

Franz, Wolfgang; Heidbrink, Gustav W.; Smolny, Werner

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## The impact of German unification on West Germany's goods and labor market: A macroeconometric disequilibrium model in action

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Forschungsschwerpunkt  
"Internationale Arbeitsmarktforschung"

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Center for International Labor Economics  
( CILE )

Fakultät für Wirtschaftswissenschaften und Statistik  
Universität Konstanz

Wolfgang Franz  
Gustav Heidbrink  
Werner Smolny

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Postfach 5560 D 139  
78 434 Konstanz  
Deutschland / Germany

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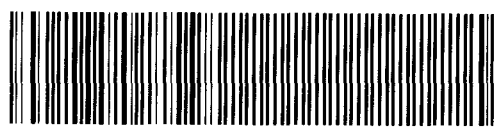
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Wolfgang Franz

Gustav Heidbrink

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### Abstract

This paper constitutes an interim report on the development of a macroeconomic disequilibrium model. Despite several caveats the model as it stands can be used already for two purposes. First, it is possible to investigate the models forecasting abilities. While the estimation period of the model ends in 1989, the forecast is made for the time period 1990 to 1993. This time period includes two events which form a real challenge to every macroeconomic model, namely German unification and the most severe recession afterwards. Secondly, the model is used to quantify selected impacts of unification on some macroeconomic variables with an exclusive emphasis on the goods and labor market. By and large, the results are in line with intuition. West Germany benefitted from unification by experiencing higher output and employment and so did major trade partners.

# 1 Introduction

The party is over in West Germany. In the aftermath of unification West Germany benefitted from enormous real growth rates which were not credited to occur in the eighties. Despite considerable immigration, employment increased and unemployment fell to levels unprecedented for many years. As of 1993, however, the West German economy suffers from one of its most severe recessions. The expected decline in real GDP in 1993 exceeds that of the previous recession in 1982. Unemployment now is higher than before unification.

Unification affected western economies in several ways. First, an expansionary fiscal shock took place partly financed by higher public deficits. Annual financial transfers to East Germany amount to some 5 percent of West Germany's GDP. While they mainly feed consumption in East Germany, customers there had strong preferences for western products. Therefore we observe an outburst of exports from West to East Germany. This is Keynesian deficit spending on a tremendous scale. Given high capacity utilization rates, West Germany could not satisfy all the goods demand from the East and had to speed up imports. Hence, trading partners also benefitted from unification due to higher imports, i.e., their economic slowdown would have been worse had there been no unification. Secondly, unification affected capital markets mainly through budget deficits resulting from transfer payments. The capital market pressure helps to explain the presence of high interest rates. In addition, the Deutsche Bundesbank pursued a restrictive monetary policy in due course of wage demands in excess of productivity growth and of the overshooting of money supply over the Bundesbank's targets. Rather than call for a realignment, partner countries in the European Monetary System, for a long time, chose to peg exchange rates and suffered from an additional slowdown in demand stemming from high interest rates. In Germany, by contrast, the lack of real appreciation has contributed to the boom.<sup>1</sup> Thirdly, labor supply in West Germany increased due to immigration and commuters. On the one hand, this skilled labor helped to mitigate the excess demand for qualified workers but was a burden to a tight housing market on the other.

While this list only represents a small selection of aspects, it highlights various channels through which unification may operate in western economies. The present paper attempts to quantify some macroeconomic consequences of

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<sup>1</sup>See Dornbusch and Wolf (1992).

unification for West Germany. The emphasis of this study is on real variables rather than on the monetary sector. Hence, we do not address the question on how monetary union affected money demand and money supply, interest rates, exchange rates and the like.<sup>2</sup> One reason for this limitation is that the macroeconomic disequilibrium model, which forms the basis of our investigation, is confined to West Germany. At present, the actual set of data on East Germany is not sufficient to allow for an econometric analysis of developments in East Germany. More specifically, separate money supplies for West and East Germany, are not well-defined. For example, banks with branches across the country can use their central bank deposits as reserves against deposits irrespective of where the deposits were made. Similar arguments hold for money demand. Moreover, we treat the exchange rate as an exogenous variable. While this is clearly a shortcoming of our study, it has been motivated partly by the unwillingness of some EMS partner countries to agree upon a realignment. Therefore, modelling exchange rate behavior econometrically looks like an extremely difficult, if not unsurmountable, task which is beyond the scope of our paper anyway.

In short, as a first goal of our paper we analyze and quantify selected impacts of unification on real macroeconomic variables, i.e., the goods and labor market take center stage in this study. A second goal, which is at least equally important, is to see our disequilibrium model in action. The estimation period only covers the years until 1989 on a quarterly basis, therefore we have to make an ex-ante simulation for a period outside the model's reference period, namely the period 1990 to 1995. Because half of this period is known, we are able to check the model's forecast abilities. As has been mentioned, another novelty of this paper is an evaluation of effects stemming from unification. This is done by various simulation experiments. Since trade with major partner countries is modelled, too, we can also address the question as to what extent German unification served as a locomotive for other countries.

The paper is organized as follows. Section 2 provides an update of some economic developments in East and West Germany. Section 3 very briefly illustrates the basic theoretical framework of the disequilibrium model including international spillovers. In section 4 the accuracy of the model's forecast is discussed. Simulation experiments with respect to unification are presented in

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<sup>2</sup>See von Hagen (1993) for a recent study on monetary union, money demand, and money supply.

section 5. Section 6 summarizes our findings and caveats.

## **2 Economic Developments in East and West Germany: An Update**

As a prerequisite for the following discussion this section is devoted to a very brief overview of economic developments in East and West Germany with an emphasis on current economic conditions in West Germany.

### **2.1 East Germany**

The formal process of German unification, from the initiating events until a full political union, was completed within one year. On November 9, 1989 borders between the Federal Republic of Germany (FRG) and the former German Democratic Republic (GDR) were opened. On July 1, 1990 the "Agreement on the Creation of a Monetary, Economic, and Social Union" (MESU) became effective. Finally, on October 3, 1990 the East German Länder – Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt, and Thuringia – joined the FRG, while East and West Berlin created the Land Berlin.

The inheritance of the socialist dictatorship in the GDR was disastrous. The level of labor productivity was evaluated to have been roughly 25 to 30 percent of the level calculated for the FRG in 1990/91<sup>3</sup> in contrast to an irresponsibly over-optimistic 50 percent estimate put forward in 1990 by the Deutsches Institut für Wirtschaftsforschung (German Institute of Economic Research) in West Berlin.<sup>4</sup> A considerable fraction of the GDR labor force was only employed because firms were overstaffed. This pertains to employees as well as to working hours spent on political tasks. One should mention in this context the political cadres and their staff (partly functionaries in enterprises, paramilitary actions etc.), the political activities of the staff during working hours (political demonstrations, combative sports units etc.), but also the wasteful administration, the times of production standstill due to missing supply of materials or to defective production plants, the missallocation of labor within the planned targets and the employees' limited willingness to produce (e.g. absenteeism during shopping hours). It has been estimated that 1.4 million employees, i.e., some 15 percent of all East German employees prior to unification were misallocated in

<sup>3</sup>Source: Statistisches Bundesamt, Fachserie 18, Reihe 1.2, Vorbericht 1991, p.272.

<sup>4</sup>Cornelsen and Kirner (1990).

due course of the aforementioned reasons.<sup>5</sup> Other economic burdens inherited from the GDR include a heavily indebted enterprise system and a distorted structure of wages and prices. Moreover, roughly two thirds of external trade was conducted with CMEA countries.<sup>6</sup> Finally, socialism in the GDR did not care about enormous environmental damage.

As if that were not great enough an obstacle against a rapid catch up with western economic standards, the MESU agreement converted wages and prices at parity, while savings and debts were converted at an average ratio of 1.8:1.<sup>7</sup> This is equivalent to a revaluation of the East German Mark of more than 300 percent<sup>8</sup>. The exchange rate shock induced a dramatic fall in international competitiveness of East German firms, exaggerated by the change of the Transfer Rouble into a convertible currency. Given the poor quality of most East German products, East German consumers and CMEA's importers immediately ignored East Germany and switched to western markets.

Rather than contributing with a relief for existing East German firms, East German unions, which at the outset were dominated by their West German "colleagues", favored a rapid catch up with wages in West Germany. The reasons for these developments have been discussed elsewhere.<sup>9</sup> Suffice it to mention that at the beginning of wage bargaining virtually no true employer was involved. Hence, it was easy to sign wage contracts at the expense of the West German tax payer who has to finance unemployment compensation and the debt of the Treuhandanstalt (the Trust Fund).

Finally, there is evidence that a considerable obstacle to a fresh start was built up by institutional barriers. It was decided in the Unification Treaty that restitution or compensation for private property appropriated by the East German State since 1945 has to be provided. In principle, property was to be restored in kind. Compensation for property loss was to take precedence only if new investments in the public interest would otherwise be hindered. As a consequence the courts will be swamped for years deciding these matters.<sup>10</sup>

Taken together, the disastrous inheritance of socialism and the mistakes in the course of unification led to a dramatic shock. The index of net produc-

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<sup>5</sup>For more details see Vogler-Ludwig (1990).

<sup>6</sup>Council for Mutual Economic Assistance.

<sup>7</sup>Source: Monatsberichte der Deutschen Bundesbank, July 1990, p.17.

<sup>8</sup>See, for example Sinn and Sinn (1992), pp.53.

<sup>9</sup>See Franz (1992).

<sup>10</sup>Heilemann and Jochimsen (1993), p.16.



tion in the manufacturing sector <sup>11</sup> declined from 195 in January 1990 to 60 in January 1991. As of June 1993 there is only a slight increase up to 73.<sup>12</sup> This outshines the Great Depression: From 1928 to 1933 industrial production dropped by "only" 40 percent <sup>13</sup>, rather than by 66 percent as in East Germany. Correspondingly, employment in the manufacturing sector fell from 3.1 million people in the first quarter of 1990 to 1.2 million in 1993/I.<sup>14</sup> In total, employment in East Germany amounted to 5.5 million people in 1993/I compared with 9.6 million in 1990/I, i.e., a reduction of 42 percent within three years. Figures for unemployment mirror these developments. As of mid 1993, 1.1 million are officially registered as unemployed (official unemployment rate: 15 percent). However, there is a considerable amount of hidden unemployment such as people who are participants in work-creating measures or vocational training courses financed by the Federal Labor Office or are on early retirement schemes (about 1.3 million people). Taking into account also short-term workers, a corrected unemployment rate for East Germany in 1993 is about 35 percent on average. Presumably, this figure exceeds that of the Great Depression, too.

