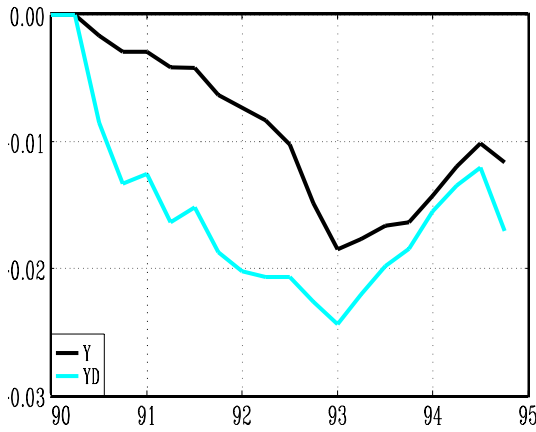Figure 5: Simulated effects of export and fiscal policy shocks

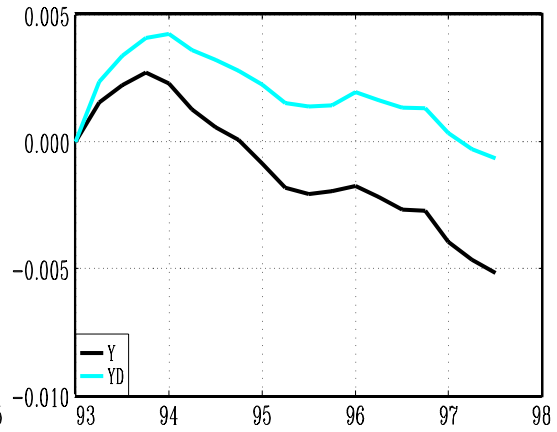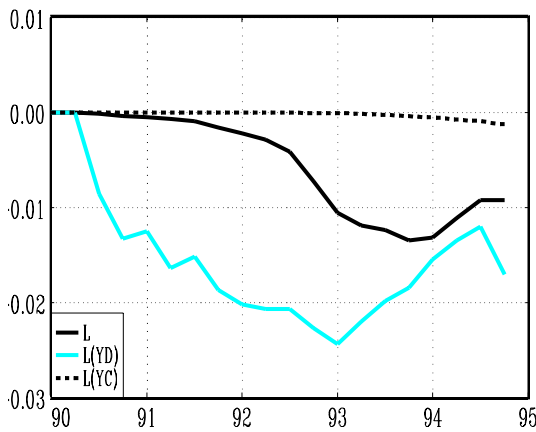Exports: West towards East Germany
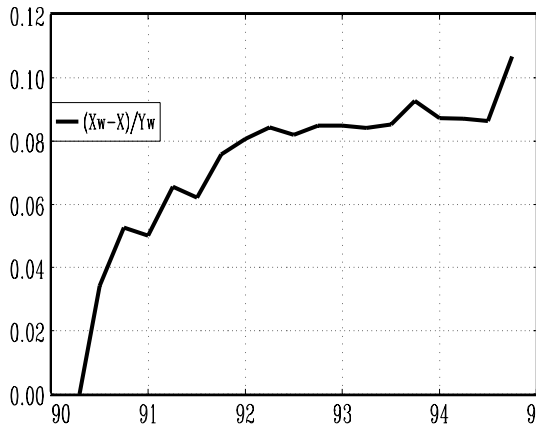
Capacities, Germany
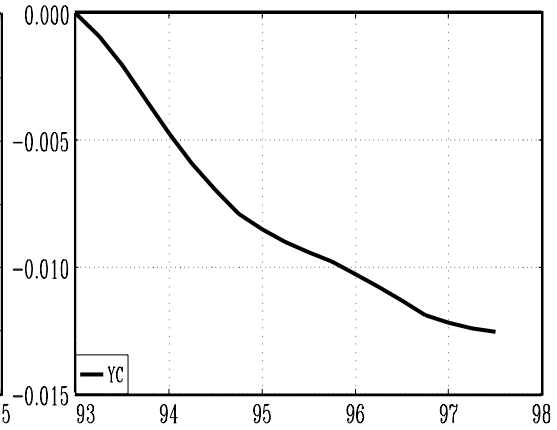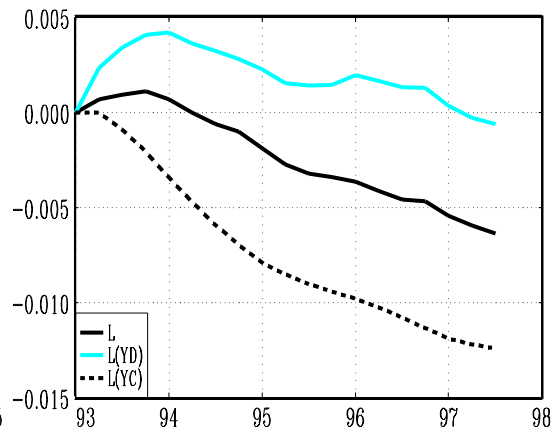
Demand and output, West

