East German Unemployment from a Macroeconomic Perspective *

by

Jens Rubart‡ and Willi Semmler¶

— Preliminary Version —

Frankfurt, New York March 1, 2007

Abstract

When reviewing the literature concerning the development of the Eastern German economy, too rigid labor markets are considered as the main source of the persistent high unemployment rates and the slow economic performance.

However, when important macroeconomic variables are considered a significant decline in investment in new technologies is observed. In addition, we find evidences that the decline in investment is affected by the steady migration of young and skilled workers to West Germany. The decline in the proportion of skilled workers induces firms not to invest in Eastern Germany which leads to a general decline in job creating activities irrespective rigid labor markets and generous social benefits.

We employ a standard Dynamic General Equilibrium model in order to study the effects of a decline in the proportion of skilled workers as well as the impacts of increasing benefit payments. Furthermore, we assume equilibrium unemployment due to search and matching frictions on the labor market. This approach enables us further to consider job creating activities of the firms.

We show that an emigration shock of skilled- workers is capable to reproduce the findings for the decline in economic activity. This effect is strengthened by assuming generous social benefit payments.

JEL - Classification:

Keywords : DSGE Model, Heterogenous Labor, Skill Biased Technological Change, Search Unemployment, Employment Protection, Minimum Wages

---

*Please note that the paper represents the author's opinions and does not necessarily reflect the views of the Deutsche Bundesbank or its staff.

We would like to thank Sandra Schaffner (RWI, Essen) for providing us with some Data of the East German labor market.

‡Deutsche Bundesbank, Economics Department, Wilhelm Epstein Strasse 14, D-60431 Frankfurt / Main, and Institute of Economics, Darmstadt University of Technology, e-mail: jens.rubart@bundesbank.de.

¶Graduate Faculty, New School for Social Research, New York and Center for Empirical Macroeconomics, Bielefeld University, Germany, e-mail: semmlerw@newschool.edu

1 Introduction

When reviewing the literature[1] concerning the German unemployment problem, particularly the high unemployment rate in the Eastern part of Germany, we generally find that most of the literature concentrates on the impacts of rigid labor market institutions and the generous benefit system as the cause of the high and partly increasing unemployment rates in the "New Bundesländer"(see, for example Merkl and Snower (2006)). A second branch of literature focusses on possible skill differences between east and west German workers as the second (possible) explanation of the observed unemployment pattern, such as, for example the turbulence models by Ljungqvist and Sargent (2005, 2006).

A third branch of literature, such as Uhlig (2006), focuses on the migration flows from east to west Germany as an explanation of the decline in East German labor productivity and the slow economic recovery of this region. As we will show below our results coincide with the conclusion of Uhlig (2006) that the economic recovery of East Germany requires a long time, however, from a different perspective.

However, most of the literature concentrates solely on the labor market. In this paper we do not neglect the importance of the labor market as well as institutional rigidities, however we primary concentrate on macroeconomic aspects which might explain why there are no jobs in eastern Germany. In particular, we follow Phelps and Zoega (2001) and concentrate on investment activities of firms as the primary force of job creating activities. Phelps and Zoega (2001), who state that the observed path of unemployment and economic performance is subject to, for instance, non-monetary shocks and developments, mainly due to investment activities of firms. In particular, investment activities determine the evolution of physical capital which is in a complementary relationship to skilled and unskilled labor. A comparison of the investment ratio (total investment per GDP) of leading OECD countries shows a significant decline in this ratio for continental European countries such as France and Germany, in contrast to steady increases for the U.S. and the U.K. (see table 1 below). During the same time period we observe a constant or increasing unemployment rate for France and Germany and low or decreasing ones for the U.S. and the U.K. (see, for example Rubart (2006)). However, although there is a general decline in the investment ratio in France and Germany, an increasing amount of investment is devoted to information and communication technologies. This means

[1] See, for example, Canova and Ravn (2000) Merkl and Snower (2006), Burda (2006), or Saint-Paul (2004).

that, although general indicators of the economic activity decline, the structural change due to investments in new technologies seems to be unbroken.

Table 1: Total and ICT Investment

Year	U.S.	U.K.	Germany	France
	Total Investment to GDP, %			
1970-80	15.2	15.5	28.8	24.1
1980-90	16.2	13.9	21.0	19.5
1990-00	17.3	15.1	21.2	19.5
2004	19.8	16.3	18.4	20.2
	ICT Investment[a]			
1980	15.2	4.8	12.2	6.8
1990	22.5	10.1	13.9	12.7
1995	26.1	15.6	13.3	13.3
2000	39.9	15.0	16.2	16.2

Sources: Colecchia and Schreyer (2001), OECD Main Economic Indicators 2005.

[a] Measured as percentage of non-residential investment of the whole economy (Cf. Colecchia and Schreyer (2001)).

The comparison of the result of table 1 shows that the investment in new technologies remained rather constant in Germany, whereas it nearly tripled in the U.K., France and the U.S. during the last 30 years.

As we show below (figures 5 and 4) the investment in new inventories, such as computers and new machinery, declined sharply since the reunification. Because of the fact that new inventories are strategic complements with skilled workers the non-existence or migration of this group of workers forces firms not to invest in Eastern Germany.[2].

The attempt of this paper is to identify the mechanisms how structural deficiencies at markets, such as a too low supply of skilled workers, determine the economic performance of countries. In particular we analyze the interaction between structural deficiencies and labor market institutions. There, we show that the non-availability or the reduction of important production inputs worsen the impacts of labor market institutions.

[2] There are two important exceptions because of High-Tech industries in Dresden and Jena (AMD, Jenoptik)

2 Stylized Facts

As can be seen from figure 1 Eastern Germany is faced with high and constant unemployment rates. Although there is a slight decline in recent times, the unemployment rates is about twice as high than in West Germany.

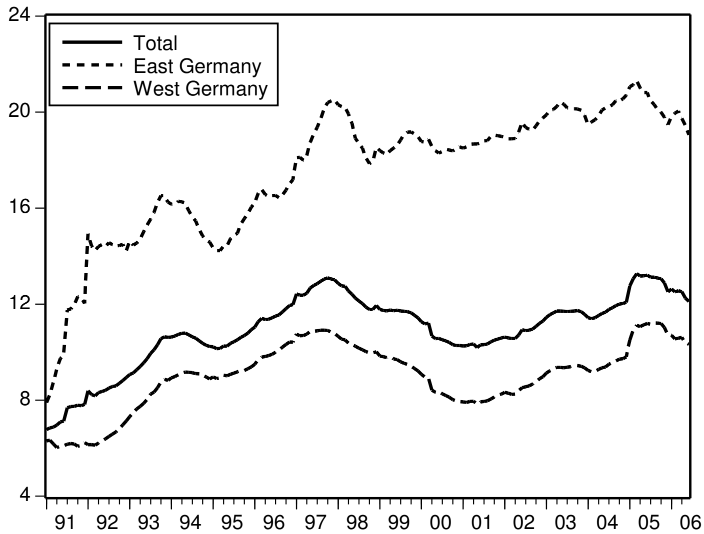

Figure 1: Unemployment Rates, 1991 - 2006

Beside this rather dramatic evolution of unemployment in Eastern Germany, an important question is whether the structure of unemployment is different in comparison to Western Germany. Table 2 describes the evolution and the structure of unemployment in East and West Germany. In Table 2 we differentiate unemployment with respect to the branch in which the worker was employed before becoming unemployed. We consider three sectors, manufacturing, basic and advanced services. Furthermore, table 2 presents the structure of employment with respect to the earned educational degree.