The forecasts for East Germany for 1994 do not give rise to greater optimism. Although real GDP is predicted to grow at a range between 7.5 percent and 5.5 percent (depending on what measures are undertaken to limit the federal government's budget deficit), employment is forecasted to continue to fall between 1.5 and 2 percent, while officially measured unemployment will remain at the 16 percent mark estimated for 1993.<sup>15</sup>

## 2.2 West Germany

Unification provided a first order demand stimulus for the West German economy which spilled over to major trading partners. As is displayed in Table 1 real GDP growth peaked in 1990 with a five percent rate. This expansion was mainly driven by an investment spurt and the tremendous increase in exports. More specifically, exports from West to East Germany amounted to an annual average of roughly 200 billion DM between 1990 and 1993, i.e., about 7 percent of West Germany's GDP. Given the high degree of capacity utilization in West

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<sup>11</sup> Second half of 1990=100.

<sup>12</sup> Source: Bundesministerium für Wirtschaft, Tagesnachrichten, various issues.

<sup>13</sup> Sinn and Sinn (1992), p.29.

<sup>14</sup> Source: Deutsches Institut für Wirtschaftsforschung, Wochenbericht, various issues.

<sup>15</sup> Source: Deutsches Institut für Wirtschaftsforschung, Wochenbericht Nr. 26-27/1993, p.371.

Table 1: West Germany's Macroeconomic Performance 1989–1993/II  
(percentages)<sup>a)</sup>

	1989	1990	1991	1992	1993 <sup>g)</sup>
real GDP growth	3.4	5.1	3.7	1.5	-2.5
real investment growth	9.4	8.7	6.5	1.5	-5.9
real export growth <sup>b)</sup>	11.5	11.1	12.8	3.2	-4.0
real import growth	8.4	11.9	11.7	3.5	-4.2
long-term interest rate	7.1	8.9	8.7	8.1	6.5
employed persons (mill.) <sup>c)</sup>	27.7	28.5	29.2	29.5	29.0
unemployment rate <sup>d)</sup>	7.1	6.4	5.7	5.9	7.2
growth rate of GDP deflator	2.6	3.4	4.1	4.5	3.6
growth rate of unit labor costs	1.1	3.0	4.2	5.0	5.9
governmental budget balance as a percentage of GDP <sup>e)</sup>	+0.1	-2.0	-3.6	-2.4	-3.5
financial transfers to East Germany as a percentage of GDP <sup>f)</sup>	–	1.9	5.0	5.6	6.0

Notes:

- a) see text for details;
- b) including exports to East Germany;
- c) employed persons incl. self employed within the borders of West Germany;
- d) as a percentage of labor force incl. self employed;
- e) according to the definition by national accounting, i.e., includes all governmental authorities and social security but not the Trust Fund;
- f) gross financial transfers to East German governmental authorities plus transfers to social security.
- g) first and second quarter only.

Sources:

Deutsches Institut für Wirtschaftsforschung, Wochenbericht 18–19/1993, 26–27/1993; 33/93; Deutsche Bundesbank, Monatsberichte, various issues; Heilemann and Jochimsen (1993); Institut der deutschen Wirtschaft, Zahlen zur wirtschaftlichen Entwicklung der Bundesrepublik Deutschland, Köln 1993; calculations by the authors.

Germany this demand was partly satisfied by imports from other countries. Real imports grew at a rate of about 12 percent in 1990/91. Correspondingly, unemployment declined to a level unprecedented in the eighties despite considerable immigration. Unemployment from 1990 to 1992 amounted roughly to estimates of the non-accelerating inflation rate of unemployment (NAIRU) or even fell short of it slightly.<sup>16</sup>

However, two unfavourable aspects clouded the economic situation. First, unions responded to the advantageous labor market conditions with demands for wage increases in excess of productivity growth. This is evidenced by the 3

<sup>16</sup>See Franz and Gordon (1993).

to 5 percent growth rate of unit labor costs from 1990–1992. Correspondingly, inflation began to spurt. It has to be recognized, however, that the rise in administered prices and indirect tax rates shares a non-negligible responsibility for the acceleration of inflation. It has been estimated that the inflation rate of consumer prices would have been 2.5 percent rather than 4.5 percent in 1993/II had administered prices remained constant.<sup>17</sup> Secondly, a major part of the financial transfers was financed by public deficits. Although Germany had worked successfully during the eighties to improve its fiscal position, the fiscal outlook deteriorated. Budget deficits as percentages of GDP exceed the three percent mark laid down in the Maastricht treaty.

In view of these developments and the overshooting of money supply over its target range,<sup>18</sup> the Deutsche Bundesbank pursued a restrictive monetary policy. For example, the discount rate was revised from 4 percent in January 1989 up to 8.75 percent in July 1992 but declined to 6.25 percent in September 1993. Long-term interest rates ranged between 8 and 9 percent in 1990 with a peak in the end of 1990 (see figure 1). Since the turn of the years 1990/91, however, long-term interest rates began to decline in Germany as well as in other industrialized countries. In 1993 most if not all long-term nominal interest rates fall short of their pre-unification levels. It is therefore not obvious that German unification induced considerably high interest rates which hurt partner countries<sup>19</sup>, let alone that “those costs outweigh any benefits generated by increased demand from Germany” [ Hughes Hallet and Ma (1993), p.422]. Unrealistic assumptions are required to emphasize a much more favourable development of interest rates in world capital markets had there been no unification and to deemphasize demand stimuli stemming from unification.<sup>20</sup> Moreover, real interest rates ranged between 5 and 2 percent in the period 1990 and 1993 depending on which value is attributed to expected inflation. On the other hand short-term interest rates exceeded long-term interest rates presumably due to the credible anti-inflationary policy of the Deutsche Bundesbank.

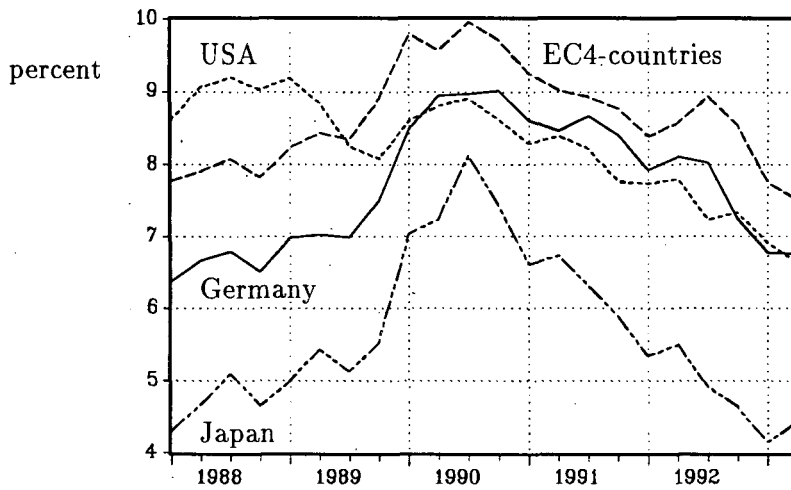
<sup>17</sup>Source: Informationsdienst des Instituts der deutschen Wirtschaft Nr.31, August 5th, 1993, p.3.

<sup>18</sup>The Bundesbank argued that the monetary union had created an excess supply of money and, hence, a potential for inflation. See von Hagen (1993) for an analysis.

<sup>19</sup>See also Issing (1993, p.4).

<sup>20</sup>A simulation study by Horn, Scheremet and Zwiener (1992) reveals the positive impacts of the German unification on EMS members and on non-EMS members which prevail even under different assumptions on interest rates and exchange rate developments.

Figure 1: Long-term interest rates



Sources:

Data for Japan, USA and for the EC4-countries (France, UK, Italy, and the Netherlands) are supplied by OECD, Main Economic Indicators, calculations by the authors. German data are taken from the Deutsche Bundesbank.

Given the slowdown in Germany's exports to major trading partners<sup>21</sup> due to the recession in these countries and given the unfavorable domestic developments such as the high public deficit, the increase in unit labor costs, and high interest rates, the West German economy has slipped into a recession since 1992. The expected decline of real GDP growth to a rate of -2 percent in 1993 exceeds that of the last recession in the early eighties. Employment is predicted to fall, hence, unemployment exceeds its pre-unification level. Moreover, there are no signs that transfer payments to the East will not stay at roughly the same level for a while. If the ambitious wage push in East Germany holds on, transfer payments may even increase. As of mid 1993, however, the federal government is working on an improvement of the fiscal outlook by cutting expenditures and raising taxes, such as a 7.5 percent income surtax to be levied in 1995 (after the presumed end of the recession).

<sup>21</sup> For example, real exports of unified Germany to foreign countries declined by 5 percent in 1991.

### 3 Overview of the Macroeconometric Disequilibrium Model

Table 2 displays the structure of our model. It can be described by four sectors: Like all models in Keynesian tradition the emphasis lies on real demand with equations explaining consumption, investment and trade. Our trade equations distinguish between German trade with four EC-countries and German trade with all other remaining countries. Regressions for transacted values of these demand variables yield notional exports and imports, i.e., exports and imports in the absence of spillover effects stemming from domestic excess demand. Total demand estimates differ from transacted values by these spillover effects.

#### Symbols:

$\Delta$	: Difference operator
$E$	: Expectation operator
$DI$	: Disposable income
$K$	: Capital stock
$R^l$	: Long-term real interest rate, (maturities more than 5 years)
$I$	: Investment
$X^{EC}$	: German exports to the EC4-countries
$M^{EC}$	: German imports from the EC4-countries
$UC$	: User costs of capital
$W$	: Wages per quarter
$P$	: Price deflator of domestic product
$PC$	: Consumption price deflator
$PI$	: Investment price deflator
$PX$	: Export price
$E^{USA}$	: Exchange rate DM/US-\$
$H$	: Worked hours
$DUL$	: Utilization of labor
$Q$	: Capacity utilisation
$YT$	: Output
$YS$	: Goods supply
$YD$	: Goods demand
$LT$	: Employment
$LS$	: Labor supply
$LD$	: Labor demand
$L_{YD}$	: Labor demand derived from goods demand
$L_{YC}$	: Labor demand derived from capacities
$LS$	: Labor supply
$UR$	: Unemployment rate
$\frac{Y}{L}$	: Labor productivity
$\frac{Y}{K}$	: Capital productivity
$t$	: Trend

The superscripts EC, USA denote the countries under consideration whereas the superscript W stand for all other countries.