Demand and output, Germany

Employment, West

Employment, Germany

1993.1 onwards. Two reasons can be put forward to explain this very sluggish reaction: First, the time span from the investment decision to its realization lasts about six quarters and the adjustment to the optimal capital stock is quite slow (see the estimates in table 1). Second, during the first quarters of our simulation period, the economy was still in a capacity regime, i.e. the reduced demand gains importance for investment decisions only from about 1992.1 onwards, when the economy turned to a demand regime. Total effects on employment L become relevant only from about 1992.1 onwards, when demand determined employment falls short of capacity employment. To sum up, the effect of our simulated export shock is more distinctive in a demand regime than in a capacity regime.

Fiscal Policy Shock

We carried out a second simulation for unified Germany in order to get an impression about the influence of the enormous public support on private investment. Therefore, we assume that the financial incentives were halved, i.e. a reduction of the variable *sub* by 50%. This reduction saves at least half of the expenditures for governmental investment subsidies in East Germany.[18] We assume that this money is spend for governmental consumption. The simulation period is chosen from 1993.2-1997.3. This implies a concentration on the capacity regime, which is dominant from 1994.2 onwards. Reported are again the relative differences of shock vs. control simulation.

The cut back of financial support causes a decrease of the capital stock by about 1.25 percent until 1997.3. This development corresponds to a loss of an accumulated gross investment volume of 86 billion DM over the whole simulation period. The slowdown of investment translates into smaller capacities YC. The upper right panel shows the simulated change of capacities YC. Although the slowdown of investment builds up to a relevant extent over the years, the short–run impact on aggregate demand is small and overcompensated by the additional governmental spending. Therefore, the simulated change in demand YD in the middle right panel is positive over almost the complete simulation period. Nevertheless, since capacities were the main limiting factor from 1994.2 onwards, the simulated reductions of investment lead to a further strengthening of this constraint and, consequently, to a decrease in output Y by 0.5 percent in 1997. This result highlights again the difference of our model with endogenous regime determination from a standard Keynesian multiplier model.

Employment L (lower right panel) is also reduced by about 0.5 percent in 1997. The effect on capacity employment L(YC) is even larger and only partially compensated by the increase of demand determined employment L(YD).

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[18]In fact, due to the resulting decrease in investment, the savings are even larger. Thus, our simulation provides a conservative estimate of the demand side effects.

6   Conclusions

The transformation process in the middle and east European economies consti-
tutes a tremendous task for policy makers and economic advisers. The case of East
Germany is a special case for several reasons. The political system was adopted
from West Germany. The change of the economic system came in one step, in
less than one year, but was cushioned by huge transfers, which are possible due to
the relative size and wealth of East and West Germany. Nevertheless, production
broke down by 40 percent and about two third of jobs were lost in East Germany.
At the same time, West Germany experienced a unification boom with increases of
demand, output and employment. The adjustment of the East German economy
towards West Germany is slow. Today, total factor productivity reached about
50 percent, starting from 40 percent in 1990, while wages are at about 60 percent
of the West German level. This implies higher unit labour costs for the East.

In this paper, the macroeconomic adjustment to the shock of German unifica-
tion is analyzed. The analysis is based on a theoretical framework with imperfectly
competitive product markets and a special emphasis on investment and employ-
ment adjustment. Clearly, the unification shock was much larger than shocks
usually analyzed in the context of macroeconometric models. Therefore, it is a
valuable finding that our macroeconometric model can cope with the resulting
regime changes to a large extent, because these regime changes are modeled en-
dogenously. Estimates are based on West German data for the period 1960-1994
and on data for unified Germany from 1991-1997 using a SUR–approach to exploit
as much information as possible. It is found that most econometric specifications
can be successfully carried over from the West German specification to a model
for unified Germany using this approach. The results also reveal differences in the
adjustment processes, in particular for investment and employment adjustment.
The differences in investment behaviour can be partially explained by the strong
influence of public subsidies on East German private investment.

Policy simulations within the macroeconometric model highlight the relevance
of the shocks related to unification and the importance of the economic regime in
West Germany when the shocks occurred. The two simulations cover the demand
increase in West from East Germany and the West German unification boom
on the one hand, and the impact of financial incentives for investment in East
Germany on the other hand.

