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The Macroeconomic Effects of German Unification:
Real Adjustments and the Welfare State

by

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Abstract

We study the effects of German unification on domestic macroeconomic variables, taking as given the wage and exchange rate parity legislated at the time of the union. We argue that a unification with these features is similar to a mass migration of low-skilled agents holding no capital in a foreing country. We show that, absent a welfare state, this event has substantial redistributive effects in favor of capital holders over the business cycle and depressive long run consequences. With a welfare state attempting to keep the distribution of income constant over the business cycle, depressive long run effects may be amplified as capital owners are forced to pay the resulting increase in welfare outlays. We argue that this is exactly what happened since the fall of the Berlin wall and the resulting recession could have been predicted. Finally, we examine two policies modifying the current status quo, a wage freeze for migrants and a wage subsidy for enterprenuers, and show that they may contrast negative long run tendencies.

JEL Classification No.:

Key words: Labor markets, Redistribution, Currency parity, Wage parity, Wage subsidies, Wage freeze.

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I want my Wall back.   A Graffiti in East Berlin

1 Introduction

The fall of the Berlin wall and the successive reunification occurred in July 1990 were phenomenal macroeconomic shocks to the German economy which lead to major adjustment problems. Several key factors may have contributed to make the adjustment more problematic. First, the unification was associated with the decision to impose a one-to-one exchange rate between the two marks and a wage parity between the East and the West. This may certainly have contributed to the substantial loss of competitiveness experienced by East German firms and to the collapse the industrial sector, which curtailed the national product of the East and led to high levels of unemployment rates. Second, the loss of protectionists measures, in place in the East even in the late 1980's, may also have contributed to the collapse of the industrial sector therefore reinforcing the previously described effects. Third, the fiscal expansion, which followed the collapse of the industrial sector in the East, has lead to higher taxes in West, to a larger budget deficit and to restrictive monetary policy in order to keep interest rates high enough to allow the government to place the debt needed to finance the reconstruction of the East. Several analysts (see e.g. The Economist (1996)) believe that this combined set of events was sufficient to induce a recession in the West which compounded the negative effects on employment and output coming from the East.

In this paper we take the wage parity, the one-to-one exchange rate and the increase in fiscal expenditure as given and ask what would have been the likely consequences of these measures once unification was achieved. We do this in a model of a single country with two types of agents, similar to the one employed by Canova and Ravn (1996). The two types of agents are modelled as high-skilled and low-skilled agents: high-skilled are more productive and own the capital stock while low-skilled are unable to insure their consumption streams.

We argue that unification under these conditions represents a formidable shock to the West German economy, qualitatively similar to a mass migration of relatively unskilled agents, holding no capital to a foreign nation. We show that such a mass migration has substantial business cycle consequences and negative long-run macroeconomic effects. Since the population growth rate temporarily increases, the capital-labor ratio decreases and the economy will devote resources to rebuild the per-capita capital stock. This will be the only observable effect if agents in the economy are homogeneous. However, with a heterogeneous work force, there is also a second effect, caused by a permanent change in the composition of the population, which generates more substantial short-run dynamics and permanent long-run effects. In particular, if the newcomers have lower productivities than the average native worker, output, capital, hours worked in efficiency units and

highly-skilled hours will be permanently lower in the new steady-state.

Under these conditions, an inflow of low-skilled labor also has short run distributional effects on natives. Low-skilled workers are negatively affected: because they earn lower wages and are restricted from participating in financial markets their income declines. In contrast, high-skilled workers, who own the capital stock, are better off because the return to capital increases.

To this setup we add a Government whose only task is to redistribute income in such a way either to keep the relative income scale of agents constant over the business cycle or to insure low-skilled agents from any kind of income fluctuations. We find that when such a policies are in place, the burden of the adjustment falls in part or totally on high-skilled/capital owners which have to finance a larger welfare state, both because the income of low-skilled agents drop and because there is a larger fraction of them. Such a redistributive schemes may be very disruptive as they alter investment opportunities over the business cycle, induce a recession, lead to a very long adjustment period and worse long-run conditions.

We argue that current policies attempting to support the income of East Germans have exactly the characteristics of an egalitarian or insurance type rule and are therefore bound to produce perverse effects both over the adjustment process and in the long run. Essentially, these policies eliminate the incentivate for entrepreneurs to make investments so that both capital and income per-capita will drop proportionally in the long run. Moreover, welfare provisions of exactly the form that we consider have been mentioned in the literature as the main difference between the East German transition process and the transitions in other formerly centrally planned economies (see e.g. Schrettl, 1992).

We examine the consequences of adopting two policies recently advocated in the popular press and in policy circles, to modify the status quo: a reduction of welfare benefits for East Germans and a tax break for capital owners. We find that both proposals have merits in contrasting the negative effects induced by the redistribution policies since they decrease labor costs over the business cycle and incentive investments in the long run.

The remainder of the paper is organized as follows: section 2 discusses the recent dynamic of macrovariables in Germany; section 3 outlines our model; section 4 analyzes the quantitative effects of unification under wage and currency parity; section 5 repeats the analysis under two different assumptions on the welfare system; section 6 discusses the implications of our results for the recent German experience; section 7 examines two alternative policies designed to reduce labor costs. Section 8 concludes.

2   Recent Macroeconomic Trends of the German Economy

We begin by providing some facts about the German economy in recent years and the changes that have occurred since the fall of the Berlin wall.

Figures 1-5 display data for West Germany up to the second quarter of 1990 and for the unified ("Pan") Germany from the first quarter of 1991. The data is from the National Government section of the OECD except for population numbers which are from the IFS database.

Figure 1 plots the evolution of the population and workforce of Germany before and after unification. The workforce of West Germany grew steadily through the period 1960-1990 with an annual growth rate of approximately 0.5 percent while population grew faster in the fifties and sixties but then levelled out. With unification population and the workforce increased by about 26%. On impact, unification generated an *increase* in real GDP of approximately 14 percent (from the second quarter of 1990 to the first quarter of 1991) but a *drop* in real GDP per-capita of around 10 percent (see figures 2 and 3). West Germany was third in the world ranking of per-capita GDP in 1989 (after Switzerland and Japan) while in 1996 unified Germany dropped to tenth place in the world ranking (even after Austria and Belgium). This is a change in macroeconomic activity much larger than what one normally sees over the business cycle. Furthermore, the average annual growth rate of the new unified Germany (1%) is considerably lower than what West Germany achieved during the 1960-1990 period (2.75%).