## DEMAND

Consumption

$$C = C(DI, K, r^1, \widehat{PC})$$

Investment

$$I = I(t-7E(YD), \frac{W/P}{UC}, t-4)$$

TRADE

with EC4-  
countries

$$X^{EC} = X^{EC}(Y^{EC}, Q, Q^{EC}, \frac{PX}{PX^{EC}}, \frac{PX}{PX^W})$$

$$M^{EC} = M^{EC}(Y, Q, Q^{EC}, \frac{PX^{EC}}{PX^W}, \frac{PX}{PX^{EC}})$$

all other  
countries

$$X^W = X^W(Y^W, Q, \frac{PX}{PX^W}, \frac{PX}{PX^{EC}})$$

$$M^W = M^W(Y, Q, Q^{USA}, \frac{PX^{EC}}{PX^W})$$

$$\Rightarrow \text{Export Demand: } XD = \widetilde{X^{EC}} + \widetilde{X^W}$$

$$\Rightarrow \text{Import Demand: } MD = \widetilde{M^{EC}} + \widetilde{M^W}$$

Goods Demand:

$$YD \equiv C + I + XD - MD + G$$

Labor Demand:

$$LD = LD(L_{YD}, L_{YC})$$

by goods demand:  $L_{YD} \equiv YD / (\frac{Y}{L})^*$

by capacities:  $L_{YC} \equiv YC / (\frac{Y}{L})^*$

$$YT = YT(YD, YS)$$

$$LT = LT(LD, LS)$$

Wages

$$W = W(\frac{W}{P} / \frac{YT}{LT}, \frac{PC}{P}, UR)$$

Prices

$$P = P(\frac{W}{P} / \frac{YT}{LT}, \frac{PM}{P}, \frac{YT}{YS}, VAT)$$

Export Prices

$$PX = PX(P, Q, PX^{EC}, Q^{EC}, E^{USA})$$

## SUPPLY/TECHNOLOGY

$$K = K_0 + I - \text{depreciation}$$

Capital Stock

optimal

$$(\frac{Y}{L})^* = g(t-4E(\frac{W}{P}), H, t, t^2)$$

- Labor Productivity

$$(\frac{Y}{K})^* = f(t-4E(\frac{PI}{P}), H, t, t^2)$$

- Capital Productivity

$$YC \equiv K \cdot (\frac{Y}{K})^*$$

Production Capacity

$$YS \equiv LT \cdot (\frac{Y}{L})^*$$

Goods Supply

$$LS \equiv LT + U$$

Labor Supply

~ denotes notional demand (without any spillover effects).

Fully endogenized variables are in bold face.

The right hand side of table 2 describes the supply side in terms of production technology, capacities, and goods supply. From these estimates of labor and capital technology we are able to calculate short term goods supply.<sup>22</sup> Taking into account investment gives production capacities.

The third block contains the matching functions of demand and supply for output and employment. While labor supply is treated as exogenous, labor demand takes into account the following aspects: Firstly, expected goods demand and optimal labor productivity determine  $L_{YD}$ , i.e., labor demand determined by expected goods demand. Second, labor demand which stems from optimal utilization of existing capacities ( $YC$ ) can be calculated from production capacities and optimal labor productivity. This gives  $L_{YC}$ . Taken together, total labor demand cannot exceed the minimum of both sources.<sup>23</sup>

The last block in our model is devoted to wage and price determination.<sup>24</sup> Whereas wage and output price equations as well as export price equations are derived from theory, consumer and investment prices are simply a weighted average of output price and import prices.

Several kinds of transmission channels are important when a shock hits the economy. Although we observe short and long run influences of wages and prices on real variables, the main transmission channels concern real values. The best way to understand the working of the model is to refer to the goods and labor markets. If employment decreases for reasons whatsoever, goods supply declines. In a situation of excess supply the resulting effects on output are negligible, the same holds for the influences on consumption and imports. The situation changes, however, in the presence of excess demand on the goods market, i.e., if output is restricted by goods supply. The decrease in output and income leads to a fall in consumption, investments, and imports.<sup>25</sup> On the other hand, a positive demand shock on the goods market will have low spillover effects on employment if the goods market is already characterized by excess demand. But if goods demand is binding for output then employment will increase according to the speed of adjustment of labor and the willingness of the firms to invest in production capacities. Depending on the speed of adjustment of labor and capital, the impacts of shocks are mitigated.

In what follows we shortly describe the behavioral equations and estimation results and concentrate mainly on long run solutions.<sup>26</sup> The equations are estimated with quarterly data and with few exceptions, for the period 1975:1 to 1989:4 (1990:4).<sup>27</sup> Except for output equations, error correction schemes are

<sup>22</sup> Goods supply is assumed to be determined by the short run fixed production factors.

<sup>23</sup> For these minimum conditions we employ CES-functions which give an estimate of an aggregate mismatch between demand and supply when transacted values are below the minimum of demand and supply. This procedure is applied to labor demand, employment and output.

<sup>24</sup> The money market is excluded in this model for reasons mentioned above. Instead of explaining the nominal interest rate we simulate the model with an exogenous real interest rate.

<sup>25</sup> The effects on imports are mitigated if the spillover effects stemming from excess demand rise.

<sup>26</sup> The estimated equations are shown in the appendix in more detail.

<sup>27</sup> Due to a restricted availability of quarterly data, the period under observation begins 1975.

used to capture short run dynamics. Small letters denote logs of the variables under consideration.

## Labor and Capital Productivities

The long run technical labor and capital productivities are derived from a CES-production function with constant returns to scale, including labor-saving and capital-saving technical progress. Due to ex-ante substitution possibilities and profit maximizing behaviour of the firms it follows that the *technical* labor and capital productivities are jointly determined by expected real factor costs (wages  $(w - p)$  and investment price  $(pi - p)$ )<sup>28</sup> and technical progress which is approximated by a mixed linear-quadratic trend  $(\gamma_L(t), \gamma_K(t))$ :

$$(yc - l)_t^* = const. + \sigma \cdot E(w - p)_t + (1 - \sigma) \cdot \gamma_L(t) + \alpha_1 \cdot h \quad (1)$$

$$(yc - k)_t^* = const. + \sigma \cdot E(pi - p)_t + (1 - \sigma) \cdot \gamma_K(t) + \alpha_1 \cdot h \quad (2)$$

where  $\sigma$  denotes the elasticity of substitution. The variable  $h$  measures the working time and captures the effects of working time shifts between quarters. Ex-post rigidities prevent firms from always meeting their desirable labor-capital relation. Due to errors in the expectation formation of real factor costs and output shifts technical productivities deviate from actual values. These factor utilizations show the same movement in response to output shocks but we expect longer adjustment delays for capital than for labor. We use business survey data of the Ifo-institute (Munich) for utilization of capital ( $DUC$ ). A dynamic specification of the same variable serves as an indicator for labor utilization ( $DUL$ ):

$$(yt - l)_t = (yc - l)_t^* - \alpha_2 \cdot (q_t - \alpha_3 \cdot q_{t-1}) \quad (3)$$

$$(yt - k)_t = (yc - k)_t^* - \alpha_4 \cdot q_t \quad (4)$$

Because of similar short run movements of  $(yt - k)$  and  $(yt - l)$ ,  $\alpha_2$  and  $\alpha_4$  should not be significantly different, whereas  $\alpha_3$  measures the adjustment speed of labor utilization.

Our estimates support the hypotheses mentioned above.<sup>29</sup> The estimates for  $\alpha_2$  and  $\alpha_3$  are of the same size 0.364 and 0.392, respectively, and 0.493 for  $\alpha_4$  which indicates that labor is adjusted to the desired optimal labor productivity within about one quarter.<sup>30</sup> The estimated substitution elasticity  $\sigma$  depends on the time period when factor price expectations are formed. The preferred estimation shows 0.517 for  $\sigma$  when expectations are taken at period  $t-4$ . Labor-saving technical progress is positive but decreases slowly during the period under consideration. Capital-saving technical progress decreases which may be explained by energy price shocks, rendering parts of the capital stock obsolete.

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This restriction also helps to circumvent distortions after the break down of the Bretton Woods area.

<sup>28</sup>We tested for an influence of user costs of capital, but the results were clearly dominated by the real investment price.

<sup>29</sup>We employ an OLS-estimator with restrictions on the adjustment processes and on the substitution elasticity.

<sup>30</sup>These results are very stable over different specifications.



The optimal (technical) productivities are main determinants of short run and long run goods supply as well as for labor demand.

### Investment

To allow for an endogenous capital stock, net investment is to be explained while the depreciation is treated exogenously. The theoretical model emphasizes expected output constraints which may prevent firms from full utilization of capital. Further, the expected share of labor and the expected share of capital are explanatory variables for net investment. Because in our estimation period labor supply restrictions were probably absent,<sup>31</sup> we only tested expected goods demand and capacity constraints as explanatory variables and succeeded with expected goods demand. As for the share of expected labor and the share of capital, our results improve when we use the ratio of real wage to user costs of capital as a proxy.<sup>32</sup> We end up with the following long run determination of the capital stock:

$$k = \beta_1 \cdot E(yd) + \beta_2 \cdot E(w - p - uc) .$$

Estimates do not show any significant influence of capital productivity on the capital formation process which may result from the short sample period.

For the expectation formation process we tested expectations formed between  $t-2$  and  $t-10$ . The preferred estimates of investment result from expected goods demand at  $t-7$  and lagged  $t-4$  factor price ratios.<sup>33</sup> The time-lag for the factor price ratio corresponds with the preferred expectation formation for the factor prices in the productivity equations.

Estimates reveal linear homogeneity between the capital stock and expected goods demand in the long-run ( $\beta_1 = 1.013$ ) and a rather strong influence of the factor price ratio ( $\beta_2 = 0.179$ ). The dynamic specification also reveals a very slow adjustment of the capital stock to desired values.

### Consumption

Real consumption per capita ( $c$ ) is modelled by a fairly standard textbook specification. The long run determinants of consumption are disposable income per capita ( $di$ ), capital stock ( $k - n$ ) as a proxy variable for real wealth, real long term interest rates ( $R^l$ ) and the consumer price inflation rate ( $\Delta pc$ ):

$$c = \delta_1 \cdot di + \delta_2 \cdot (k - n) - \delta_3 \cdot R^l - \delta_4 \cdot \Delta pc .$$

<sup>31</sup> Labor supply restrictions should increase the capital-labor ratio.

<sup>32</sup> This may be due to the difficulties in measuring profits by labor and capital shares.

<sup>33</sup> Expectations at time  $t-7$  can only be interpreted as an average of expectations formed at different time periods. This does not exclude revisions of investment plans due to changes in expectations afterwards, but it stresses the long adjustment of capital accumulation. Several expectation formations for  $E(YD)$  are highly correlated and lead to multicollinearity problems. The expectation procedure for the factor price ratio is dominated by lagged values.

The real interest rate stands for intertemporal consumption/saving decisions while the inflation rate serves as an indicator for real wealth effects on consumption.<sup>34</sup>

The estimated elasticity with respect to income ( $\delta_1$ ) is 0.780 and the wealth elasticity ( $\delta_2$ ) is 0.174. The sum of both coefficients is not significantly different from one. We find a stable negative influence of the long term real interest rate ( $\delta_3=0.008$ ) and a smaller influence of the inflation rate ( $\delta_3=0.004$ ).