It becomes obvious that the unemployment rates in the manufacturing and basic services sector are much higher in East Germany than in Western Germany. Furthermore, it is shown that the unemployment duration is much higher in the "New Bundesänder". Only slight differences between both parts of Germany are observed for the advanced services sector which captures, for example, research and development activities. The results suggest further that the higher the proportion of skilled workers the lower is the unemployment rate as well as the duration of unemployment.

Table 2: The Structure of Unemployment in East and West Germany

	Entire Germany		East		West	
			Manufacturing			
	1999	2005	1999	2005	1999	2005
Unemployment Rate	15.0	20.3	23.9	33.7	12.1	16.4
Unemployment $>$ 1 Year	36.4	36.4	29.8	40.6	40.6	33.9
Proportion of Workers						
without Education	44.8	44.1	27.3	27.3	56.2	54.2
vocational Training	53.0	53.3	72.3	72.1	41.1	42.8
University degree	0.5	0.9	0.4	0.6	0.6	1.0
			Basic Services			
Unemployment Rate	13.8	16.9	22.4	26.6	11.4	14.4
Unemployment $>$ 1 Year	42.0	42.2	39.0	49.4	43.6	38.8
Proportion of Workers						
without Education	39.1	40.2	23.8	24.3	47.3	47.7
vocational Training	55.7	54.0	70.4	70.0	47.8	46.4
University degree	1.5	2.5	1.6	2.4	1.5	2.5
			Advanced Services			
Unemployment Rate	8.8	8.8	12.7	13.2	7.5	7.7
Unemployment $>$ 1 Year	33.3	31.8	30.2	35.6	34.9	29.9
Proportion of Workers						
without Education	12.1	14.1	7.5	10.7	14.6	15.7
vocational Training	39.9	21.1	37.6	41.8	41.2	42.3
University degree	28.2	29.0	29.1	31.7	27.7	27.8

A similar result is obtained when we consider unemployment rates with respect to different educational groups. Figure 2 shows that the unemployment rats of workers which earned rather low educational degrees are significantly higher than for employees with university degrees. Furthermore, when comparing East and West Germany, the unemployment rates of low educated workers are more than twice as high than in West Germany.

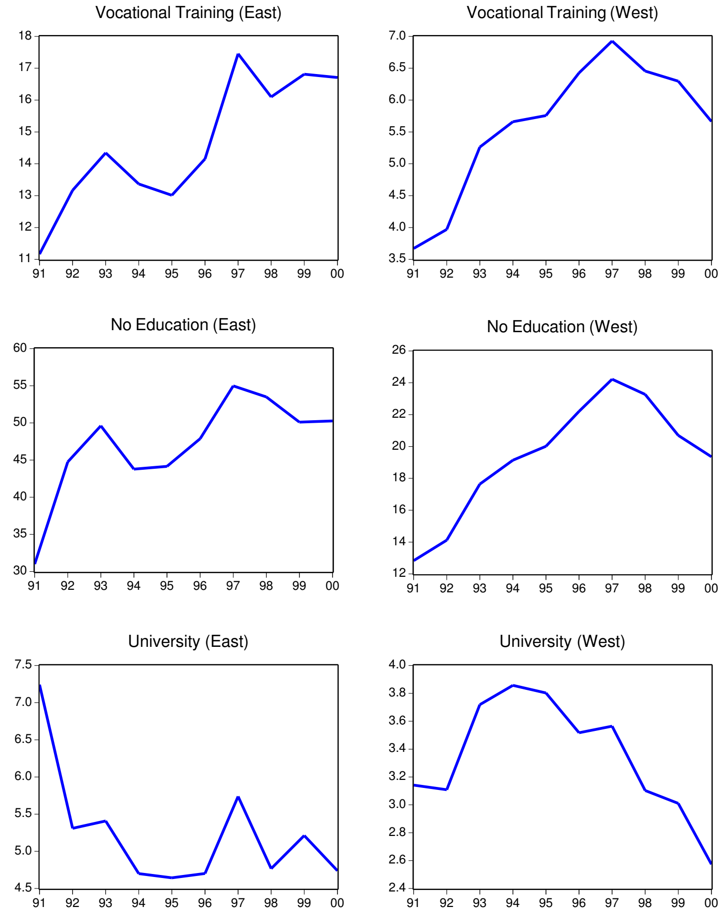

Figure 2: Unemployment Rates of Different Skill Groups, 1991-2000

By following the suggestions of Phelps and Zoega (2001) we consider gross investment (including public) and investments in new inventories. The ratio of gross investment per GDP is still higher in East than for West Germany, however, the investments in new inventories show also a steep decline and are in recent times below the respective investment ratio of West Germany. This might lead to the suggestion that a lot of investment in the Eastern part of Germany are not spent for new technologies. (figure 4)

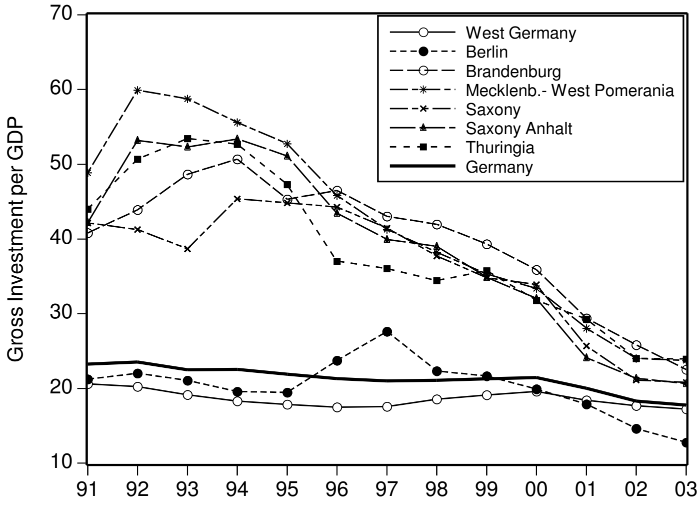

Figure 3: Gross Investment per GDP

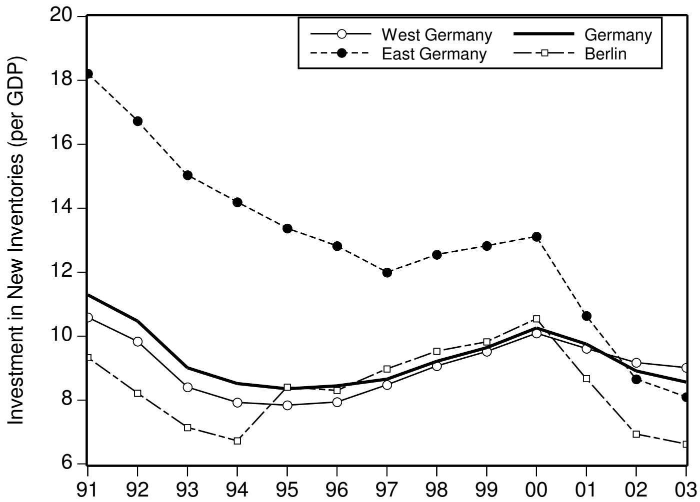

Figure 4: Investment in New Inventories (per GDP)