Interestingly, this drop in per-capita GDP is *not* reflected in the level of fixed investments (see figure 4). Per-capita real fixed investments of unified Germany is roughly the same as the one of West Germany before unification: at reunification the investment share in GDP of "Pan" Germany increased to its highest level since the boom of the 1979/1980 and then to a level last achieved in 1974. Thus with the unification a boom in aggregate investments occurred in conjunction with a contraction in aggregate output per capita.

Figure 5 plots employment level, defined as the number of wage and salary earnen, and the unemployment rate, defined as registered unemployed to the workforce[1] for the last 36 years. At unification, the percentage increase in employment is larger than the associated increases in either population or the workforce [2] but this tendency was quickly reversed and employment constantly decreased in the period 1991-1996. Associated wi this decline is the surge in the unemployment rate (though there are very recent signs of a reversal of this trend). Unemployment in West Germany was very low prior to 1974, but rose dramatically after that and after the recession of the early 1980's. Immediately before unification, West German unemployment was trending downward but reunification produced a very strong upward trend very different from what was historically experienced, with unemployment reaching an unprecedented 7 percent of the workforce. Hence, reunification generated an increase in total activity, a decrease in output per-capita, an increase in the investment share and an increase in hours followed by a decline.

At regional level differences between the east and the west have substantially deepened

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[1]The workforce is defined as the population between 15 and 64 years of age.

[2]Because employment figures excludes self-employed, these differences are exaggerated since a large portion of West German population was self-employed prior to unification while the number of self-employed in East Germany before and immediately after unification is small.

after unification. In 1995 the per-capita GDP in the East (excluding Berlin) was 50% of that of the West while the West accounted for approximately 90% of the GDP and 98% of the exports of the "unified" Germany. Notice that the GDP of the East dropped by about 35% in the first two years after unification (from 15% to 8% of the total). Also, the average growth rate in the East, after annual rates of about 7-8% for the 1992-94 period, collapsed to a 1.8% in 1996 and no changes are forecasted in the years to come. Furthermore, while the unemployment rate in the West has increased from 5% in 1992 to more than 7.0% in 1996, in the East landers it has oscillated around 16% after an initial jump from 0% to about 25% in 1991. This implies that while during the last years of the Berlin Wall, nine million workers were employed in the East, now only 65% of these have jobs. Finally, on the average over the last five years, job creation as percentage of labor force has been only 2.8% in the East. This small increase was due to the high average wage costs: in 1996 they were about 35% higher than in the West with public services and construction being the only sectors with costs comparable to the West (with differentials being 2% and 12%, respectively). Note also that 50% of the workers in the East have been retrained since unification to adapt them to the western style of management.

The deepening of the wedge between the east and the west is typically attributed to two exogenous facts: the currency union, with a one-to-one exchange rate between the two marks and the rapid rise of Eastern wages towards Western levels. Wage increases have not been supported by corresponding productivity increases with a loss of competitiveness for the industrial sector and of jobs. For example, in the first year of unification, industrial production in the East dropped to about one-third of the pre-unification level. In comparison, US industrial production fell by 35% during the Great Depression and in other East European countries the decrease was on average 25%.

In 1995, East Germany produced only 60% of what it consumed thanks to the generous and comprehensive "welfare net" that has protected the East since unification. For example, during the first year of unemployment benefits are between 63 and 68% of terminal wages and between 53 and 58% in the second year. After two years, unemployment benefits are substituted by welfare payments at the same level obtained after one year of unemployment, with some restrictions applying if the spouse if working. One reason typically cited for such massive transfer program has been that without such financial support East Germans would have started a mass migration toward the western part of the country creating political and organizational problems. The result has been that West Germans pay higher taxes (for example, West Germans pay a 7.5% solidarity income and corporation surchange to help to finance the East), accept higher interest rates, experienced larger than usual budget deficits (slightly above 3% of GDP on average over the 1991-1996 period while in West Germany before unification budget deficit was only 1.5%), and a loss of competitiveness in international markets.

Public transfers to the Eastern landers have reached approximately 200 billion marks per year in the last 6 years, an amount which corresponds to 4-5% of the annual West German GDP (about 35% of the local GDP every year), approximately DM 7500 per-

capita or twice the disposable income of Poland. Of these transfers social insurance related payments accounts for about 45% while investment subsidies accounts for 12%. Akerlof et al (1991) have estimated that without subsidies, given the wages hikes of 1990, only 8.2% of the industrial workers could have retained their jobs if production had continued with the old technologies.

In the 1990-1995 period the German government concentrated investment efferts on improving the infrastructure in the East but this has come together with the complete disappearance of the export sector (due to the breakdown of the COMECOM trading area) and of the manufacturing sector (because of high wage costs). As a consequence of subsidies, transfers and infrastructural investments, the size of the public sector has roughly doubled in the last 6 years.

Given this evidence, the questions we are interested in asking are: can we rationalize the economic changes occurred after the fall of the Berlin wall in a dynamic model of the business cycle? Could we have predicted the consequences that the induced wage parity had on the German economy after the unification? What are the effects of the huge tax-transfer subsidies that the government pays to maintain an egalitarian distribution of income between the two parts of Germany? Should we expect unified Germany to go back to the previous standard of living (relative to the trend), once the negative effects of unification are exhausted, or stay at a permanently lower level? Given the exchange rate and the wage policy adopted, are there policies that could alleviate the negative tendencies that unification had on macroeconomic variables?

3 The Basic Model

The model we use is highly stylized but contains most of the key features needed to understand the recent developments in the German economy we are interested in. First of all, we model German unification as a mass-migration of agents from one country to another. We assume that arriving migrants acquire the political, legal and work rights of local residents. This seems a reasonable working hypothesis since German unification has occurred according to article 23 of the West German Constitution which gave the former GDR (German Democratic Republic) or part of it, the right to join the FRG (Federal Republic of Germany) with an equal partner status, provided it accepted the conditions set by the FRG. In practice, the political, legal and social security system of the FRG was applied with minor changes to the former GDR.