## Trade

Besides the productivity equations, the estimation of German imports and exports of goods represent key elements of our model. In order to estimate the effects of the German unification on our main EC-trading partners, total German exports and imports are separated into two country groups: trade with four EC-countries (France, Italy, UK and the Netherlands (EC4-countries)) and trade with all other countries (W). While exports and imports are part of total output the trade equations also indicate the spillover effects which result from excess demand on the domestic market. The model predicts that excess demand increases import *demand* and decreases exports because consumers and investors try to circumvent domestic rationing by increasing imports. The influence of excess demand on exports is not obvious. We expect a negative influence of the domestic rationing indicator on exports if German producers prefer to deliver to their home markets. These effects are mitigated if domestic firms do not want to jeopardize their export market positions and serve these markets firstly. Spillover effects from abroad influence trade in goods in the same manner. The capital utilization rates serve as indicators for these rationing barriers.

The explanatory variables for notional exports and imports are output of the importing country (as an indicator for notional import demand), relative export prices and the capacity utilization rate of the foreign country. This shows up in the following long run specification for German exports and imports:

$$X^i = XD(z^i) - \gamma_1^i \cdot (q - q^{\min}) \quad (5)$$

$$M^i = MD(v^i) + \gamma_2^i \cdot (q - q^{\min}) \quad (6)$$

with  $i = \text{EC4, W}$

$XD^i(MD^i)$  means export and import demand, respectively.  $z^i, v^i$  are vectors of the explaining variables described above.  $\gamma_1^i$  measures the negative influence of the deviation of the utilization rate from its historical minimum and  $\gamma_2^i$  is the corresponding coefficient for German imports which increase when the

<sup>34</sup>The capital stock only includes real wealth components. Nominal components of wealth are devalued by increasing inflation rates. It follows an expected negative influence of  $\Delta pc$  on consumption. Earlier work of Franz, Heidbrink, Scheremet (1992) reveals a negative influence of the unemployment rate which mirrors expectations about future income according to the life-cycle hypothesis of consumption. The data of our period under consideration does not show any significant influence of the unemployment rate which may result from low variations of this variable and from unemployment benefits.

utilization rate exceeds its minimum value.<sup>35</sup>

Results indicate that there are strong spillover-effects of German excess demand on imports. For both, imports from the EC4-countries as well as for imports from all other countries, we find nearly equal coefficients ( $\gamma_1$ ) of about one. This high value may be in favour of the locomotive hypothesis of the German economy. In the export equations, the coefficients ( $\gamma_2$ ) are significantly negative, i.e., German firms are likely to serve their home markets firstly. The relative low values for  $\gamma_2$  of about 0.3 indicate that the spillover effects on exports are modest.

## Output and Employment

Having calculated export demand and import demand we are now able to determine total demand:

$$YD = C + I + XD - MD + G \quad (7)$$

where  $G$  denotes the exogenous component of demand, e.g. government demand, net trade in services, housing investment and inventories. By making use of our estimates of the technical productivities goods supply  $YS$  and capacities  $YC$  can be derived:

$$YS \equiv YT/(Y/L)^* \quad (8)$$

$$YC \equiv K \cdot (Y/K)^* \quad (9)$$

Output is then estimated with the following CES-function:

$$yt = \log \{ YD^{-\rho_G} + YS^{-\rho_G} \}^{-1/\rho_G} \quad (10)$$

The estimate of  $\rho_G$  is 27.26 which indicates a considerable mismatch on the goods market.

As has been shown labor demand consists of two components: labor demand derived from goods demand  $L_{YD}$  and labor demand derived from capacities  $L_{YC}$ :

$$LD = \{ L_{YD}^{-\rho_{L_2}} + L_{YC}^{-\rho_{L_2}} \}^{-1/\rho_{L_2}} \quad (11)$$

$$\text{with } L_{YD} \equiv YD/(Y/L)^* \quad (12)$$

$$L_{YC} \equiv YC/(Y/L)^* \quad (13)$$

The mismatch parameter  $\rho_{L_2}$  of the labor demand CES-function is estimated within a CES-function which determines employment:

$$lt = \log \{ LS^{-\rho_{L_1}} + LD^{-\rho_{L_1}} \}^{-1/\rho_{L_1}} \quad (14)$$

We find no significant mismatch  $\rho_{L_1}$  between labor supply and labor demand, but a significant though low mismatch  $\rho_{L_2}$  between capacities  $L_{YD}$  and  $L_{YC}$ . The dynamic specification also reports a fairly low adjustment speed of employment to long run values.<sup>36</sup>

<sup>35</sup>These specifications assume that there is no spillover effect on trade flows when the German capital utilization rate is at its minimum value.

<sup>36</sup>From our econometric experience it is hard to distinguish between mismatch and low adjustment speed. The results for  $\rho_{L_1}$  and  $\rho_{L_2}$  may be assessed together with the adjustment process.

## Wages and Prices

Our wage and price equations essentially follow the approach by Franz, Smolny (1993) and Franz, Gordon (1993). Here, we employ a TSLS estimation.

$$w = p + (yt - lt) - \nu_1 \cdot UR \quad (15)$$

$$p = w - (yt - lt) + \nu_2 \cdot q + \nu_3 \cdot (pm - p) \quad (16)$$

Long run determinants of wages and output prices are real unit labor costs ( $w - p - yt - lt$ ). Moreover, there is a strong long run influence of the unemployment rate ( $\nu_1 = 3.5$ ) on wages.

The price equation is formulated as a mark-up pricing rule where the mark-up depends on the capacity utilization rate ( $\nu_2 = 0.575$ ). Prices increase also with increasing relative import prices ( $\nu_3 = 0.043$ ).

Consumer prices and investment prices are modelled as weighted averages of output prices and import prices, whereas the German export price is explained by output prices, capacity utilization rates in the EC4-countries and Germany, EC4-export prices and the US-dollar exchange rate.<sup>37</sup>

## Regime Shares

The upshot of the whole model can be highlighted by [figure 2](#) which displays the estimated proportions of firms being constrained either by aggregate demand or by existing capacities. These regime proportions are in the center of interest of the disequilibrium model.<sup>38</sup> The periods 1975–1978 and 1981–1984 are characterized by a preponderance of demand constraints. Referring to the period after 1984 an increasing importance of capacities constraints can be observed. This is, to some extent, due to restrictive monetary and fiscal policies pursued in the beginnings of the eighties which led to an investment squeeze.

## 4 Forecasting: Challenges and Results

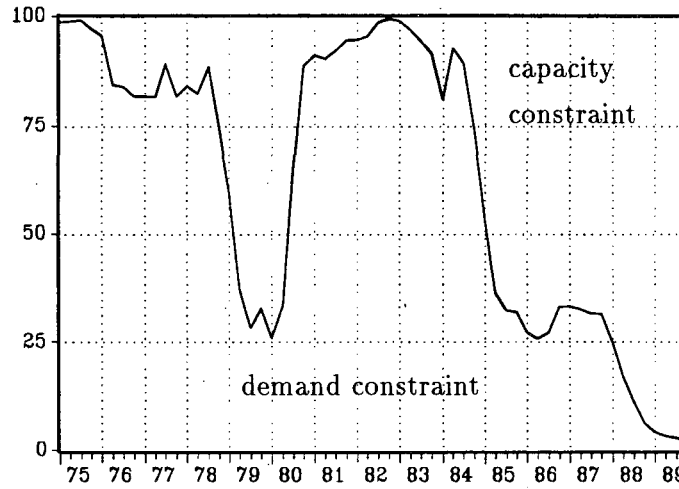
Unexpected shocks constitute a major challenge to many if not all econometric models. This holds especially for the event of German unification which represents a large scale or, according to H. Siebert (1993), a “cosmic” shock. Since the estimation period of our model covers the time period until 1989, one of the most demanding tests of the working of our model is to look at the model’s forecasts for the time period, say, 1990 to 1993.

As if that does not perform strong enough a test of our model, this time period also witnesses the most severe recession Germany has experienced in the past three decades. As has been discussed in section 2, real GDP growth declined from 3.7 percent in 1991 to 1.5 percent in 1992 and is expected to amount to some -2 percent in 1993. To the best of our knowledge, hardly any economic research unit did forecast such a tremendous downturn. As a piece of

<sup>37</sup> See the appendix for detailed results.

<sup>38</sup> Labor supply constraints are the third regime. It does not seem to be of any importance in the period after 1975. Due to slow adjustments of labor, employment can be explained by labor demand.

Figure 2: Regime shares of the German labor market



evidence, [table 3](#) displays the forecasts of three highly reputable institutions, the German Council of Economic Experts (CEE), the Group of German Institutes of Economic Research (GGIER), and the German Institute of Economic Research (DIW) in Berlin.<sup>39</sup> As can be seen, the CEE's forecast for 1992 (published in November 1991) was 2.5 percent for real GDP growth (actually: 1.5 percent); the GGIER's forecast for 1993 (published in June 1992) was +2.5 percent as opposed to actual values of about -2 percent. These forecast errors mirror the difficulties professional forecasters had with this time period even though they had the possibility to update their models. Although forecasting is not an issue our model is pursuing and the estimation period ends in 1989, it is nevertheless interesting to see to what extent the disequilibrium model joins or even exceeds those forecast errors. If so, the next obvious question is what went wrong in the model and which possibilities for a cure exist.

To begin with, the model described in the last section was estimated for the period 1975 to 1989 using quarterly data.<sup>40</sup> The exogenous variables such as foreign income, foreign capacity utilization rates, and foreign prices as well as domestic governmental expenditures correspond with their actual values for the forecast period 1990 to 1992. For the forecast period 1993 to 1994 they are adopted from a forecast made by the German Institute of Economic Research (DIW). Appendix B displays the numerical values for all exogenous variables. As has been explained before, the present version of the model is not complete especially with respect to the monetary and public sector. Therefore, the domestic real interest rate as well as exchange rates are treated as exogenous variables. This is clearly a shortcoming, but an enlargement of the model is under work. Hence, the following presentation should be viewed as an interim

<sup>39</sup> Note that the DIW belongs to GGIER, too.

<sup>40</sup> We also employ residuals of the labor and capital productivity equations until 90:4 instead of the time period until 89:4.