Our future research will include further simulations of the effects of unification,
especially the impact of policy measures, e.g. effects on prices and wages, user
costs of capital taking into account the fiscal incentives, and the international
spill-over of the unification shock. Furthermore, the model will be completed by
integrating capital markets, the 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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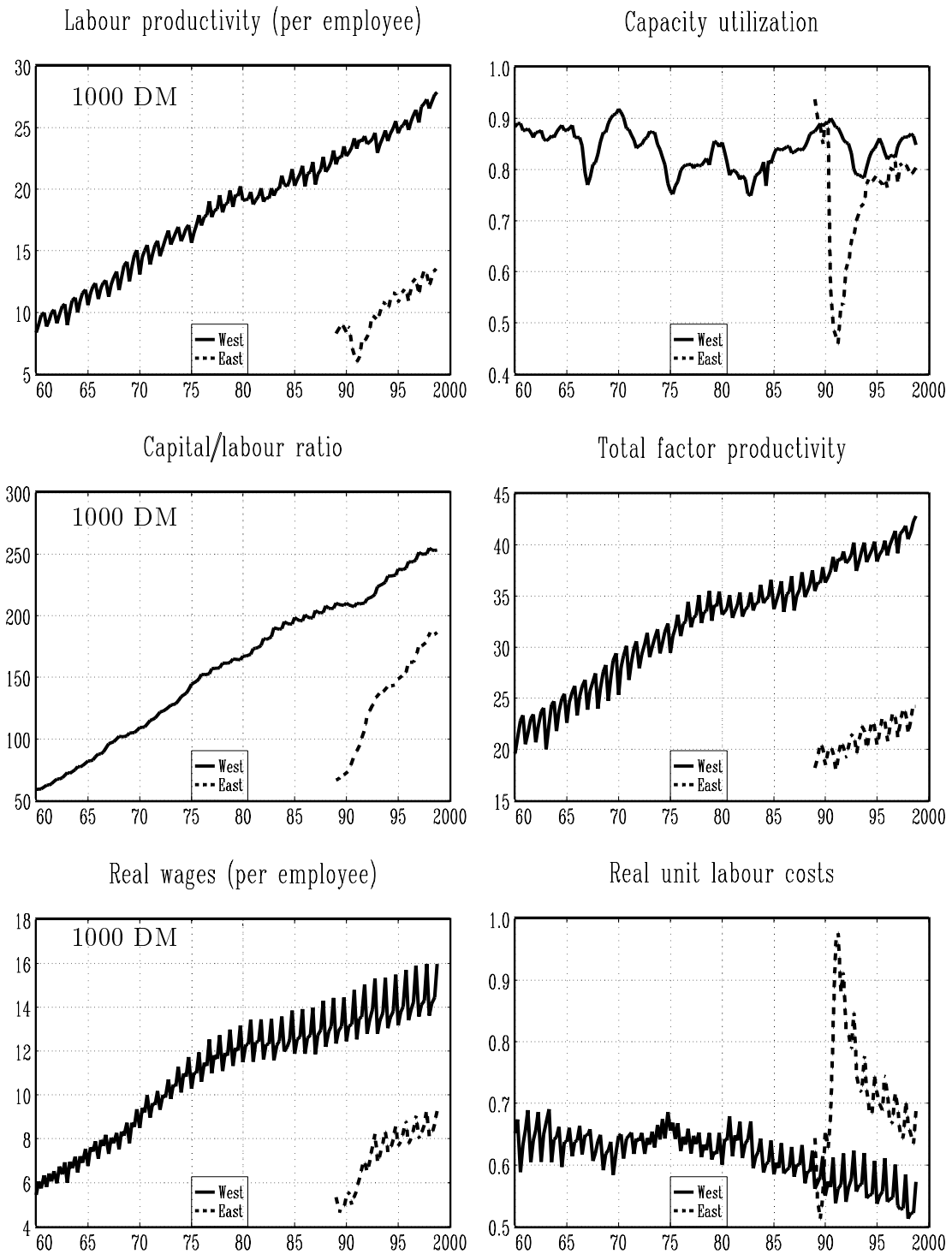
Appendix

Figure 6: Productivity

Labour productivity (per employee)

Capacity utilization

Capital/labour ratio

Total factor productivity

Real wages (per employee)

Real unit labour costs

Table 3: Wald Tests

Wald Test: Chi-square		
	Investment	Employment
dynamic	155.93 (0.00)	10.78 (0.15)
long term	84.06 (0.00)	0.91 (0.64)

p−values in parentheses