Secondly, we assume that the sending country disappears once migrants move and, as a consequence, that its capital stock instantaneously depreciates. In other words, we assume that migrants do not bring any productive capital with them. Since it has been estimated that between 50% and 70% of the capital stock in place in the former GDR was obsolete or unusable for production methods in competitive markets (see Siebert (1990) and Sinn and Sinn (1992, p. 44)) and that the productivity of East German capital at

the time of unification was between 16% and 40% of that of West German capital (see Akerlof, et. al. (1991) and Sinn and Sinn (1992)) this assumption is not so extreme as it may appear.

Third, we assume that the receiving economy possesses two types of agents that differ in their productivity levels as in Kydland (1984, 1995) and Rios-Rull (1993)). We treat unification as an inflow of low-skilled workers into the economy. At the time of unification, East German workers had a level of human capital (measured either in terms of years of education or education level of employed) which was about 40% higher than that of West German workers. Nevertheless, we think it is appropriate to treat East German workforce as low-skilled since it had to be extensively retrained to assimilate their skills to western style of production (see Akerlof at al. (1991)).

Fourth, we assume that low-skilled agents are unable to save for future occurrences. The fact that low-income households are restricted from accessing financial markets is well documented in the literature. For example, Campbell and Mankiw (1989) and Mankiw and Zeldes (1991) have estimated that approximately 50% of US households are liquidity constrained. Given the skill features of newcomers, we should expect them to be liquidity constrained as well. However, we go a step further and assume that low-skilled agents (both local and newcomers) are unable to intertemporally smooth consumption. Although this assumption may look too strong, it is the case that East Germans are currently unable to purchase private insurance contracts which would allow them to smooth their consumption stream over the period of interest and gives a scope to the insurance activities of the Government. In any case, this simplifying assumption only affects the composition of the labor supply over the adjustment path but it does not influence the qualitative implications of the model.

Finally, and as a first approximation, we ignore the international repercussions of the unification and assume that the economy of the receiving country is, for all purposes, closed. This prevents us from considering questions related to external borrowing to finance the construction of the capital stock (a fact which appears to be of some importance for the case of Germany since it went from being the country with the largest trade surplus in 1990 to having a current account deficit since 1992). However, this assumption does not change the qualitative implications of our exercise and provides an upper bound to the costs that may have actually been born by a resident of unified Germany.

It is instructive to present the economy first and then discuss unification later. We denote the two groups of agents by $i = s, u$ where s denotes high-skilled and u low-skilled. There are N_t^i agents of type i at time t and γ_t is the time t share of skilled agents.

We assume that there is a large number of identical competitive firms renting factors of production from the households. Production takes place using labor in efficiency units (H^e) and capital (K) and we assume that the production function is Cobb-Douglas with constant returns to scale to these two factors. Hours in efficiency units is modelled as a CES-aggregate of the two types of labor with an elasticity of substitution of $1/\rho$. Skilled hours are more productive than unskilled hours and we let $\omega \geq 1$ denote productivity

differences. When the two types of labor are perfect substitutes $H^e = H^u + \omega H^s$, where H^i denotes total number of hours of workers of type i used in production.

The maximization problem of the representative firm is:

$$\max_{\{H_t^s, H_t^u, K_t\}} z_t \left[\omega(H_t^s)^{1-\rho} + (H_t^u)^{1-\rho}\right]^{\frac{\alpha}{1-\rho}} K_t^{1-\alpha} - w_t^s H_t^s - w_t^u H_t^u - r_t K_t \qquad (1)$$

where $H_t^i \equiv N_t^i \cdot h_t^i$, h_t^i is the number of hours of a worker of skill i and z_t is a productivity disturbance. Converting (1) into per-capita terms using our definition of γ_t, we obtain:

$$\max_{\{h_t^s, h_t^u, k_t\}} z_t \left[\omega(\gamma_t h_t^s)^{1-\rho} + ((1-\gamma_t)h_t^u)^{1-\rho}\right]_t^{\frac{\alpha}{1-\rho}} (k_t/g_t^p)^{1-\alpha}$$
$$-\gamma_t w_t^s h_t^s - (1-\gamma_t)w_t^u h_t^u - r_t k_t/g_t^p \qquad (2)$$

where lower case letters denote per-capita variables defined as :

$$k_t = K_t/N_{t-1}, \quad g_t^p = N_t/N_{t-1}$$

It follows immediately from the assumptions of competition that all factors are paid by their marginal products and the relative wage of skilled and unskilled agents is:

$$\frac{w_t^s}{w_t^u} = \omega \left(\frac{\gamma_t h_t^s}{(1-\gamma_t) h_t^u}\right)^{-\rho}$$

which depends positively on the productivity difference and on the share of unskilled agents (since we assume that $\rho \geq 0$).

The two groups of agents face different intertemporal utility maximization problems because we assume that low-skilled workers own no capital and are prevented from purchasing insurance contracts. The problem faced by these agents is:

$$\max_{\{c_t^u, l_t^u\}} E_0 \sum_{t=0}^{\infty} \beta^t U\left(c_t^u, l_t^u\right) \qquad (3)$$

subject to a sequence of budget constraints:

$$c_t^u \leq w_t^u h_t^u (1 - \tau_t^u) \qquad (4)$$

and time constraints:

$$l_t^u + h_t^u \leq 1 \qquad (5)$$

where c^u denotes consumption, l^u is leisure, h^u is hours worked, τ^u is the net income tax (including transfers), β is the subjective discount factor and where we have normalized the time endowment to one each period. If we let the utility function be of the CRRA type, $U(c_t^u, l_t^u) = \frac{1}{1-\sigma^u}\left(\left[(c_t^u)^{\theta^u}(l_t^u)^{1-\theta^u}\right]^{1-\sigma^u} - 1\right)$, the solution to the problem is:

$$h_t^u = \theta^u, \quad y_t^u = \theta^u \cdot w_t^u, \quad c_t^u = (1 - \tau_t^u) \cdot y_t^u$$

Thus these agents work a constant number of hours and they simply consume their after-tax income period-by-period.