Table 3: Economic forecasts for West Germany 1990-1994

forecast		1990	1991	1992	forecast		1991	1992	1993	1994
DIW 26-27/89 <sup>b)</sup>	y	3.0			GGIER 42-43/91 <sup>a)</sup>	y	3.5	2.0		
	i	4.0				i	6.5	2.5		
	l	1.1				l	3.0	1.0		
GGIER 43/89 <sup>a)</sup>	y	3.0			CEE JG 91/92	y	3.5	2.5		
	i	4.5				i	6.5	2.5		
	l	1.0				l	3.0	1.0		
CEE JG 89/90	y	3.0			DIW 1-2/92 <sup>b)</sup>	y	3.5	1.0		
	i	5.0				i	6.5	2.0		
	l	1.5				l	3.0	1.5		
DIW 1-2/90 <sup>b)</sup>	y	3.5			GGIER 16-17/92 <sup>a)</sup>	y	3.4	1.5		
	i	5.0				i	6.7	0.5		
	l	1.0				l	2.6	1.0		
GGIER 15/90 <sup>a)</sup>	y	3.75			DIW 26-27/92 <sup>b)</sup>	y	3.4	1.5	2.5	
	i	6.0				i	6.7	1.0	3.5	
	l	1.5				l	2.6	1.0	0.5	
DIW 26-27/90 <sup>b)</sup>	y	4.0	3.0		GGIER 44/92 <sup>a)</sup>	y	3.7	1.5	0.5	
	i	7.0	5.5			i	6.5	1.0	-0.5	
	l	2.0	1.5			l	2.6	1.0	-0.5	
GGIER 43-44/90 <sup>a)</sup>	y	4.0	3.0		CEE JG 92/93	y		1.5	0.0	
	i	8.5	4.5			i		1.5	-0.5	
	l	2.5	1.5			l		1.0	-0.5	
CEE JG 90/91	y	4.0	3.5		DIW 1-2/93 <sup>b)</sup>	y		1.5	-1.0	
	i	8.0	5.0			i		1.5	-3.0	
	l	2.5	2.0			l		0.8	-0.5	
DIW 1-3/91 <sup>b)</sup>	y	4.5	3.5		GGIER 18-19/93 <sup>a)</sup>	y		1.5	-2.0	
	i	8.0	5.5			i		1.5	-2.5	
	l	2.5	2.5			l		0.8	-1.5	
GGIER 18-19/91 <sup>a)</sup>	y	4.7	3.0		DIW 26-27/93 <sup>b)</sup>	y		1.5	-2.0	1.0
	i	8.8	5.5		Version A	i		1.5	-4.5	0.5
	l	2.8	2.5			l		0.8	-1.5	-0.5
DIW 26-27/91 <sup>b)</sup>	y		2.0	1.0	DIW 26-27/93 <sup>b)</sup>	y				0.0
	i		5.5	3.5	Version B	i				0.0
	l		3.0	1.5		l				-1.0

Annual growth rates

y: real GDP

i: real investment

l: employment

The figures refer to the aggregate economy and include the public sector

Sources:

CEE JG: Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung, Jahresgutachten, various issues

DIW/GGIER: Deutsches Institut für Wirtschaftsforschung, Wochenbericht, various issues

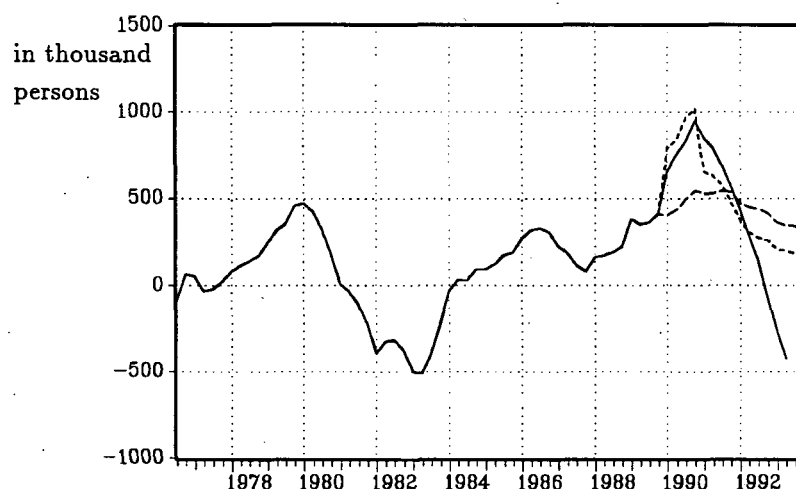
<sup>a)</sup> common forecast of the Group of German economic research institutes (including the DIW), (Arbeitsgemeinschaft deutscher wirtschaftswissenschaftlichen Forschungsinstitute)

<sup>b)</sup> forecast of the German Economic Research Institute, (Deutsches Institut für Wirtschaftsforschung, DIW).

report.

The following figures 3 and 4 display the ex-post forecasts for employment and output. A rough inspection reveals already that the forecasts are anything but very close to the actual values. On the other hand, they at least do not exceed those forecast errors discussed before, sometimes our results outperform those displayed in table 3. More specifically, the dynamics of employment are underestimated. This holds for the boom phase 1990 as well as for the recession starting in 1992. For example, the model predicts an increase of employment of about half a million as opposed to 800,000 persons as the actual outcome. What are the reasons for this failure?

Figure 3: Changes in employment in West Germany<sup>a)</sup>



a) The solid line shows changes in employment, the dotted (dashed) line refers to the simulation with the static (dynamic) employment equation. See text for further explanations.

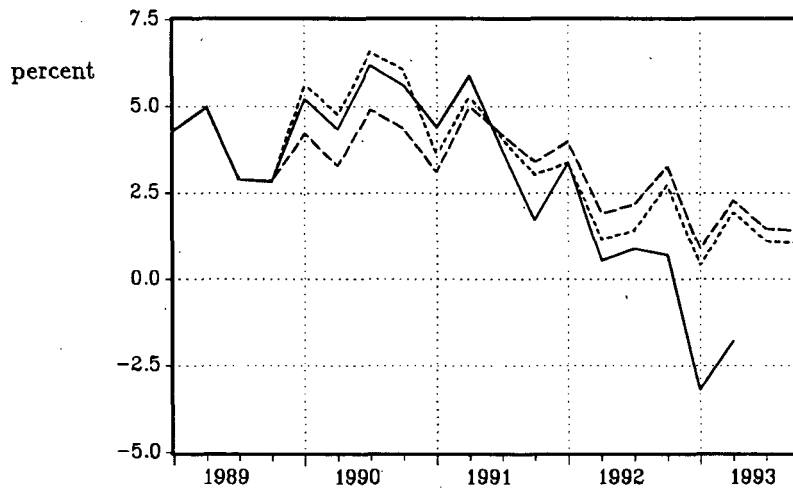
As a prerequisite for such an investigation, it has to be noted that such a spurt in employment was unprecedented during the model's estimation period. Between 1989/4 and 1990/4 about one million jobs were created which is more than twice as high as the maximum increase of employment during 1960 to 1989. As is evidenced in table 1 in section 2, between 1989 and 1992 nearly two million additional people became employed which amounts to 6.5 percent of total employment in 1989.

There are two obvious reasons as to why the model underpredicts employment changes in the simulation period under consideration. Firstly, the dynamics of employment may not be captured adequately, and/or secondly, the development of output may fail to mimic actual values. These aspects are discussed in turn.

The suspicion is that the model predicts an employment adjustment too slowly compared with actual behavior. In order to elaborate on this point we

estimated also a static employment equation for the time period 1975 to 1989. The results are shown in figure 3, too (dotted line). While the dynamic employment equation (broken line) underestimates the employment increase in 1990, the static employment equation leads to a slight overestimation of this employment change. Taken together, for 1990/1991 instantaneous adjustment seems to be more in line with observed employment changes. This is at variance with the development during the estimation period 1975 to 1989 where the dynamic employment equation, which indicates a rather slow adjustment speed, outperforms the static version. In other words, the suspicion may be raised that the speed of employment adjustment has increased since 1990. On a more speculative note, the increase of labor supply due to immigration and commuters contributed to a much greater decline of the importance of qualifications and/or regional mismatch on the labor market than captured by the mismatch parameter in the employment equation. In light of this experience the following results are based on the static version of the employment equation.

Figure 4: Changes in output in West Germany<sup>a)</sup>



a) The solid line shows changes in employment, the dotted (dashed) line refers to the simulation with the static (dynamic) employment equation. See text for further explanations.

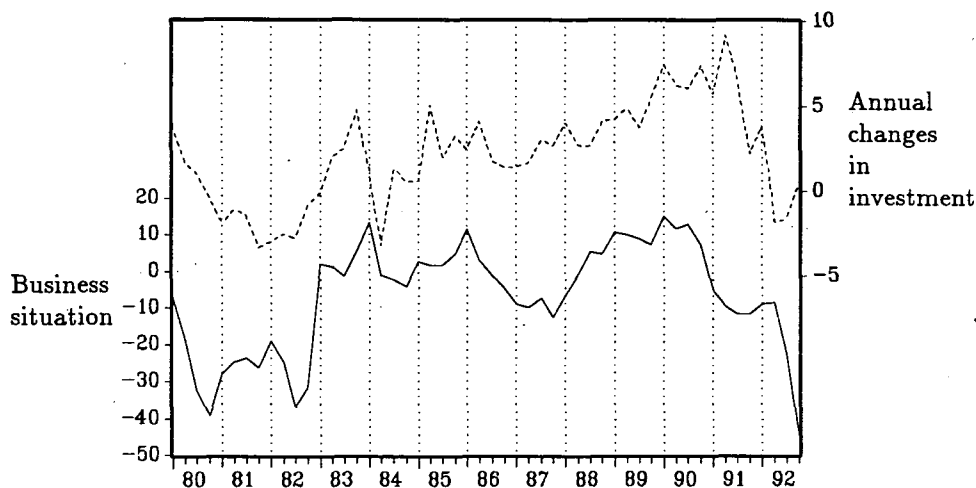
As has been mentioned, a second reason for the forecast error with respect to employment may be found in an inadequate prediction of output changes. Figure 4 reveals that this is truly the case. While our estimates are in line with the predictions made by the CEE, GGIER, and DIW, they clearly overestimate real GDP growth rates especially in 1992 and 1993. A closer look reveals that it is mainly the development of investment rather than consumption or exports which is responsible for the failure. Observed growth rates of real net investment during 1990/91 are as high as 10 percent whereas the model winds up with a roughly 7 percent increase. On the other hand, during 1992/2 and



1993/2 actual investment declines by some 3 percent while the model predicts zero growth rates. As a consequence decreases of real GDP growth rates as well as employment reductions, as predicted by the model, fall short of their actual values.

In light of various unsuccessful experiments such as with different lag structures in the investment equation, we offer the following albeit speculative interpretation. Demand expectations deteriorated long before economic activity actually declined. More precisely, figure 5 shows the time pattern of the so-called "business situation expectations" which are adopted from a business survey taken by the Ifo-Institute, Munich. The series reports the difference between the proportion of firms expecting an improvement and deterioration of future business conditions, respectively. As can be seen, firms expected a worsening of business conditions already by the end of 1990, i.e., approximately one year ahead of the actual slowdown of economic activity. But investment still increased with considerable high growth rates until the end of 1991. While this may be due to lags between investment decisions and investment expenditures, it is more important that this relation between expectations and investment expenditures seems to be unique for the period 1990 to 1992. In former time periods such as in the eighties a much faster response of investment to expectations (changes) can be observed. Hence, even modifications of our investment equation, which take into account business expectations explicitly, were unable to predict actual 1990/92 investment more adequately, let alone the problem how to model those expectations in view of explanatory factors such as adverse developments for sales in East Europe or the public discussion about "Germany as a promising location of business" and the like.