As shown above the five new "Bundesländer" exhibit a significant decline in investment. In particular, the investment in new capital goods, such as new machinery (new technologies) does not exceed the respective investment ratio of Western Germany (see table xx, below). In addition, the empirical result of figure 4 shows that the investment ratio is significantly negatively correlated to the unemployment rate.[3]

[3]The dashed line is obtained through OLS, $\beta = -0.607$(-5.4818), R^2 : 0.68, $D.W.$: 1.918, t-statistics in parentheses.

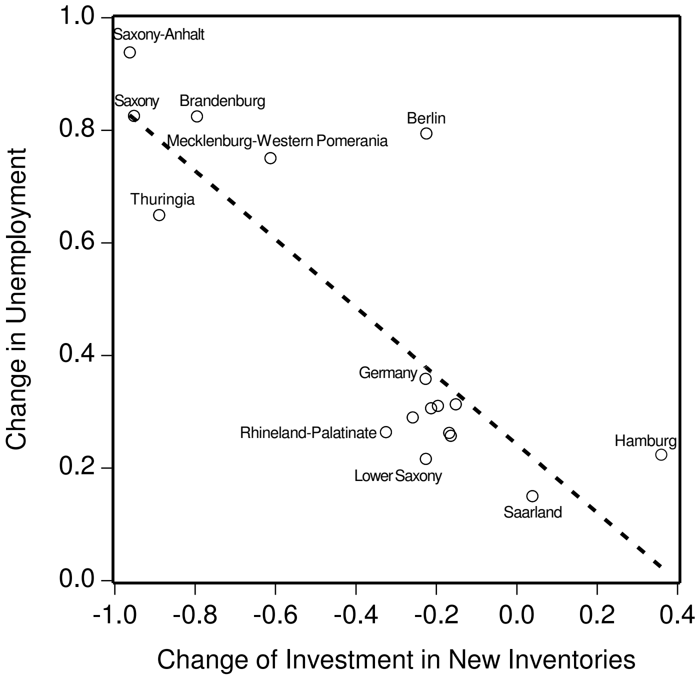

Figure 5: Unemployment and Investment in New Inventories

By employing simple OLS estimations in order to get further information for the relationship between unemployment and investment activities in East Germany, we find that the unemployment rate is negatively related to investment activities. A result, which is already shown by figure 4.

Table 3: Unemployment and Investment, 1992-2002

Dep. Variable	Independent Variable					
	Emigration			I/Y		
	const.	Var.	R^2	const.	Var.	R^2
I/Y	**0.193**	-4.889	0.24			
	(5.131)	(-1.7161)				
Unemp.	**0.1338**	3.386	0.18	**0.256**	**-0.605**	0.54
	(4.151)	(-1.385)		(10.602)	(-3.2735)	

t-statistics in parentheses, bold=significant

Table 3 supports the evidence that the emigration of young (and skilled) workers leads to a decline in investment activities. Furthermore, we find significant evidence that a decrease in investment increases unemployment in Eastern Germany (table 3, right column).

A possible explanation of the decline in investment as well as in the increase in unemployment, particularly of lower-skilled workers, might be the observed emigration of workers to West Germany in the first half of the 1990s.

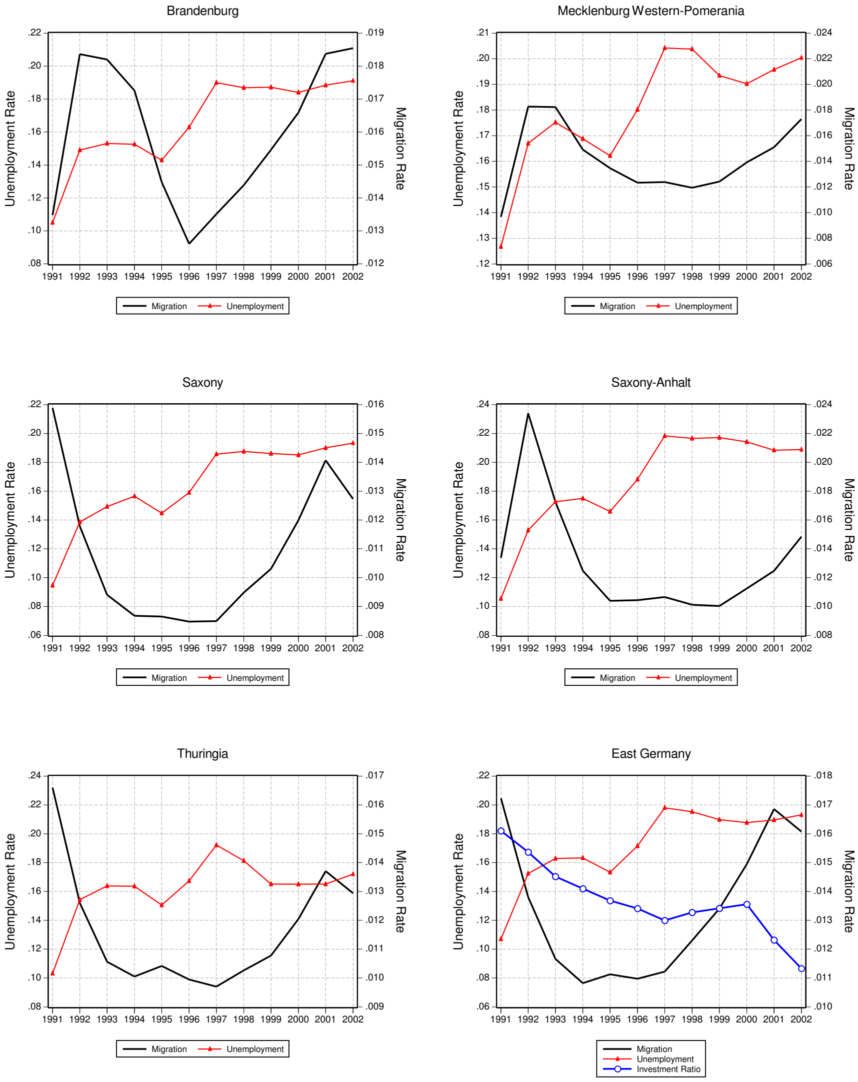

Figure 6: Migration and Unemployment

As figure 6 shows, for any East German state we observe a sharp increase in migration after the reunification in 1991. Afterwards, the migration rates declined but started to increase again at the end of the 1990s. A second fact, that can be obtained from figure 6, is that unemployment started to rise shortly after the increase in migration. An additional fact that can be observed some countries is that migration and unemployment are positively correlated.[4] Particularly, the loss of young

[4]For example, for Brandenburg and Mecklenburg Western-Pommerania the correlation coeffi-

and rather skilled workers might goes hand in hand with the decline in investment in new equipment (technologies) which determines the long run performance of theses states.