The problem faced by high-skilled agents is:

$$\max_{\{c_t^s, h_t^s, k_t\}} E_0 \sum_{t=0}^{\infty} \beta^t U(c_t^s, l_t^s) \tag{6}$$

subject to a sequence of budget constraints:

$$c_t^s + x_t/\gamma_t \leq (w_t^s h_t^s + r_t k_t/\gamma_{t-1})(1 - \tau_t^s) \tag{7}$$

time constraints:

$$l_t^s + h_t^s \leq 1 \tag{8}$$

and the capital accumulation equation:

$$k_{t+1} = (1 - \delta)k_t/g_t^p + x_t \tag{9}$$

where x_t denotes investments, τ^s the tax rate on skilled agents, and δ is the depreciation rate[3]. If we assume that the utility function is of CRRA type, the intertemporal and intratemporal optimality conditions are :

$$\frac{1 - \theta^s}{\theta^s} \frac{c_t^s}{1 - h_t^s} = w_t^s(1 - \tau_t^s)$$

$$\lambda_t = \beta E_t \lambda_{t+1} \left((1 - \delta) + (1 - \tau_{t+1}^s)r_{t+1} \right)$$

where λ is the multiplier on the budget constraint (7) and θ^s is the share parameter that enters as the power of consumption in the utility function. The first of these conditions sets the marginal rate of substitution between consumption of goods and leisure equal to the relative price of these two goods; the second sets the intertemporal marginal rate of substitution equal to the relative price of consumption between period t and period $t+1$.

We assume that there is a government whose only aim is to redistribute income across classes of agents via taxes and transfers and it is forced to do this by balancing its budget on a period-by-period basis. As we argue later, excluding intertemporal borrowing does not affect the essence of out exercise. We assume that $\tau_t^u = \tau_t^s - \mu_t$, so that μ_t is a tax rebate on low-skilled workers and that τ_t^s is endogenously chosen to target certain redistributive policies, while μ_t is endogenously determined to satisfy the government budget constraint:

$$\tau_t^s \gamma_t y_t^s = (\mu_t - \tau_t^s)(1 - \gamma_t)y_t^u \tag{10}$$

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[3](7) and (9) includes the population growth rates and the share of skilled agents because these agents own all the capital stock. Define k_t^s as the capital holding of a representative skilled household at time t. We then have that $k_t^s N_{t-1}^s = N_t K_t$. Then use that $k_t = K_t/N_{t-1}$ and that $\gamma_{t+1}/\gamma_t = g_{t+1}^s/g_{t+1}^p$ where g_{t+1}^s is the growth rate of the skilled population. In particular, it follows that: $k_t^s = k_t/\gamma_{t-1}$.

where y_t^s and y_t^u are the incomes of the two types of agents. The right hand side of (10) is the real tax revenue received from taxation of skilled agents while the left hand side is the net transfer to unskilled agents.

In the aggregate the following income composition and resource constraints must hold:

$$y_t^s = \frac{1}{\gamma_t} [y_t - (1 - \gamma_t) y_t^u] \tag{11}$$

$$y_t = \gamma_t c_t^s + (1 - \gamma_t) c_t^u + x_t \tag{12}$$

Finally, we assume that z_t is first-order autoregressive process,

$$z_t = (1 - \psi)\bar{z} + \psi z_{t-1} + \varepsilon_t \tag{13}$$

where $\psi \in (0, 1)$ and $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$.

3.1 The Business Cycle Properties of the Model

Before analyzing the effects of unification, it is instructive first to look at the cyclical properties of the economy after we calibrate the parameters of the model. For future discussion, we present steady state relationships in Appendix A.

We calibrate the model to match annual data and try to use standard parameter values whenever it is possible. The depreciation rate is set equal to 10% and the real interest rate to 4%. The parameter α (the labor share of income) is set to 64% (as in Akerlof at al., 1991). We also assume that the population is stationary in the steady-state. For moderate values of the income tax parameters these values imply a capital-output ratio close to 2.5 which seems to represent sufficiently well the conditions in West Germany before unification. We set the intertemporal rate of substitution to 0.5, and assume that θ is equal to 0.3. This implies that low skilled workers use 30% of their non-sleeping time on market activities. All these values are similar to those used by Canova and Marrinan (1996) for West Germany in calibrating a three country model of the business cycle.

For the productivity differential ω Kydland (1984) and Rios-Rull (1993) suggest a value of 2, which seems a reasonable upper bound for the average productivity differences between East and West Germany at the time of unification (see Sinn and Sinn (1992)). We assume that the share of low skilled agents is 50% which is roughly the percentage of West German workers with a secondary education degree or less. Finally, we need to calibrate the elasticity of substitution between skilled and unskilled workers, $1/\rho$. We do not know too much about this parameter so we experiment with two cases: $\rho = 0$, so that the two types of labor, apart from the productivity difference, are perfect substitutes and $\rho = 2/3$, implying a more moderate substitutability of the two types of labor.

We have discussed elsewhere in details, the dynamics of this type of model, following a productivity disturbance (see Canova and Ravn (1996)). Here we only briefly summarize the results of this exercise to give a flavor of the properties of the model.

The aggregate dynamics are very similar to those obtained from a standard model of this type. Investment increases on impact by approximately 3% above its steady state value (following a 1% temporary increase in productivity) along with output, total hours and total consumption. also increase but with considerably smaller elasticities. Furthermore, since agents are risk averse, the consumption path is smoother than that of other variables. The capital stock also increases and peaks with a lag of 6-7 years. The aggregate marginal product of labor (in efficiency units) increases on impact by almost exactly the size of the disturbance while the real interest rate initially increases and then declines below the steady-state. All variables smoothly converge to their steady-state 8-10 years after the shock.