Figure 5: Business situation and investments in West Germany<sup>a)</sup>



a) See text for explanations.

While the discussion so far concentrated on two forecast errors common to

most if not all professional forecasts this should not lead to the impression that the results of our model are generally a disaster. Given the unique event of German unification and the subsequent recession, the model's predictions are rather accurate for many other variables. Our goal, however, is to emphasize developments which are not adequately taken into account by the model in order to search for needs to improve it.

Table 4 compares actual and simulated variables until 1993/2. For example, forecasts for inflation are rather close to actual values until 1992. It goes without saying that an increase of indirect taxes is treated as exogenous. Hence, in the simulations we allow for tax increases such as higher taxes on oil in 1991/II which account for nearly one percentage point of the inflation rate. Moreover, higher inflation due to a rise in administered prices in order to stabilize public debt is also very difficult to handle within the model. Therefore, the slight underestimation of inflation until 1992 does not come as a surprise.

Wage behavior is also fitted quite accurately until 1990/91. More interesting is the overestimation of nominal wage inflation in 1992 of roughly 2 percentage points. One reason is that actual productivity falls short of this predicted value. This is due to the underestimation of the recession which leads to an underutilization of labor and, consequently, to lower productivity gains if any. Another possible reason may be seen in the bargaining situation in spring 1992. The public sector was the leading sector in this wage round. While this is not uncommon, the strikes in the public sector in 1992 and the acceptance of the bargaining outcome by the unions despite an overwhelming rejection of this outcome by the strikers constitute a hitherto not observed strong position of public employers who, in view of the huge public deficit and supported by the public opinion, successfully resisted higher wage demands by the unions.

In summing up our experience with the model's predictive power, the model meets the challenge of unification and a recession of an unpredicted scale with limited success.

## **5 A Simulation Experiment**

From the description in the model in section 4 it should be clear that the main emphasis of the model is an identification of disequilibrium situations. An important aspect of the working of the model is, therefore, to simulate some of the effects of German unification on the West German economy. The motive for such a simulation experiment is, for example, the view held in the public that unification postponed the recession in West Germany. It is said that West Germany would also have experienced a recession in 1989/90 together with other industrialized countries had there been no unification. Despite the caveats outlined in the previous section the model should be able to address to this question.

In what follows we attempt to simulate a hypothetical situation which, however, neglects several developments stemming from unification. More precisely, we simulate major macroeconomic variables in West Germany for the time period 1990 to 1995 in the absence of the following magnitudes (attributed mainly

Table 4: Annual growth rates of actual and simulated variables<sup>a)</sup>

		90	91	92
LT	actual	3.35	2.95	0.78
	simulated	3.78 (1.99)	2.37 (2.21)	1.19 (1.80)
YT	actual	5.34	3.94	1.38
	simulated	5.76 (4.19)	4.00 (3.92)	2.18 (2.84)
C	actual	5.28	3.55	0.94
	simulated	5.57 (4.41)	3.10 (3.07)	2.44 (3.07)
I	actual	9.95	8.01	0.46
	simulated	7.41 (6.74)	3.72 (5.12)	1.46 (2.25)
$X^{EC}$	actual	-1.31	-2.70	0.66
	simulated	-0.08 (1.38)	-2.51 (-2.36)	0.87 (0.17)
$M^{EC}$	actual	10.84	11.71	2.14
	simulated	11.73 (5.71)	10.65 (9.69)	5.02 (7.51)
W	actual	5.62	6.43	5.27
	simulated	5.46 (5.09)	6.95 (5.93)	7.10 (6.31)
PY	actual	3.27	3.96	4.42
	simulated	3.05 (3.05)	3.36 (3.14)	4.10 (3.70)
UR <sup>b)</sup>	actual	6.2	5.5	5.7
	simulated	5.9 (7.3)	5.6 (7.1)	5.7 (6.7)

Notes:

- a) Simulated values are based on the static employment equation. Figures in parentheses are simulated values based on the dynamic version of the employment equation.
- b) Level of unemployment rate.

Table 5: Migrants and Commuters (thousand persons)<sup>a)</sup>

	1989	1990	1991	1992	1993	1994	1995
migrants	241	276	137	91	39	30	20
commuters	0	75	292	351	290	290	290

a) Data until 1993 are taken from the Institute für Arbeitsmarkt und Berufsforschung 4/1992), forecasts for 1994/95 are our own estimates.

to unification).

- a) Higher real net exports from West to East Germany (billion DM): 1990: 65.4, 1991: 154.4, 1992: 171.5, 1993 to 1995: 184.5 each year. Data until 1993 are taken from DIW (Wochenbericht 1-2/1993), data for 1994/95 are our own estimates. Export prices are 1985=100.
- b) Higher labor supply in West Germany due to German emigrants from East Germany ("Übersiedler") and commuters. Note that the figures in table 5 for emigrants are migrants multiplied by their labor force participation rate.
- c) Tax increases: a 7.5 percent surcharge tax on income tax payments ("Solidaritätszuschlag") 1991/III to 1992/II (actually a 3.75 percent rate for both years 1991 and 1992 is applied according to the rules adopted by the tax authorities); 1 percentage point higher value added tax rate since 1993/I; 1 percentage point higher inflation rate of consumer prices due to the increase of oil taxes since 1991/III; increase of the tax wedge of 2 percent of income starting in 1994/I due to the announced reintroduction of the surcharge tax.
- d) The real interest rate is held constant on its average level prevailing in 1988/89 (4.43 percent).

It goes without saying that neither all the figures above are exactly the result of unification only, nor are all unification effects allowed for. Note West Germany's public expenditures for East Germany (including transfer payments) are not included in the national accounts for West Germany used here.

Table 6 highlights the effects of German unification on several variables of our model. The figures represent the differences between simulated values "without unification" and forecasts as described before which include effects of unification.<sup>41</sup> In short, these simulation experiments mirror the outcome of a Keynesian expenditure program on a great scale. This is most visible for employment (LT) and real GDP (YT). In 1990 the demand stimulus is still small with an additional employment (output) growth rate of +0.4(+0.9) percent due to unification. The effects become more important during 1991 to 1993. Without unification real GDP growth would have fallen short of actual growth

<sup>41</sup> Figures for both series are, of course, available on request.

by roughly 2 percentage points in 1991 and 1.5 percentage points in 1992 and 1993. Correspondingly, employment growth would have been lower had there been no unification (1.5 percentage points on average 1991 to 1993). By 1995, however, employment growth is no longer affected by unification. This can be seen already for the 1994 output growth which is 0.4 percentage points higher in the absence of unification. The reason for this result is that the demand stimulus of higher "exports" from West to East Germany is held constant so that no additional gains for economic growth are estimated. Moreover, the stimulus from emigrants from East to West Germany vanishes. Finally, tax increases which would not have been levied had there been no unification hit the West German economy.

Spillovers to and from foreign markets are displayed by West German exports to four EC countries (France, Italy, Netherlands, and United Kingdom,  $X^{EC}$ ) and West German imports from these countries ( $M^{EC}$ ). Exports to these countries are lower but imports from them are higher in due course of unification. From this viewpoint major trading partners have benefitted considerably from German unification. Extreme (and unrealistic ?) assumptions about interest effects are necessary to compensate these gains (see section 2).

Inflation would have been lower in the absence of unification. As has been mentioned actual inflation rates contain the effects of higher administered prices and indirect taxes.

Finally, the development of unemployment is the result of adverse effects stemming from higher immigration and positive impacts in due course of higher labor demand.

## 6 Conclusion

This paper constitutes an interim report on the development of a macroeconomic disequilibrium model. Despite several caveats the model as it stands can be used already for two purposes. First, it is possible to investigate the models forecasting abilities. While the estimation period of the model ends in 1989, the forecast is made for the time period 1990 to 1993. This time period includes two events which form a real challenge to every macroeconomic model, namely German unification and the most severe recession afterwards. The performance of our model is mixed. It underestimates the dynamics of employment both in the boom phase 1990 and in the recession after 1991. Similar observations hold for the development of output. The challenge is that equations which perform better for the time period after 1989 are less able to describe the developments before 1990. Several (speculative) arguments are offered to show what might have happened to variables such as expectations and adjustment speeds. It is a cold comfort, however, that professional forecasts on the basis of a more updated model are also subject to these or even worse failures.

Secondly, the model is used to quantify selected impacts of unification on some macroeconomic variables with an exclusive emphasis on the goods and labor market. By and large, the results are in line with intuition. West Germany benefitted from unification by experiencing higher output and employment and

so did major trade partners.

As has been stressed the model is incomplete. Therefore it can tell only parts of the whole story. Most obvious is the need for an inclusion of a detailed financial and governmental sector. Moreover, an updating and extension of the model until 1993 will enable mimicing of events hitherto unobserved such as unprecedented demand stimuli and/or recessions.

Table 6: Simulated effects of German unification<sup>a)</sup>

	90	91	92	93	94	95
LT	0.4	1.2	1.5	1.7	0.3	0.0
YT	0.9	1.9	1.5	1.6	-0.4	-0.4
C	0.2	0.3	1.5	3.6	-2.0	-0.6
I	2.8	9.5	2.9	4.0	-6.5	-0.4
$X^{EC}$	-0.9	-1.5	-1.1	-1.1	0.7	0.4
$M^{EC}$	3.4	7.0	5.3	5.5	-2.5	-2.3
W	-0.4	-0.6	-0.1	1.0	1.8	1.8
PY	0.1	0.8	1.0	0.9	1.1	1.5
UR	1.2	1.4	1.0	-0.2	-0.2	-0.1

a) The figures denote differences of growth rates of simulated series including unification effects and simulated series in absence of German unification. Figures of the unemployment rate are differences in levels.