Summing up the empirical facts about Eastern Germany, a several structural problems seem to account for the obvious (un-)employment dilemma:

1. Structural changes due to the technological adjustment of the Eastern German manufacturing sector.

2. Decreasing investment in new technologies and, therefore, new jobs.

3. Migration of young and skilled workers to West Germany.

4. Mismatch problems, particularly for lower skilled workers, because of different education systems (cf. figure 2).

5. Rigid labor market institutions as well as generous social benefit payments which prevent unemployed workers to search for new job offers.

All in all, when considering the downward adjustment of investment behavior (cf. figures 3, 4) which seems, from out point of view one of the most important causes of the rather low economic and employment performance in Eastern Germany we have to ask for the explanation of this observation. Based on a rather standard dynamic general equilibrium model with labor market frictions as well as the assumption of different kinds of labor we analyze the impacts of rigid employment emigration and labor market rigidities on main economic variables such as output and employment.

3 The Model

3.1 Market Structure

The model discussed in this paper is based on the seminal work by Kydland (1984), Merz (1995) and on suggestions made by Cahuc and Zylberberg (2004) as well as Heckman, Lochner, and Taber (1998). Furthermore, we follow the approach by Rubart (2006, 2007) who provides a detailed discussion of the effects of skill-biased technology shocks on the relative employment position and relative wages in a dynamic general equilibrium context.

---

cients are 0.21 and 0.19, respectively.

Without loss of generality we concentrate on, from our point of view, two main sources of the East German dilemma. First, we study the impacts of an emigration of one type of workers, i.e. skilled workers. ($\rightarrow$ we find similar results as the literature of "New Economic Geography", agglomeration hypothesis, Uhlig (2006)). Furthermore, we study the effects of rigid labor markets and generous benefit payments which also requires an extension of the baseline model.

The model economy consists of two sectors, a household sector which supplies labor and physical capital to the production sector. The labor force is differentiated into two skill groups, high and low skilled workers, which are assumed to be imperfect substitutes in production. The production sector consists of many small firms using capital and both types of labor services in order to produce a single good which can be either consumed or invested. The market for final goods is characterized by perfect competition, whereas the labor market is characterized by search and matching frictions. It is assumed that jobs for high and low skilled workers are destroyed in any period at an exogenous rate $\psi_i \in (0,1)$ with $i = s, u$. Furthermore, we assume a two sided search process, i.e. both unemployed workers of each skill group (s=skilled, u=unskilled) and firms with vacant jobs seek for new job matches.

The economy's labor force is assumed to be constant and is normalized to one. Let $l_{i,t}$ denote the ratio of labor of the skill group $i = s, u$, i.e. $n = 1 = l_s + l_u$. Each type of labor can either be employed or unemployed, i.e. $l_i = h_i + u_i$. The employment of each skill group evolves according to

$$h_{s,t+1} = (1-\psi_s)h_{s,t} + M_{s,t} \tag{1}$$

$$h_{u,t+1} = (1-\psi_u)h_{u,t} + M_{u,t}, \tag{2}$$

where $\psi_i \in (0,1)$ denotes an exogenous rate of job destruction and $M_{i,t}$ gives the number of newly created jobs in period t. New job matches are created through a "standard" matching technology,

$$M_i = M(s_{i,t}u_{i,t}, v_{i,t}). \tag{3}$$

As mentioned above, it is assumed that both skill groups are separated from each other, i.e. low-skilled workers can not apply for high-skilled jobs and vice versa. The matching technology given by eqn. 3 implies the following transition probabilities from unemployment to employment and from an unfilled to a filled job vacancy of type i:

$$p_{i,t} = \frac{M_{i,t}}{s_{i,t}(1-h_{i,t})} \tag{4}$$

$$q_{i,t} = \frac{M_{i,t}}{v_{i,t}}. \tag{5}$$

The market tightness for each type of worker, θ_i, follows as

$$\theta_{s,t} = \frac{v_{s,t}}{(1-h_{s,t})} \tag{6}$$

$$\theta_{u,t} = \frac{v_{u,t}}{(1-h_{u,t})}. \tag{7}$$

With the definition of $l_{i,t} = u_{i,t} + h_{i,t}$ the respective employment and unemployment rates of each skill group follow as $\tilde{h}_{i,t} = h_{i,t}/l_{i,t}$ and $\tilde{u}_{i,t} = u_{i,t}/l_{i,t}$, i.e.

$$\tilde{u}_{i,t} = 1 - \tilde{h}_{i,t}. \tag{8}$$

The Household Sector

We assume a representative household with a large number of inhabitants which is normalized to one. The household chooses consumption, c_t, and the search intensities, $s_{i,t}, i = s, u$ of the respective skill group in order to maximize the present discounted value of its life-time utility. Households receive income from lending capital to firms at the interest rate r_t and from having a fraction of both types of its members $n_{i,t}$ work at the respective wage rates $w_{i,t}$. The household's maximization problem reads as follows:

$$U_t = \max_{c_t, s_{i,t}} \sum_{t=0}^{\infty} \beta^t U(c_t, h_{s,t}, h_{u,t}) \tag{9}$$

subject to

$$\begin{aligned}
c_t + I_t + \sum_i \kappa_i(s_{i,t})(1-h_{i,t}) &= \sum_{i=s,u} w_{i,t}h_{i,t} + \\
&\quad \sum_{i=s,u} \tau_i^h (1-h_{i,t}) + r_t k_t && (10)\\
k_{t+1} &= (1-\delta)k_t + I_t && (11)\\
h_{s,t+1} &= (1-\psi_s)h_{s,t} + p_{s,t}s_{s,t}(1-h_{s,t}) && (12)\\
h_{u,t+1} &= (1-\psi_u)h_{u,t} + p_{u,t}s_{u,t}(1-h_{u,t}), && (13)
\end{aligned}$$

where the expression $\tau_i(1-h_{i,t})$ denotes the benefits obtained from an unemployed type i worker. From equations (9)-(13), the Lagrange function follows as

$$\begin{aligned}
\max_{c_t,s_{i,t}} \mathcal{L}^{\mathcal{H}} &= E_t\Big\{\sum_{t=0}^{\infty}\beta^t\Big[U(c_t,h_{s,t},h_{u,t}) \\
&+\lambda_t\Big(\sum_{i=s,u} w_{i,t}h_{i,t}+\sum_{i=s,u}\tau_i^h(1-h_{i,t})+r_tk_t \\
&-c_t-I_t-\sum_i \kappa_i(s_{i,t})(1-h_{i,t})\Big) \\
&+\xi_{1,t}\big(h_{s,t+1}-(1-\psi_s)h_{s,t}-p_{s,t}s_{s,t}(1-h_{s,t})\big) \\
&+\xi_{2,t}\big(h_{u,t+1}-(1-\psi_u)h_{u,t}-p_{u,t}s_{u,t}(1-h_{u,t})\big)\Big]\Big\},
\end{aligned} \tag{14}$$