At disaggregated level it is the high-skilled workers which provide the additional hours necessary to take advantage of the improved technological conditions (since labor supply of low-skilled is fixed) and smooth over time the benefits of the disturbance by varying the level of investments. Low-skilled workers benefit from the improved technological conditions because their wages increase over the adjustment path. Since there are only $\gamma\%$ of high skilled agents in the population, the increase in their hours worked exceeds the increase in per-capita hours of the economy. On impact the income of high-skilled agents increases more than that of low-skilled agents because of they are more productive and own the capital stock. Also the consumption path of high-skilled agents is smoother than the one of low skilled agents as we have forced these agents consume their income on a period-by-period basis.

4 The Dynamic Effects of the Unification

Next, we describe the effects of a unification with the features we have described. We begin by considering the case where there is no government and, therefore, we set all taxes and redistributive parameters to zero. This step is useful in order to understand how unification would have affected the properties of the West German macrovariables in isolation from issues of arising from redistribution.

4.1 Demographics

We model unification as an exogenous temporary increase in the growth rate of unskilled workers, N_t^u. While it is straightforward to endogenize migrations as a function of business cycle conditions, we do not look at this possibility here since the fall of the wall and the successive reunification were unrelated to the state of the West German cycle.

The temporary increase in number of unskilled workers has two demographic effects. First, the aggregate population growth rate rises directly. This effect alone produces short run dynamics since the long-run capital-output ratio is determined by the parameters of technology and preferences and none of the other steady-state conditions are affected.

Second, there is a permanent effect on the composition of the population which alters long run conditions. These changes occur because the productivity differences across agents are exogenous. While this would have been an untenable assumption for long run analysis, it is defendable for business cycle considerations.

The demographic effects can be worked out in the following way. Assume that the population growth rate of high-skilled workers, g_t^s, is constant over time and equal to g and that the population growth rate of the low-skilled workers is :

$$g_t^u = (1 + e_t) g \tag{14}$$

where e_t is possibly an autocorrelated process. Define the following recursive variable:

$$\Pi_t \equiv \prod_{i=1}^{t} (1 + e_i) = (1 + e_t) \Pi_{t-1} \tag{15}$$

It then follows that:

$$g_{t+1}^p = \frac{(1 - \gamma_0) \Pi_{t+1} + \gamma_0}{(1 - \gamma_0) \Pi_t + \gamma_0} g \tag{16}$$

$$\gamma_{t+1} = \frac{\gamma_0}{(1 - \gamma_0) \Pi_{t+1} + \gamma_0} \tag{17}$$

where $\gamma_{t+1}/\gamma_t = g/g_{t+1}^p$. The growth rate of population g_{t+1}^p is stationary as long as e_t is a stationary process, while there is a permanent effect on the composition of the population regardless of the properties of e_t. This implies that migration flows create short term adjustments and long run effects when there are skill differences between migrants and the average native worker.

4.2 Long-run effects

Before describing short run dynamics it is useful to consider the long-run effects. Table 1 summarizes the long-run effects of a change in the share of skilled agents. As mentioned, an inflow of low-skilled workers permanently decreases the share of skilled workers in the population. This change does not affect the steady-state capital-output ratio (see appendix A), but it changes the steady-state per-capita output level because of the effect it has on the per-capita hours in efficiency units, $\omega(\gamma h^s)^{1-\rho} + ((1 - \gamma)\theta)^{1-\rho}$.

In appendix B we show that, as long as $\omega > 1$ when $\rho = 0$, per-capita hours in efficiency units is increasing in γ. Hence, steady-state capital and output per-capita decrease, high-skilled agents work fewer hours, invest less but have higher income and consumption because capital income is higher, while low-skilled workers are unaffected because wages are determined solely by the capital-output ratio which is unaffected. Thus, unification leads to a long-run decrease in aggregate per-capita activity and to a higher welfare for the capital owners. The latter result is familiar from static analyses of migration: the locals which gain are those that differ most from the newcomers, see e.g. Benhabib (1996). Our

results differ from standard ones because we allow capital accumulation. Here unskilled agents, who are identical to the migrants, are unaffected in the *long-run*, while they would experience lower welfare if the capital stock was kept fixed over the business cycle.

The magnitudes of the aggregate effects are relatively large. Assuming that the before-unification share of skilled agents was 50 percent, then if all former East German workers are to be classified as unskilled, the share of skilled workers would decrease to approximately 40 percent. If this change in the skill composition persists, then our model predicts a drop in output-per-capita of 6.67 percent (relative to the previous steady state). This drop in activity corresponds to the decrease in effective hours and is associated with an increase in skilled consumption of approximately 1 percent. If the change in the skill composition is smaller than this, for example, if unified Germany had 45 percent of skilled workers rather than 40 percent, these changes should be halved.

It has been estimated (see Sinn and Sinn (1992)) that it would take a over trillion DM of private investment to reconstruct the capital stock per-worker in the East at 1989 West German level. Assuming that 1989 level was the pre-migration steady state, this implies that over 100 billion DM a year for ten years are need for East Germany to catch up, with mean share of investment to GDP between 80 and 130% (in West Germany in 1990 the mean share was, depending on the calculation, between 13 and 26%).

The outcome of this though experiment in our model depends on the definition of labor. In terms of labor unadjusted for the productivity of the workers, the required change in the capital stock needed to keep the capital labor ratio unchanged is approximately 50 percent of the initial GDP before unification. Thus, if this was to be financed within East Germany and achieved within 10 years, it would necessitate to an investment share of approximately 57%, as compared with a steady-state share of roughly 26%. In terms of labor in efficiency units the numbers are smaller because the change in total effective hours is lower than the change in total unadjusted hours. In this case, the model implies that the investment share should increase to approximately 45%.

4.3   Dynamic effects

As discussed in section 2, the population and the workforce of the former East Germany was approximately 26 percent of the corresponding West German numbers at the time of the unification. Examining the effects of a one-time shock of this size may lead to unrealistic and extreme results given out assumption that migrants do not carry productive capital with them. One way to produce more reasonable estimates of the adjustment process is to assume that the migration happens gradually rather than at "unification-day" thereby allowing for gradual scrapping of the existing capital. Therefore we consider a migration shock that leads to a 20 percent change in the steady-state share of skilled workers (from 50 percent to 40 percent) and the migration is modelled such that 75 per-

cent of the capital is scrapped in the first year[4]. For the sake of illustration, we assume $\rho = 0$. The effects on aggregate *per-capita* variables are illustrated in panel A of figure 6 while panel B shows the effects on disaggregated variables.