## References

- [1] Dornbusch, R. and H. Wolf. Economic Transition in Eastern Germany. *Brookings Papers on Economic activity*, 1:235-261, (1992).
- [2] Franz, W. Im Jahr danach – Bestandsaufnahme und Analyse der Arbeitsmarktentwicklung in Ostdeutschland. In H.J. Ramser B. Gahlen, H. Hesse, editor, *Von der Plan- zur Marktwirtschaft*, pages 245-274. Tübingen, (1992).
- [3] Franz, W. and R.J. Gordon. German and American Wage and Price Dynamics: Differences and Common Themes. *European Economic Review*, 37:719-762, (1993).
- [4] Franz, W., G.W. Heidbrink, and W. Scheremet. International trade in a disequilibrium model. In Vosgerau, H.J., editor, *European Integration in the World Market*, pages 513-561. Springer, Berlin, (1992).
- [5] Franz, W. and W. Smolny. Sectoral Wage and Price Formation and Working Time in Germany: An Econometric Analysis. *Zeitschrift für Wirtschafts- und Sozialwissenschaften*, (1993). Forthcoming.
- [6] Heilemann, M. and R. Jochimsen. *Christmas in July?, The Political Economy of German Unification Reconsidered*. Brookings Institution, Washington D.C., (1993).
- [7] Horn, G.A., Scheremet, W. and R. Zwiener. Domestic and International Macroeconomic Effects of German Economic and Monetary Union. Simulations on QUEST. *Journal of Forecasting*, 11:459-490, (1992).
- [8] Horn, G.A., W. Scheremet and R. Zwiener. *German Unification and its Impacts on the U.S.-Economy*. Deutsches Institut für Wirtschaftsforschung, Discussion Paper No.65, Berlin, (1993).
- [9] Hughes Hallet, A.J. and Y. Ma. East Germany, West Germany, and their Mezzogiorno Problem: A Parable for European Economic Integration. *Economic Journal*, 103:416-428, (1993).
- [10] Issing, O. Gesamtwirtschaftliche Folgen des deutschen Einigungsprozesses. *Deutsche Bundesbank, Auszüge aus Presseartikeln*, 55:1-6, (1993).
- [11] Masson, P.R. and G. Meridth. Domestic and International Macroeconomic Consequences of German Unification. In L. Lipitz and D. McDonald, editors, *German Unification*, pages 93-114. Economic Issues, International Monetary Fund, Occasional Paper Nr.75, Washington D.C., (1990).
- [12] Siebert, H. The Big Bang with the Big Brother. German Unification in Its Third Year. *Kieler Diskussionsbeiträge 211*, Kiel, (1993).
- [13] Sinn, G. and H.-W. Sinn. *Jumpstart. The Economic Unification of Germany*. MIT-Press, Cambridge, (1992).
- [14] von Hagen, J. Monetary Union, Money Demand, and Money Supply: A Review of the German Monetary Union. *European Economic Review*, 37:803-836, (1993).

## Appendix A

Table 7: Assumptions for exogenous variables (rates of change):

	1993	1994	1995
EC4-income	-0.2	1.2	2.0
world-income	1.5	2.4	2.0
EC4-export prices	4.4	4.1	4.0
world-export prices	3.1	3.3	4.0
prices of raw materials	3.1	3.3	4.0
EC4-capacity utilization	constant level since 92/4		
world-capacity utilization	constant level since 92/4		
US-\$/DM-exchange rate	constant since 93/2		
population	constant since 93/2		
labor supply	0.0	0.4	0.0
working time	-1.0	0.5	-0.5
tax wedge	0.2	2.3	0.0
exogenous demand components <sup>a</sup>	-1.0	1.0	1.0
real interest rate	constant level since 93/2		

a) Government purchases, housing, and inventory changes

The forecasts for 1993/94 are partly taken from DIW-Wochenbericht 26-27/93



## Appendix B: Estimation results for behavioral equations

### Labor and Capital Productivity

$$\begin{aligned}
\Delta(yt - lt)_t = & \underset{(6.76)}{0.364} \cdot (\Delta q_t - \underset{(-3.54)}{0.493} \cdot \Delta q_{t-1}) + \underset{(7.44)}{0.429} \cdot \Delta h_t \\
& - \underset{(-3.25)}{0.278} \cdot \left( \Delta(yt - lt)_{t-1} - 0.364^* \cdot (\Delta q_t - 0.493^* \cdot \Delta q_{t-1}) - 0.429^* \cdot \Delta h_{t-1} \right) \\
& - \underset{(-2.14)}{0.153} \cdot \left( \Delta(yt - lt)_{t-2} - 0.364^* \cdot (\Delta q_{t-2} - 0.493^* \cdot \Delta q_{t-3}) - 0.429^* \cdot \Delta h_{t-2} \right) \\
& + \underset{(7.59)}{0.554} \cdot \left( \Delta(yt - lt)_{t-4} - 0.364^* \cdot (\Delta q_{t-4} - 0.493^* \cdot \Delta q_{t-5}) - 0.429^* \cdot \Delta h_{t-4} \right) \\
& + \underset{(3.60)}{0.269} \cdot \left( \Delta(yt - lt)_{t-5} - 0.364^* \cdot (\Delta q_{t-5} - 0.493^* \cdot \Delta q_{t-6}) - 0.429^* \cdot \Delta h_{t-5} \right) \\
& - \underset{(-3.65)}{0.157} \cdot \left( (yt - lt)_{t-1} - \underset{(-3.65)}{0.514^*} \cdot (yt - lt)_{t-4} E(w - py)_{t-1} - (1 - 0.514^*) \cdot \left( \underset{(4.34)}{0.013} \cdot t - \underset{(-1.44)}{0.00003} \cdot t^2 \right) \right. \\
& \quad \left. - 0.364^* \cdot (q_{t-1} - 0.493^* \cdot q_{t-2}) - 0.429^* \cdot h_{t-1} \right)
\end{aligned}$$

SMPL: 64:1 - 92:3, SEE: 0.00913, Q(8): 8.9

$$\begin{aligned}
\Delta(yt - k)_t = & \underset{(6.54)}{0.392} \cdot \Delta q_t + 0.429^* \cdot \Delta h_t \\
& - 0.278^* \cdot (\Delta(yt - k)_{t-1} - 0.392^* \Delta q_{t-1} - 0.429^* \cdot \Delta h_{t-1}) \\
& - 0.153^* \cdot (\Delta(yt - k)_{t-2} - 0.392^* \Delta q_{t-2} - 0.429^* \cdot \Delta h_{t-2}) \\
& + 0.554^* \cdot (\Delta(yt - k)_{t-4} - 0.392^* \Delta q_{t-4} - 0.429^* \cdot \Delta h_{t-4}) \\
& + 0.269^* \cdot (\Delta(yt - k)_{t-5} - 0.392^* \Delta q_{t-5} - 0.429^* \cdot \Delta h_{t-5}) \\
& - 0.157^* \cdot \left( (yt - k) - \underset{(-1.61)}{0.514^*} \cdot (yt - k)_{t-4} E(pi - py) - (1 - 0.514^*) \cdot \left( \underset{(-1.61)}{-0.004} \cdot t + \underset{(0.84)}{0.0001} \cdot t^2 \right) \right. \\
& \quad \left. - 0.392^* q - 0.429^* h_{t-1} \right)_{t-1}
\end{aligned}$$

SMPL: 64:1 - 92:3, SEE: 0.01022, Q(8): 8.1

Investment:

$$\begin{aligned}\Delta k_t = & \frac{0.524}{(4.78)} \cdot \Delta k_{t-1} + \frac{0.311}{(2.54)} \cdot \Delta k_{t-4} - \frac{0.221}{(-2.00)} \cdot \Delta k_{t-5} \\ & - \frac{0.007}{(-3.38)} \cdot \left( k_{t-1} - \frac{1.013}{(10.73)} {}_{t-7}E(YD)_{t-1} - \frac{0.179}{(2.26)} \cdot (wr - uc)_{t-4} \right)\end{aligned}$$

SMPL: 75:1 – 89:4, SEE: 0.00036, Q(8): 6.4

Consumption per head:

$$\begin{aligned}\Delta c_t = & \frac{0.689}{(6.46)} \cdot \Delta di_t - \frac{0.236}{(-2.05)} \cdot \Delta di_{t-4} + \frac{0.249}{(2.27)} \cdot \Delta c_{t-4} \\ & - \frac{0.500}{(-5.02)} \cdot \left( c - \frac{0.780}{(10.77)} \cdot di - \frac{0.174}{(3.25)} \cdot k + \frac{0.008}{(-2.66)} \cdot r^l + \frac{0.004}{(-2.53)} \cdot \hat{p}c \right)_{t-1}\end{aligned}$$

SMPL: 75:1 – 90:4, SEE: 0.00581, Q(8): 4.2

Exports:

into the EC4 – countries

$$\begin{aligned}\Delta x_t^{EC4} = & \frac{-0.319}{(-2.18)} \cdot \Delta q_{t-1} + \frac{0.620}{(2.87)} \cdot \Delta q_t^{EC4} + \frac{2.140}{(27.7)} \cdot \Delta y^{EC4} - \frac{0.115}{(-1.64)} \cdot \Delta(px - px^W)_{t-3} \\ & - \frac{0.658}{(-5.20)} \cdot \left( x^{EC4} - 2.140^* \cdot y^{EC4} + 0.319^* \cdot q - 0.620^* \cdot q^{EC4} + \frac{0.314}{(-4.07)} \cdot (px - px^{EC4}) \right)_{t-1} \\ & - \frac{0.200}{(-1.92)} \cdot \left( x^{EC4} - 2.140^* \cdot y^{EC4} + 0.319^* \cdot q - 0.620^* \cdot q^{EC4} + 0.314^* \cdot (px - px^{EC4}) \right)_{t-3}\end{aligned}$$

SMPL: 75:1 – 89:4, SEE: 0.02395, Q(8): 7.4

to all other countries:

$$\begin{aligned}\Delta x_t^W = & \frac{-0.292}{(-2.47)} \cdot \Delta q_{t-1} \\ & - \frac{0.697}{(-6.18)} \cdot \left( x^W - \frac{1.278}{(31.0)} \cdot y^W + 0.292^* \cdot q + \frac{0.151}{(-5.04)} \cdot (px - px^W) + \frac{0.140}{(-1.91)} \cdot (px - px^{EC4}) \right)_{t-1} \\ & - \frac{0.248}{(-2.23)} \cdot \left( x^W - 1.278^* \cdot y^W + 0.292^* \cdot q + 0.151^* \cdot (px - px^W) + 0.140 \cdot (px - px^{EC4}) \right)_{t-3}\end{aligned}$$

SMPL: 75:1 – 89:4, SEE: 0.02439, Q(8): 7.2

Imports:

from the EC4 – countries:

$$\begin{aligned}
\Delta m_t^{\text{EC4}} = & \frac{1.055}{(4.20)} \cdot \Delta q_t - \frac{0.442}{(-1.43)} \cdot \Delta q_t^{\text{EC4}} + \frac{0.928}{(2.64)} \cdot \Delta y_t + \frac{0.513}{(2.75)} \cdot \Delta(px - px^{\text{EC4}})_{t-1} \\
& + \frac{0.538}{(3.11)} \cdot (px - px^{\text{EC4}})_{t-5} - \frac{0.342}{(-2.70)} \cdot \left( \Delta m^{\text{EC4}} - 1.055^* \cdot \Delta q + 0.442^* \cdot \Delta q^{\text{EC4}} \right)_{t-1} \\
& + \frac{0.141}{(1.45)} \cdot \left( \Delta m^{\text{EC4}} - 1.055^* \cdot \Delta q + 0.442^* \cdot \Delta q^{\text{EC4}} \right)_{t-4} \\
& - \frac{0.621}{(-4.14)} \cdot \left( m^{\text{EC4}} - \frac{1.527}{(14.63)} \cdot y + \frac{0.581}{(-1.93)} \cdot q^{\text{EC4}} - 1.055^* \cdot q + \frac{0.030}{(-0.65)} \cdot (px^{\text{EC4}} - px^{\text{W}}) \right)_{t-1}
\end{aligned}$$