from which the following first-order conditions are derived

$$U_c(\cdot) = \lambda_t \tag{15}$$

$$-\kappa_{s_s,s}(s_{s,t})\lambda_t = \xi_{1,t}p_{s,t} \tag{16}$$

$$-\kappa_{s_u,u}(s_{u,t})\lambda_t = \xi_{2,t}p_{u,t} \tag{17}$$

$$\lambda_t = \beta E_t\Big\{\lambda_{t+1}(1+r_{t+1}-\delta)\Big\} \tag{18}$$

$$\begin{aligned}
\xi_{1,t} &= \beta E_t\Big\{U_{h_s}(\cdot)-\lambda_{t+1}\big(w_{s,t+1}-\tau_s^h+\kappa_s(s_{s,t+1}\big) \\
&+\xi_{1,t+1}\big((1-\psi_s)-p_{s,t+1}s_{s,t+1}\big)\Big\}
\end{aligned} \tag{19}$$

$$\begin{aligned}
\xi_{2,t} &= \beta E_t\Big\{U_{h_u}(\cdot)-\lambda_{t+1}\big(w_{u,t+1}-\tau_u^h+\kappa_u(s_{u,t+1}\big) \\
&+\xi_{2,t+1}\big((1-\psi_u)-p_{u,t+1}s_{u,t+1}\big)\Big\}.
\end{aligned} \tag{20}$$

The firm's problem is given by

$$\Pi_t = f(\cdot)-\sum_i w_{i,t}h_{i,t}-r_tk_t-\sum_i \tau_i^f\psi_ih_{i,t}-\sum_i a_iv_{i,t}, \tag{21}$$

where Π_t denotes the firm's profits, in addition $\sum_{i=s,u}\tau_i^f\psi_ih_{i,t}$ denote the sum of firing costs the firm is faced with when eliminating a job. In accordance to the literature (e.g. Merz (1995)), the firm has to solve the following optimization problem:

$$\max_{k_t,v_t} E_t\sum_{t=0}^{\infty}\beta^t\lambda_t\Pi_t, \tag{22}$$

subject to

$$h_{s,t+1} = (1-\psi_h)h_{s,t}+q_{h,t}v_{h,t} \tag{23}$$

$$h_{s,t+1} = (1-\psi_u)h_{u,t}+q_{u,t}v_{u,t}. \tag{24}$$

The Lagrangean function of the above problem reads as follows,

$$\begin{aligned}
\max_{k_t, v_{i,t}} \mathcal{L}^F &= E_t\Big\{\sum_{t=0}^{\infty}\beta^t\Big[\lambda_t \Pi_t \\
&+\chi_{1,t}\big(h_{s,t+1}-(1-\psi_s)h_{s,t}-q_{s,t}v_{s,t}\big) \\
&+\chi_{2,t}\big(h_{u,t+1}-(1-\psi_u)h_{u,t}-q_{u,t}v_{u,t}\big)\Big]\Big\}.
\end{aligned} \tag{25}$$

The respective first-order conditions follow as,

$$f_k(\cdot) = r_t \tag{26}$$

$$\chi_{1,t} = -\frac{\lambda_t a_s}{q_{s,t}} \tag{27}$$

$$\chi_{2,t} = -\frac{\lambda_t a_u}{q_{u,t}} \tag{28}$$

$$\begin{aligned}
-\chi_{1,t} &= \beta E_t\Big\{\lambda_{t+1}(f_{h_s,t+1}(\cdot)-w_{s,t+1}-\tau_s^f\psi_s) \\
&-\chi_{1,t+1}(-1+\psi_s)\Big\}
\end{aligned} \tag{29}$$

$$\begin{aligned}
-\chi_{2,t} &= \beta E_t\Big\{\lambda_{t+1}\big(f_{h_u,t+1}(\cdot)-w_{u,t+1}-\tau_u^f\psi_u\big) \\
&-\chi_{2,t+1}(-1+\psi_u)\Big\}.
\end{aligned} \tag{30}$$

Furthermore, it is assumed that the total amount of the firing tax is equal to the amount of unemployment benefits, i.e. we assume a simple budget equation for the social security system:

$$\sum_{i=s,u}\tau^f\psi_i h_{i,t} = \sum_{i=s,u}\tau_i^h(1-h_{i,t}). \tag{31}$$

Wages are set according to a Nash bargaining scheme. The wage of a type i worker follows as

$$\begin{aligned}
w_{i,t} &= \phi_i\Big[f_{h_i}(\cdot)+\sum_i a_i\theta_{i,t}-\tau_i^f\psi_i\Big] \\
&+(1-\phi_i)\Big[\frac{u_{h_{i,t}}(\cdot)}{\lambda_t}-\kappa_i(s_{i,t})+\tau_i^h\Big].
\end{aligned} \tag{32}$$

Please note that the modified wage equation differs from the basic one in two aspects. First, the firing costs reduce the worker's surplus by $\tau_i^f\psi_i$, but the benefit payments increase the worker's reservation wage by τ_i^h.

3.2 Equilibrium Solution

According to Langot (1995) the symmetric general equilibrium solution is obtained as follows: first the optimal job search and vacancy creation behavior are computed, and the wage rate is determined within a Nash-bargaining framework. Second, market clearing conditions in the goods and capital markets are imposed. However, because the wage is not the price which clears, for example a Walrasian labor market, the solution to this problem is not a Pareto optimum.[5] Because of the time-consuming matching process on the labor market, this market is characterized by a stochastic rationing pattern, i.e. there is a positive probability $1-q(\theta_i)$ that a hiring firm does not find a worker and a probability $1-\theta_i q(\theta_i)$ that an unemployed worker does not find a vacant job position. An equilibrium of this economy is a set of variables

$$\begin{aligned}\Omega_t &= \{k_{t+1}, h_{s,t+1}, h_{u,t+1}, s_{s,t}, s_{u,t}, p_{s,t}, p_{u,t}, q_{s,t}, q_{u,t}, M_{s,t},\\ &\quad M_{u,t}, v_{s,t}, v_{u,t}, u_{s,t}, u_{u,t}, c_t, y_t, I_t, r_t, w_{s,t}, w_{u,t}, \theta_{h,t}\theta_{u,t}, z_t\}\end{aligned}$$

which is determined by the household's and the firm's Euler equations as well as the respective resource constraints.