The response of aggregate variables is similar, in some respect, to the adjustments brought about by a sudden disruption of the capital stock. Because the capital-labor ratio (measured in efficiency units) initially falls, the return on capital increases. This leads to an increase in the investment share (7 percent in the first year - of its steady-state value of 26 percent) and, in our case, also to an increase in investment per capita[5]. The decline in output per-capita is smaller than the initial drop in the capital-labor ratio (about 15%) because skilled agents work harder following the inflow of low-skilled agents to increase the (total) capital stock faster.

Note that the model predicts "undershooting" output dynamics: output per-capita drops by approximately 7 percent in the short run and keeps on decreasing for 3 years before picking up. This phenomena is consistent with the German data presented in figure 2. The associated change in aggregate consumption is larger (10 percent on impact), but the turn-around is faster (aggregate consumption picks up again after 2 years). Clearly, the large relative fall of consumption in the model is the consequence of the need to increase investments.

Because the associated changes in per-capita variables are smaller than the increase in population (15 percent in the first year), the model also predicts that total investment and total output increase. Quantitatively, the magnitude of the short run changes is comparable with the ones actually observed in Germany. For example, in the model total output grows by about 8% and investment by about 19% while there is a 14% percent increase in total output and a 25% increase in fixed investments in the data in first year after reunification. The model also predicts, in per-capita terms, a 7% drop in output and an increase in investments of about 1 percent while in Germany output per-capita declined by 10 percent and investments where roughly unchanged in the first year.

In the short-medium long, the wage per efficiency unit decreases in the model (because of the drop in the capital-labor ratio) and the interest rate increases. This differential behavior of the marginal product of the two factors of production produces a substantial redistribution of income across classes of agents along the adjustment path: in fact low-skilled workers' income and consumption decline. Thus, while unskilled agents are unaffected in the long-run, they are adversely affected in the short to medium run.

Akerlof et. al. (1991) have estimated that, if 4% of the East German labor force would migrate to the West, wages will be depressed on average by 3.15%. Since 4% of the

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[4]In other words, we assume that the migration happens gradually and that e_t is an AR(1) process with persistence parameter 0.75. The short run dynamic effects depend on this assumption but the medium-run and long-run effects are unaffected.

[5]The effect on the investment share is independent of the assumption that migration is gradual while the effect on investment per-capita does depend on this assumption. The reason is that with gradual migration, the investment response is stronger because today's migration signals future migration as well.

East German labor force correspond roughly to a 1% temporary flow of migrant we can calculate the maximum drop caused by this inflow on the unskilled wage of the receiving economy. We find that, in the model, the initial drop in unskilled wages is approximately 0.5% (recall that wages are unchanged in the long-run).

Overall, there are two highly intertwined qualitative effects following a unification with the features we have described. First, there is a redistributive effect over the business cycle with holders of capital benefitting and workers (both skilled and unskilled) being worse off as competition from newcomers decreases their wage rate. Second, there is a strong income effect in the long-run since high skilled workers, which are now a smaller fraction of the population, permanently own more capital per head. This makes their income and consumption permanently higher and their hours permanently lower since the relative abundance of low-skilled labor, results in substitution of high-skilled labor in production. Therefore, absent a welfare state, unification would have been unambiguously encouraged by those sectors of the economy which own capital and/or are highly productive.

5   Unification and the Welfare State

In this section we examine whether the macroeconomic effects we have described change when there is government actively pursuing redistributive policies. We consider two different policies:

• *an egalitarian rule* (ER), where the income tax rate on high-skilled workers is chosen so as to keep the ratio of income of skilled to unskilled agents constant; that is, the government chooses the income tax rate on skilled agents (τ_t^s) and the transfer rate (μ_t) to satisfy the government budget constraint and

$$(1 - \tau_t^s) y_t^s = \psi (1 - (\tau_t^s - \mu_t)) y_t^u \tag{18}$$

where ψ is the wedge in the after-tax income of the two types of agents.

• *an insurance rule* (IR), where the government insures the income (consumption) of low-skilled agents from any type of fluctuations, i.e., taxes and transfers are chosen to satisfy the government budget constraint and to make:

$$(1 - (\tau_t^s - \mu_t)) y_t^u = \bar{y}^u \tag{19}$$

where $\bar{y}^u$ is a constant.

The first rule is very common both in theoretical studies examining the static effects of migration (see Razin and Sadka (1995)). Egalitarian rules also turn our to be sufficiently popular as redistributive tools in standard models of public finance (see e.g. Auerbach and Kotlikoff (1987)) to grant them a particular status in our study.

The second rule is of particular interest for two reasons. First, Schrettl (1992) suggests that the distinguishing feature of the East German transition process compared to that

of other formerly centrally planned economies was that West Germany provided exactly this type of insurance[6]. Secondly, the introduction of such a scheme effectively provide credit constrained agents with publicly funded insurance (see e.g. Padoa-Schioppa (1987) for the rationale for such a scheme in the context of a European fiscal union).

We assume that before unification the income tax rate on skilled agents is 5%, a value we believe is reasonable once it is taken into account that the tax rate in our model relates only to the parts of the government budget associated with redistribution.

5.1 Egalitarian Tax Rule

The first type of tax rule we consider is such that the entire (after-tax) income distribution may move over the cycle as long as its relative structure is unchanged. Here we treat ψ as a parameter and the benchmark value corresponds to the value implied by a 5% income tax rate on skilled agents. Given other parameters of the model, this implies that the unskilled after-tax income is 38% of the after tax income of the skilled.

Table 2 summarizes the long-run effects of migration in this setup. In contrast to the model without a welfare state, the capital-output ratio and the capital-labor ratio change because the tax rate must increase in the long run. This leads to a bigger drop in long-run aggregate activity in per-capita terms[7]. For example, a 10 percent change in the skill composition now leads to a decrease in output per-capita of 4.2% as compared to 3.3% in the baseline model. Notice that skilled consumption now drops in the long-run (it increased in the baseline model) and that low-skilled agents now gain from migration: the capital owners' income increase so that taxes and redistribution increase.