SMPL: 75:1 – 89:4, SEE: 0.02596, Q(8): 10.4

from all other countries:

$$\begin{aligned}
\Delta m_t^{\text{W}} = & \frac{0.494}{(2.03)} \cdot \Delta q_t + \frac{1.008}{(2.98)} \cdot \Delta y_t - \frac{0.460}{(-1.63)} \cdot \Delta y_{t-1} \\
& - \frac{0.637}{(-5.17)} \cdot \left( m^{\text{W}} - \frac{1.896}{(19.94)} \cdot y + \frac{0.416}{(-2.15)} \cdot q^{\text{USA}} - \frac{0.947}{(2.95)} \cdot q - \frac{0.082}{(1.70)} \cdot (px^{\text{EC4}} - px^{\text{W}}) \right)_{t-1} \\
& + \frac{0.339}{(3.05)} \cdot \left( m^{\text{W}} - 1.896^* \cdot y + 0.416^* \cdot q^{\text{USA}} - 0.947^* \cdot q - 0.082^* \cdot (px^{\text{EC4}} - px^{\text{W}}) \right)_{t-3} \\
& - \frac{0.176}{(-1.76)} \cdot \left( m^{\text{W}} - 1.896^* \cdot y + 0.416^* \cdot q^{\text{USA}} - 0.947^* \cdot q - 0.082^* \cdot (px^{\text{EC4}} - px^{\text{W}}) \right)_{t-4} \\
& - \frac{0.133}{(-1.65)} \cdot \left( m^{\text{W}} - 1.896^* \cdot y + 0.416^* \cdot q^{\text{USA}} - 0.947^* \cdot q - 0.082^* \cdot (px^{\text{EC4}} - px^{\text{W}}) \right)_{t-6}
\end{aligned}$$

SMPL: 75:1 – 89:4, SEE: 0.02255, Q(8): 6.3

Goods market:

$$\begin{aligned}
yt_t = & \log \{ Y S_t^{-\rho_G} + Y D_t^{-\rho_G} \}^{-1/\rho_G} \\
\rho_G = & \frac{27.26}{(52.7)}
\end{aligned}$$

SMPL: 75:1 – 89:4, SEE: 0.00342, Q(8): 36.4

Labor market:

— Static Version

$$lt_t = \log \left\{ LS^{-\rho_L^1} + \{L_{YD}^{-\rho_L^2} + L_{YC}^{-\rho_L^2}\} \rho_L^1 / \rho_L^1 \right\}^{-1/\rho_L^1}$$

$$\rho_L^1 = \begin{matrix} 69.7 \\ (0.81) \end{matrix}$$

$$\rho_L^2 = \begin{matrix} 45.0 \\ (4.59) \end{matrix}$$

SMPL: 75:1 – 89:4, SEE: 0.01417, Q(8): 111

— Dynamic Version

$$\begin{aligned} \Delta lt_t = & \begin{matrix} 0.087 \\ (0.80) \end{matrix} \cdot \Delta lt_{t-1} + \begin{matrix} 0.494 \\ (6.02) \end{matrix} \cdot \Delta lt_{t-4} - \begin{matrix} 0.320 \\ (-3.83) \end{matrix} \cdot \Delta lt_{t-5} \\ & + \begin{matrix} 0.196 \\ (-5.12) \end{matrix} \cdot \left( \pi_{LYD} \cdot \Delta l_{yd} + \pi_{LYC} \cdot \Delta l_{yc} + \pi_{LS} \cdot \Delta ls \right)_t \\ & + \begin{matrix} 0.123 \\ (-2.61) \end{matrix} \cdot \left( \pi_{LYD} \cdot \Delta l_{yd} + \pi_{LYC} \cdot \Delta l_{yc} + \pi_{LS} \cdot \Delta ls \right)_t \\ & - \begin{matrix} 0.103 \\ (2.88) \end{matrix} \cdot \log \left\{ LS_t^{-\rho_L^1} + LD_t^{-\rho_L^1} \right\}^{-1/\rho_L^1} \end{aligned}$$

with:  $LD = \left\{ L_{YC}^{-\rho_L^2} + L_{YD}^{-\rho_L^2} \right\}^{-1/\rho_L^2}$ ,

$$\pi_{LYD} = \frac{\partial LT}{\partial LD} \cdot \frac{LD}{L_{YD}} = \left[ 1 - \left( \frac{LS}{L^*} \right)^{-\rho_L^1} \right] \cdot \left( \frac{L_{YD}}{LD} \right)^{-\rho_L^2},$$

$$\pi_{LYC} = \frac{\partial LT}{\partial LD} \cdot \frac{LD}{L_{YC}} = \left[ 1 - \left( \frac{LS}{L^*} \right)^{-\rho_L^1} \right] \cdot \left( \frac{L_{YC}}{LD} \right)^{-\rho_L^2},$$

$$\pi_{LS} = \frac{\partial LT}{\partial LS} \cdot \frac{LS}{LT} = \left( \frac{LS}{L^*} \right)^{-\rho_L^1}$$

with  $L^* = \left\{ LS^{-\rho_L^1} + LD^{-\rho_L^1} \right\}^{-1/\rho_L^1}$ .

$$\rho_L^1 = \begin{matrix} 821 \\ (0.0) \end{matrix}$$

$$\rho_L^2 = \begin{matrix} 64.72 \\ (2.36) \end{matrix}$$

SMPL: 75:1 – 89:4, SEE: 0.00203, Q(8): 6.2

Wages per hour:

$$\begin{aligned}\Delta w_t = & \underset{(-3.20)}{-0.237} \cdot \Delta w_{t-1} + \underset{(12.25)}{0.571} \cdot \Delta w_{t-4} \\ & - \underset{(-3.71)}{0.170} \cdot \Delta(w - p - (yt - lt))_{t-2} + \underset{(3.68)}{0.245} \cdot \Delta(w - p - (yt - lt))_{t-5} \\ & - \underset{(-3.95)}{0.146} \cdot \left( (w - p - (yt - lt)) + \underset{(-5.27)}{1.822} \cdot UR - \underset{(2.78)}{0.932} \cdot (pc - p) \right)_{t-1}\end{aligned}$$

SMPL: 71:2 - 90:4, SEE: 0.00791, Q(8): 6.2

Prices:

$$\begin{aligned}\Delta p_t = & \underset{(-3.41)}{-0.221} \cdot \Delta p_{t-1} + \underset{(3.17)}{0.201} \cdot \Delta p_{t-3} - \underset{(2.15)}{0.057} \cdot \Delta^4(p - w + (yt - lt))_{t-1} \\ & - \underset{(-2.53)}{0.067} \cdot \Delta^4(yt - lt)_{t-3} - \underset{(-3.20)}{0.095} \cdot \Delta(yt - lt)_{t-4} + \underset{(0.60)}{0.125} \cdot \Delta VAT \\ & + \underset{(3.67)}{0.012} \cdot \Delta(pm^{r_{ho}} - p)_{t-4} + \underset{(10.27)}{0.223} \cdot \Delta w_t \\ & - \underset{(-6.89)}{0.151} \cdot \left( (p - w + (yt - lt)) - \underset{(8.73)}{2.94} \cdot dul - \underset{(1.39)}{0.034} \cdot (pm - p) \right)_{t-1}\end{aligned}$$

SMPL: 71:2 - 90:4, SEE: 0.00352, Q(8): 4.3

Instruments for w:  $UR_t, \Delta^4 pc_{t-1}$

Consumption price:

$$\begin{aligned}\Delta pc = & \underset{(2.75)}{0.049} \cdot \Delta pm_t + \underset{(2.12)}{0.036} \cdot \Delta pm_{t-2} + \underset{(7.97)}{0.612} \cdot \Delta pc_{t-4} + \underset{(1.65)}{0.174} \cdot \Delta py_{t-5} \\ & - \underset{(-2.60)}{0.198} \cdot \left( pc - \underset{(25.63)}{0.934} \cdot py - (1 - 0.934) \cdot pm \right)_{t-1}\end{aligned}$$

SMPL: 75:1 - 90:4, SEE: 0.00442, Q(8): 3.7

### Investment price:

$$\begin{aligned}\Delta pi_t = & \underset{(3.01)}{0.050} \cdot \Delta pm_{t-1} + \underset{(1.70)}{0.026} \cdot \Delta pm_{t-4} + \underset{(2.58)}{0.279} \cdot \Delta py_{t-1} \\ & + \underset{(1.89)}{0.185} \cdot \Delta py_{t-4} - \underset{(-1.29)}{0.180} \cdot \Delta pi_{t-1} \\ & - \underset{(1.87)}{0.076} \cdot \left( \underset{(8.02)}{pi - 0.776 \cdot py - (1 - 0.776^*) \cdot pm} \right)_{t-1}\end{aligned}$$

SMPL: 75:1 - 90:4, SEE: 0.004137, Q(8): 7.2

### Export price:

$$\begin{aligned}\Delta px_t = & \underset{(3.52)}{0.043} \cdot \Delta e_t^{US} - \underset{(-2.04)}{0.018} \cdot \Delta e_{t-4}^{US} \\ & + \underset{(3.48)}{0.076} \cdot \Delta q_t + \underset{(3.03)}{0.067} \cdot \Delta q_{t-1} + \underset{(2.65)}{0.100} \cdot \Delta q_{t-3}^{EC4} \\ & + \underset{(2.57)}{0.062} \cdot \Delta px^{EC4} - \underset{(-2.09)}{0.043} \cdot \Delta px_{t-2}^{EC4} + \underset{(2.50)}{0.192} \cdot \Delta py_t + \underset{(3.99)}{0.337} \cdot \Delta px_{t-1} \\ & - \underset{(-5.30)}{0.293} \cdot \left( \underset{(14.54)}{px - 0.477 \cdot py - 0.300 \cdot px^{EC4} - 0.069 \cdot q} \right)_{t-1}\end{aligned}$$

SMPL: 75:1 - 90:4, SEE: 0.002678, Q(8): 8.7

### Symbols

- $\Delta$  : Difference operator
- $\Delta^4$  : Difference operator with respect to annual difference
- ${}_{t-i}E$  : Expectation operator at time t-i
- SMPL: Observation period
- SEE : Standard error of regression
- Q(8) : Ljung-Box Q-statistic with 8 lags

The superscripts EC, W, USA denote the countries under consideration. The data set for Germany is supplied by the Bundesbank, Deutsches Institut für Wirtschaftsforschung (DIW, Berlin) and the Ifo-Institut (Munich). The aggregate variables for the EC4-countries are calculated from data of OECD disks (Quarterly National Accounts, Main Economic Indicators) and of EUROSTAT. The aggregation of real values uses constant purchasing power parities whereas nominal values include changes in exchange rates.