From the first-order conditions of households' maximization problem, given by eqns (15)-(20), the following Euler equations are derived

$$\beta E_t\Big\{\frac{U_c(c_{t+1})}{U_c(c_t)}(1+r_{t+1}-\delta)\Big\} = 1 \tag{33}$$

$$\begin{aligned}\beta E_t\Big\{-U_{h_s}(h_{s,t}) + \lambda_{t+1}(w_{s,t+1}-\tau_s^h+\kappa_s(s_{s,t+1}))+&\\ \frac{\kappa_{h_s,s}(s_{s,t+1})}{p_{s,t+1}}\lambda_{t+1}(1-\psi_s-p_{h,t+1}s_{s,t+1})\Big\}&\\ -\frac{\kappa_{h_s,s}(s_{s,t})\lambda_t}{p_{s,t}} &= 0\end{aligned} \tag{34}$$

$$\begin{aligned}\beta E_t\Big\{-U_{h_u}(h_{u,t}) + \lambda_{t+1}(w_{u,t+1}-\tau_u^h+\kappa_u(s_{u,t+1}))+&\\ \frac{\kappa_{h_u,u}(s_{u,t+1})}{p_{u,t+1}}\lambda_{t+1}(1-\psi_u-p_{u,t+1}s_{u,t+1})\Big\}&\\ -\frac{\kappa_{h_u,u}(s_{u,t})\lambda_t}{p_{u,t}} &= 0.\end{aligned} \tag{35}$$

Note that λ_t denotes the Lagrange multiplier of the household's optimization problem.

By rearranging the first-order conditions of the firm's decision problem given by

[5] Cf. Langot (1995): 297.

equations (26)-(30), the following Euler equations are derived

$$
\begin{aligned}
f_k(\cdot) - r_t &= 0 && (36)\\
\frac{\lambda_t a_s}{\lambda_{t+1} q_{s,t}} - \beta E_t \Big\{ f_{h_s}(\cdot) - w_{s,t+1} - \tau_s^f & \\
+ \frac{a_s}{q_{s,t+1}}(1-\psi_s) \Big\} &= 0 && (37)\\
\frac{\lambda_t a_u}{\lambda_{t+1} q_{u,t}} - \beta E_t \Big\{ f_{h_u}(\cdot) - w_{u,t+1} - \tau_u^f & \\
+ \frac{a_u}{q_{u,t+1}}(1-\psi_u) \Big\} &= 0. && (38)
\end{aligned}
$$

The equilibrium solution is specified by the household's and the firm's Euler equations (33)-(38), as well as equations (3), (1), (2), (4), (5), (6), (7), (8), (**??**), (**??**), (**??**), (32) and the aggregate resource constraint, which is given by

$$
c_t + I_t + \kappa_s(s_{s,t}) + \kappa_u(s_{u,t}) + a_s v_{s,t} + a_u v_{u,t} = y_t. \tag{39}
$$

Furthermore the budget rule of the benefit payments (eqn. 31) has to be considered.

The household's preferences are described by the following utility function:

$$
U(c_t, h_{s,t}, h_{u,t}) = \frac{c_t^{1-\Phi}}{1-\Phi} - \frac{h_{s,t}^{1-\nu_s}}{1-\nu_s} - \frac{h_{u,t}^{1-\nu_u}}{1-\nu_u} \tag{40}
$$

with $\Phi, \nu_1, \nu_2 \geq 0$, where Φ denotes the intertemporal substitution elasticity of consumption and ν_1, ν_2 represent the respective elasticities for the supply of labor. The production technology is chosen in accordance with Heckman, Lochner, and Taber (1998) who assume both types of labor as well as labor and capital as imperfect substitutes:

$$
f(\cdot) = z_t \left(\alpha \Big(\gamma (z_t^{\xi_s} h_{s,t})^{\rho_1} + (1-\gamma)(z_t^{\xi_u} h_{u,t})^{\rho_1} \Big)^{\frac{\rho_2}{\rho_1}} + (1-\alpha) k_t^{\rho_2} \right)^{\frac{1}{\rho_2}}, \tag{41}
$$

where z_t is determined by a stationary Markov process, i.e.

$$
z_t = \rho z_{t-1} + \epsilon_t^z \qquad \text{with} \quad \epsilon_t^z \sim \mathcal{N}(0, \sigma^2).
$$

Furthermore, the parameters $\xi_u, \xi_h > 0$ denote external effects of technology on the respective type of labor.

Migration and Benefit Shock

As already mentioned, the focus of the recent study is to analyze the impacts of an emigration shock of skilled workers as well as an increase in benefit payments particularly for lower skilled workers.

Therefore, we have to rewrite equations (1). For the evolution of the number of skilled workers, assume that an emigration shock reduces the available workforce, i.e. eqn. (1) rewrites to

$$h_{s,t+1} = (1 - \psi_s)h_{s,t} + M_{s,t} + z_t^{\text{em}} \tag{42}$$

with

$$z_t^{\text{em}} = \rho_2 z_{t-1}^{\text{em}} - \epsilon_t^{\text{em}}. \tag{43}$$

An increase in benefit payments for low skilled workers is modeled in a similar way. There we assume a positive shock

$$\tilde{\tau}_{u,t}^{h} = \rho_3 \tilde{\tau}_{u,t-1}^{h} + \epsilon_t^{\tau}. \tag{44}$$

3.3 Numerical Results

In the following section we calibrate the model described above in order study the following questions: what are the effects of a migration shock of skilled workers on employment and economic activity and how do increases in unemployment benefits strengthen such migration shocks.

The equilibrium levels of employment as well as the unemployment rates of the different skill groups, $\tilde{u}_i$, are chosen according to the empirical evidence as reported by table **??**, i.e. total unemployment of the respective skill group follows as: $u_i = h_i \cdot \tilde{u}_i$. The elasticity of substitution between both types of labor services, σ_1, is chosen analogue to Heckman, Lochner, and Taber (1998) who estimated an elasticity of 1.4, furthermore we follow their empirical results of a elasticity of substitution between capital and labor which is close to 1. The external effects of new technologies are specified in line with the results of Greiner, Rubart, and Semmler (2004). The values of the worker's bargaining power ϕ_i are chosen in a way that both firms and work share the surplus of a productive job equally which coincides, in general, with the results of a centralized wage bargaining which is often found in continental European countries. The parameters of the matching technologies as well as the search costs are chosen in accordance to Merz (1995) and Pierrard and Sneessens (2003), in general we assume that a skilled worker has lower search costs than an low-skilled worker and for the firm we assume the opposite case, i.e. it is more expensive to hire a worker with a university degree than a worker without such a degree. By following Kluve, Schaffner, and Schmidt (2005) the quarterly job destruction rates for skilled and unskilled workers are chosen as 1.8 and 5.6%. It should be noted that lower destruction rates are reported for West Germany. For example, Ridder and van den Berg (2003) report destruction rates between 1 and 2%.