The impulse responses following a migration disturbance with the same features we have considered before are in figure 7. The most important change relative to the baseline case occurs because the marginal tax rate on skilled agents increase as the before-tax high-skilled income increases. This increase in marginal taxes discourages investments producing smaller initial effects on investment, hours in efficiency units and productio and also leads to a slower adjustment process in the transition to the new steady-state. At the disaggregated level, the tendencies we have previously outlined are exasperated. Because there are permanent changes in the income distribution in favor of capital holders, these agents now bear the majority of the adjustment costs associated with the unification.

Overall, the results suggest that this redistribution scheme has important side effects when unification takes place under the conditions we have described. With an inflow of low-skilled workers, the "size" of the welfare system increases and skilled agents, which are

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[6]Schrettl (1992) also suggests that the "insurance" was provided by the German state as income transfers to the former East Germany in exchange for the property rights to the capital stock of the former East German government.

[7]Notice also that the effects on hours in efficiency units are identical to those in table 1. This is due to the proportional tax rate combined with the assumptions of homothetic preferences and the fixed relative wage between the two types of labor.

a smaller fraction of the population, must contribute a larger percentage of government outlays. Because they are taxed more heavily they lower investments generating a reduction of per-capita income that exceeds that observed in the case without redistribution.

Which sectors of the society benefit from the presence from an egalitarian rule when unification takes place under wage and exchange rate parity? Skilled agents are definitely worse off since their consumption declines in the long run while unskilled agents benefit since their consumption increases.

5.2 Insurance Tax Rule

Table 3 summarizes the long-run effects of unification of this tax scheme. As under the previous tax rule, unification increases the marginal tax rate and leads to changes in the capital-output and capital-labor ratios and this reinforces the negative long-run effects on aggregate activity. Quantitatively, the effects are slightly smaller than in the previous case: a 10 percent changes in the composition of the population now leads to a 4.1 percent drop in output per capita as compared to 4.2 percent in the previous case and this is due to the fact that unskilled consumption now is unchanged whereas it actually increased in the previous case. Thus, the associated tax changes are smaller under this rule.

The impulse responses of the variables following a migration disturbance under this rule are presented in figure 8. In general, the responses of macro variables to the disturbance are very similar to those presented in figure 7. The short run tax effects are slightly larger than under the egalitarian rule because wages fall in the short run (thus taxes need to be increased more than in the previous case because skilled income is also adversely affected by the drop in wages). This produces a slightly larger short run decrease in investments and a smaller increase in skilled hours. The quantitative differences between this scenario and the egalitarian case are however small.

To summarize, the unification of two countries under the conditions described here leads to a substantial increase of the size of the welfare state. Since skilled workers/capitalists bear the burden of this increase, the long run repercussions may be dramatic both in terms of permanently lower per-capita income level and the time needed to reach the new steady state. Also, the short run recessionary effects will be exasperated leading to a prolonged and deep downturn in the economy.

6 Lessons for the German Experience

Our exercise has provided us with some indications on how to interpret the recent developments in the German economy after the fall of the Berlin Wall.

Given wage and exchange rate parities, we modelled the unification of the two sides of Germany as a mass-migration of low skilled agents, holding no capital from one country to another. Absent any government redistribution scheme, this combination of circumstances

has effect very similar to that of a sudden disruption of the per-capita capital stock of the receiving economy. In the short run entrepreneurs will invest more to rebuild the capital stock (given the high real interest rate). In the long run, both capital and output per-capita will be lower even though the capital-output ratio and therefore investment share are constant. In our model there is no unemployment, but it is clear from the way we have set it up that if some of the migrants are unemployed, for example, because unskilled wage is above market clearing, our qualitative conclusions will still hold. Quantitatively, the short run effects on investment, capital stock and real interest rates will be smaller, because the relative abundance of capital and labor changes, while in the long run the decline in capital and output per-capita could be amplified. Our model predicts that a unification without redistribution will have generated an investment boom, led to a temporary increase in the growth rate of output, to a permanent redistribution of income to the entrepreneur sector and to a long run decline in per-capita income because the capital-labor ratio falls. Hence, in this ideal situation, capital owners (the westeners) would have largely benefitted from the unification and the drop in the world ranking of per-capita income experienced by Germany after unification should have expected following the decline in the capital-labor ratio.

Clearly the permanent redistribution in favor of the entrepreneur section would have not been substantiable and may have led to political unrest. The choice of the government to engage in generous redistribution schemes in an attempt to shield low-skilled agents from income fluctuations or to kept them in a close income range of the high skilled should not come to a surprise. What are the consequences of these actions? We have seen that the redistributive burden on the high-skilled/capital owners may have substantially exasperated the negative effects of the shock leading to permanently lower per-capita income in the long-run. Moreover, the increased tax burden discouraged private investments and produced a net decrease in the contribution of these agents to the welfare state, just at a time when welfare outlays were about to increase. Hence, as the tax burden began to bite, investment and output per-capita declined relative to the no redistribution case, even in short run.

Two qualifications are important to strengthen these statements. We have assumed that the government finance transfers on a period-by-period basis, while in the actual German economy, transfers are partially financed by borrowing. If the economy is Ricardian or the horizon of repayment of the government debt is short (because of the tight corset of Maastricht rules), our setup mimics well the expected qualitative effects that would occur even when borrowing is present [8]. Second, we have neglected the possibility that low-skilled migrants may be endowed with some wealth at the time when they reach the receiving country. This feature can be easily added to the model without changing

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[8]If some borrowing is allowed, it is likely that the government will try to smooth tax rates over the transition period, implying a lower burden on the skilled workers on the path to the new steady state. In a Ricardian economy like ours however steady states are unchanged by borrowing decisions of the government.

the qualitative results of the analysis. Because without redistribution, the income of low skilled declines, it is conceivable that migrants will run down their assets to increase current consumption along the adjustment path. Therefore, the addition of a wealth (saving) endowment to the model will have effect neither on capital accumulation nor on the long run output level. If migrant wealth (savings) is canalized toward investment, rather than consumption, both low-skilled and high-skilled consumption will decline less and there may be small or no effect on long run output. In other words, if East Germans could be convinced to be more patient in their consumption needs, the whole economy could be better off, both along the adjustment path and in the long run. However, given that consumption desires have been limited for so many years, this possibility will hardly be an option for the future.