Table 4: Parameter Settings

$\bar{h}_s$	$\bar{h}_u$	$\bar{\bar{u}}_s$	$\bar{\bar{u}}_h$	$\bar{z}, \bar{\bar{z}}, \bar{\tilde{z}}$	α	β
0.25	$1 - \bar{N}_h$	0.05	0.10	1	0.64	0.99
δ	$\bar{R}$	Φ	γ	μ	ν_s, ν_u	$\bar{\kappa}_h$
0.025	$1/\beta$	0.5	0.5	1.0	0.8	0.025
$\bar{\kappa}_u$	ψ_s	ψ_u	$\sigma_1(\sigma_2)$	ρ_1	ρ_2	a_h
$2 \times \kappa_h$	0.01	0.02	0.3 (0.1)	0.7	0.7	$2 \times a_u$
a_u	ϕ_h	ϕ_u	ε_h	ε_u	$\omega_z, \omega_{\bar{z}}, \omega_{\tilde{z}}$	$\epsilon_z, \epsilon_{\bar{z}}, \epsilon_{\tilde{z}}$
0.025	0.5	0.5	1.5	1.0	0.95	0.007

For the subsequent analysis the steady state of the deterministic part of the model is computed numerically by a Newton-Raphson method provided by DYNARE[6]. The impulse response functions rely on a first order approximation of the stochastic model around its steady state.

3.4 Numerical Results

Figures 7 and 10 below show the impulse-responses of an emigration shock, i.e. a sharp reduction in the supply of skilled workers, and an increase in unemployment benefits.

[6]Dynare is a pre-processor and a collection of MATLAB or SCILAB routines which solve non–linear models with forward looking variables. See `http://www.cepremap.cnrs.fr/dynare/`.See Juillard (1996) for details.

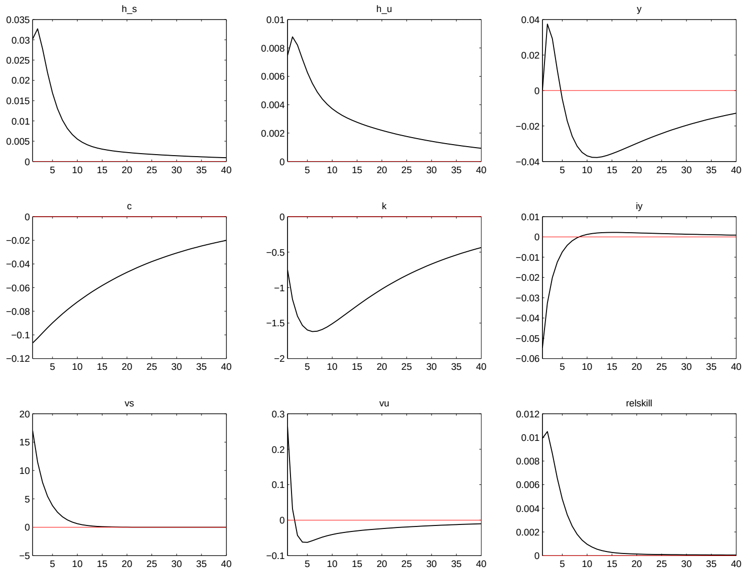

Figure 7: Emigration of Skilled Workers

When the supply of skilled workers declines, firms immediately increase vacancies vs. Because of the given stock of employment (of both types of workers) and of physical capital production is increased in order to finance the rising search costs for skilled workers. However, due to the decline of the household's income consumption declines and the firms have no incentives to invest in new production capital. Therefore, investment per GDP as well as the stock of capital declines. Because of the decline in capital, and the non-availability of skilled workers the response of output becomes negative after 5 to 6 quarters. In general, we find a similar picture in the short boom after the German reunification between 1991 and 1993.

Figures 8 and 9 show the effects of an increasing persistency of emigrating skilled workers.

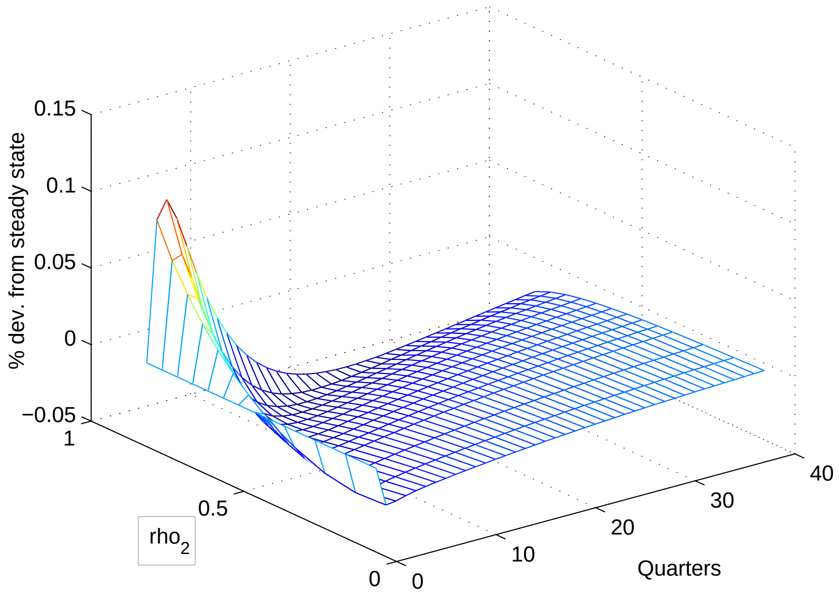

Figure 8: Sensitivity Analysis, Output

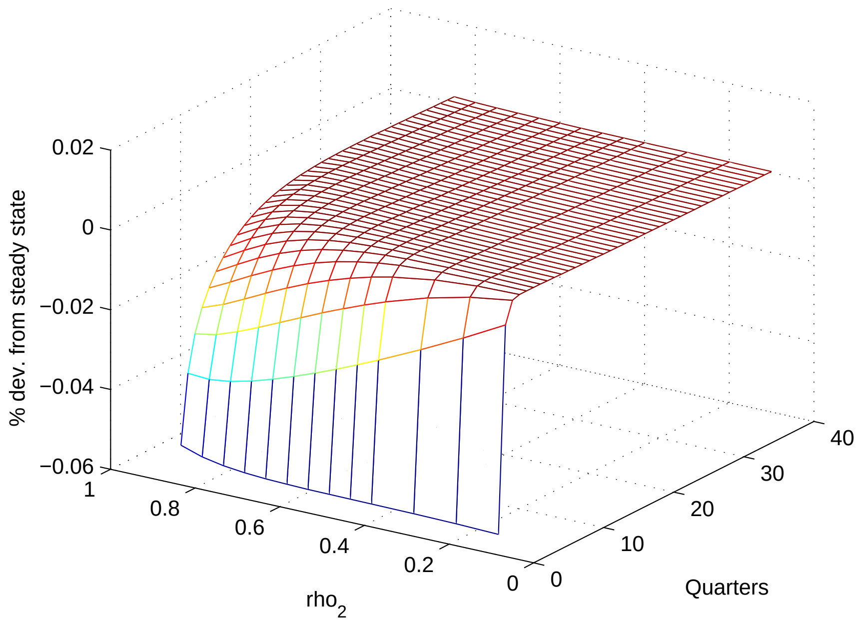

Figure 9: Sensitivity Analysis, I/Y-Ratio

As expected, we observe a more persistent reduction in investment activities when the outflow of skilled workers is more persistent (figure 9). Similarly, the negative response of output is also more persistent. Although the immediate responses of output, which is required in order to finance the search activities in order to hire skilled workers, increases the obtained results are still in line with the observations.

The impact of an increase in unemployment benefits leads to a similar picture. At first, there are general incentives for both types of workers (because of the assumed income pooling) not to search for a new job. However, the lower magnitude of the negative response of vacancy creation for skilled workers forces this type of workers to search for new jobs because the expected value of a job exceeds the skilled workers outside option. On the other hand, because of higher benefit payments, low-skilled workers reduce search activities after one year. Because of the high negative response of vacancy creation of low skilled workers the employment pattern of this type of workers shows the immediate and persistent decline.

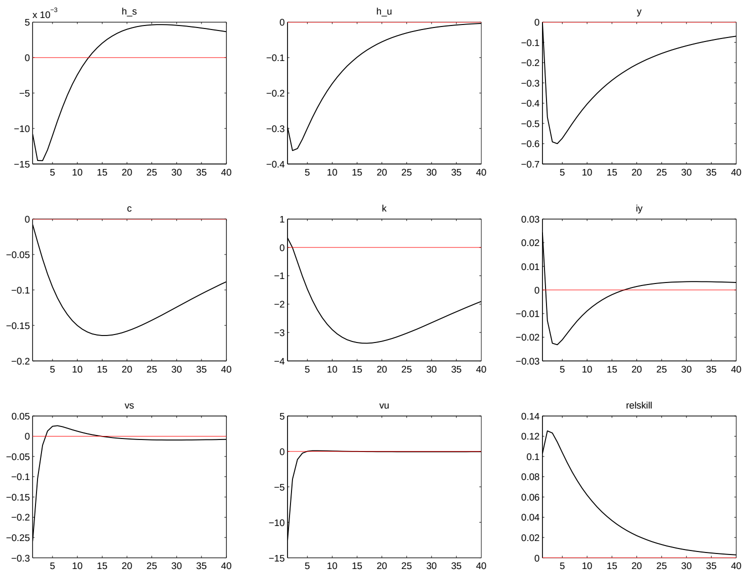

Figure 10: Increase in Benefits for Low-Skilled Workers

about here, further simulation results and sensitivity examinations,
some data taken from Kluve, Schaffner, and Schmidt (2005)

4 Conclusion

In the recent paper we asked whether the East German unemployment problem is only a problem of the labor market and labor market rigidities such as employment protection mechanisms only. In parts, we can conclude in this way.

However, on the macroeconomic level (as well as shown in the data) too low investments in productive activities are observed. Because of the strategic complementarity between investments in technologies and skilled workers (which leave Eastern Germany) firms reduce investments or do not invest in most of the East German regions (only Dresden and Jena show significant lower unemployment rates in comparison to the rest of Eastern Germany).

We found further supports of the results and suggestions by Phelps and Zoega (2001), furthermore we have shown in a general equilibrium model that we can replicate the empirical findings without assuming sclerotic labor markets. However, our results should further be a warning to politicians just to increase public spending in Eastern Germany. Eastern Germany requires productive investments by entrepreneurs and not from governments!

However, our results have to be justified by further empirical examinations of the interplay between skills, investment and economic activity.

References

Burda, M. C. (2006): "Factor Reallocation in Eastern Germany after Reunification," *American Economic Review Papers and Proceedings*, 96(2), 368–374.

Cahuc, P., and A. Zylberberg (2004): *Labor Economics*. The MIT Press, Cambridge, Mass.

Canova, F., and M. O. Ravn (2000): "The Macroeconomic Effects of German Unification: Real Adjustments and the Welfare State," *Review of Economic Dynamics*, 3, 423–460.

Colecchia, A., and P. Schreyer (2001): "ICT Investment and Growth in the 1990s: Is the U.S. a Unique Case? A Comparative Study of Nine OECD Countries," OECD STI Working Papers, No. 2001/7, Paris.

Greiner, A., J. Rubart, and W. Semmler (2004): "Economic growth, skill-biased technical change and wage inequality: A model and estimations for the U.S. and Europe," *Journal of Macroeconomics*, 26(4), 597–621.

Heckman, J. J., L. Lochner, and C. Taber (1998): "Explaining Rising Wage Inequality: Explorations with a Dynamic General Equilibrium Model of Labor Earnings with Heterogeneous Agents," *Review of Economic Dynamics*, 1, 1–58.

Juillard, M. (1996): "DYNARE: A program for the resolution and simulation of dynamic models with forward variables through the use of a relaxation algorithm," CEPREMAP Working Paper, No. 9602, Paris.

Kluve, J., S. Schaffner, and C. M. Schmidt (2005): "Labor Force Status Dynamics in the German Labor Market: Individual Heterogeneity and Cyclical Sensitivity," Mimeo, Collaborative Research Center (Sonderforschungsbereich) 475, "Reduction of Complexity for Multivariate Data Structures", University of Dortmund, February.

Kydland, F. E. (1984): "Labor-Force Heterogeneity and the Business Cycle," *Carnegie-Rochester Conference Series on Public Policy*, 21, 173–208.

Langot, F. (1995): "Unemployment and Business Cycle: A General Equilibrium Matching Model," in *Advances in Business Cycle Research*, ed. by P.-Y. Henin, pp. 287–326, Berlin, Heidelberg. Springer.

Ljungqvist, L., and T. J. Sargent (2005): "The European Unemployment Experience: Uncertainty and Heterogeneity," Mimeo. Stockholm School of Economics and New York University, August.

——— (2006): "Do Taxes Explain European Employment? Indivisible Labor, Human Capital, Lotteries, and Savings," Mimeo. Stockholm School of Economics and New York University, July.

MERKL, C., AND D. J. SNOWER (2006): "The Caring Hand that Cripples: The East German Labor Market after Reunification," The Kiel Institute for the World Economy, Kiel Working Paper, No. 1263, January (revised April).

MERZ, M. (1995): "Search in the Labor Market and the Real Business Cycle," *Journal of Monetary Economics*, 36, 269–300.

PHELPS, E. S., AND G. ZOEGA (2001): "Structural Booms," *Economic Policy*, 16(32), 85–126.

PIERRARD, O., AND H. R. SNEESSENS (2003): "Low-Skilled Unemployment, Biased Technological Shocks and Job Competition," IZA Discussion Paper, No. 784, Bonn, May.

RIDDER, G., AND G. J. VAN DEN BERG (2003): "Measuring Labor Market Frictions: A Cross-Country Comparison," *Journal of the European Economic Association*, 1(1), 224–244.

RUBART, J. (2006): "Heterogeneous Labor, Labor Market Frictions and Employment Effects of Technological Change. Theory and Empirical Evidence for the U.S. and Europe," Darmstadt Discussion Papers in Economics, No. 158, January.

——— (2007): *The Employment Effects of Technological Change – Heterogeneous Labor, Wage Inequality and Unemployment.* Springer Verlag, Berlin, Heidelberg.

SAINT-PAUL, G. (2004): "Why Are European Countries Diverging in Their Unemployment Experience," IZA Discussion Paper No. 1066, Bonn, March.

UHLIG, H. (2006): "Regional Labor Markets, Network Externalities and Migration: The Case of German Reunification," *American Economic Review Papers and Proceedings*, 96(2), 383–387.