In conclusion, the decline in the standards of living of Germany, observed after unification, could have been entirely predicted by the model and attributed to a combination of constrains on investment opportunities and heavy redistribution which tilted the economy into a "vicious" path.

Are the remedies to this situation? In the next section we offer some suggestions in this regard either based on the results so far obtained or following policies advocated in policy circles and in the popular press.

7 Policy Corrections

Our model indicates that the economy could be better off in the long run without redistribution, i.e., tightening up the belt now, may have beneficial consequences in the long run. While this may be an option, it may not be feasible given the current state of affairs. The model also suggests that if the pool of saving existing in the East could be incentivated and directed to investment purposes, the temporary reduction of the standard of living in the East may be compensated by a improved conditions in the long run. However, channelling savings toward investment may take time and may not give a sufficiently strong jumpstart to the economy in the short medium run.

As alternatives, we examine two policies suggested by the popular press and policy commentators. First, we consider a reduction of the welfare benefits for migrants, in the sense that the government let their income be unrelated to (and possibly lower than) the income of unskilled locals. We believe such policy could mimic current unions actions toward achieving more flexibility in the labor market in the Eastern länders. It also appears to be duable in the current conditions since wage differential is apparently not one of the major determinants of East German decision to move to the West, and since East Germans are apparently willing to accept it as long as jobs are available (see Akerlof, et. al. (1991)). In the context of our model we consider a limiting case where the government redistribute only to locals and attempts to keep only the income of locals in

a fixed proportion. In this case the budget constraint is

$$\tau_t^s \gamma_0 y_t^s = (\tau_t^s - \mu_t)(1 - \gamma_0) y_t^u \tag{20}$$

where γ_0 is the proportion of skilled agents before the migration and we still assume that (18) holds for local residents. The goods market clearing condition for this case is $y_t = \gamma_t c_t^s + \gamma_t^u c_t^u + \gamma_t^e c_t^e + x_t$ where γ_t^u is share of unskilled native, γ_t^e is the share of unskilled migrants and c_t^e their consumption (which equals their wage income).

Figure 9 illustrates the effects of unification for this tax scheme. The dynamics are intermediate between those of the baseline model and the pure egalitarian model. Because redistribution is now only among the native, the tax effects are smaller than those in the pure egalitarian case. Thus, there are smaller disincentives on investment and skilled labor supply: investment per-capita now is roughly unchanged on impact and the skilled labor supply rises by almost as much as in the previous model. The long-run declines in output and investment are therefore smaller than in the egalitarian model but larger than in the baseline model. The main distributional effect of this scheme, relative to the egalitarian tax scheme, is that there is a reallocation from the newcomers to the "native" unskilled agents. Hence, the "native" unskilled gain because of the larger pool of tax revenues produced by the increase in skilled agents' income.

Second, we will consider the possibility of taxing the capital and wage portion of the income of skilled agents differently. We have seen that the German government has made huge infrastructural investments in the East, while this possibility was not allowed for in the model. Nevertheless, we can predict the effect of such an action in the model if we interpret government investment effort as a differential tax rate on capital vs. labor income, with the first one being fixed in the adjustment process. In this case we assume that the budget constraint for the government is:

$$\tau_t^{sc} \gamma_t (r_t k_t / \gamma_{t-1}) + \tau_t^{sl} \gamma_t (w_t n_t) + = \tau_t^u (1 - \gamma_t) y_t^u \tag{21}$$

where τ^{sc} are capital income taxes and τ^{sl} are labor income taxes and the egalitarian rule implemented by the goverment is

$$(1 - \tau_t^{sc}) \gamma_t (r_t k_t / \gamma_{t-1}) + (1 - \tau_t^{sl}) \gamma_t (w_t n_t) + = \psi (1 - \tau_t^u) y_t^u \tag{22}$$

Table 10 presents the dynamic effects of unification under this scheme. At aggregate level the path of macrovariables is very similar to the one produced in the case of no redistribution. In particular, investments increase at impact and decline less in the long run relative to the basic redistributive cases and the wage rate converges to the old steady state. In general, the long run decline in capital stock and investment is smaller with this rule than with any other schemes. At disaggregated level, skill consumption still declines in the long run, there is less redistribution in favor of unskilled (the gap between their income and their consumption is smaller) relative to the egalitarian scheme but unskilled consumption increases in the long run.

Overall this scheme reduces the distortions on investments caused by egalitarian redistribution and transfer the benefits of the higher capital income to the unskilled. Hence, unskilled agents (both local and newcomers) will be better off relative to both the baseline and the egalitarian case, while skilled agents are not necessarily worse off relative to the egalitarian setup.

8 Summary and Conclusions

In this paper we have analyzed the macroeconomic consequences of German unification under wage and exchange rate parity when there is a welfare state interested in either maintaining an egalitarian distribution of income or from shielding newcomers from the adjustment process. We emphasize that unification under these conditions resembles a mass migration of low-skilled agents holding no capital from one country to another.

We find that such an event induces adjustments which, to some extent reproduce those that would take place if the capital stock were suddenly disrupted. An inflow of low-skilled workers leads to higher investments over the adjustment path, and, because agents are heterogeneous in their productivity characteristics, it also has a composition effect which leads both to long run changes (a decrease in the per-capita level of capital, output and investment) and to differential impact on skilled and unskilled agents.

These effects are altered by the presence of redistribution schemes. When the government attempts to keep the ratio of skilled to unskilled agents after tax income constant, there is a stronger negative effect on the capital stock in the long run since the unification forces skilled agents to finance a larger welfare state. In addition, we observe a prolonged period of adjustment with a long cycle of large amplitude and to an overall decline in welfare for both types of agents.

We interpret these results in light of the German experience and conclude that the attempt of the government to shield East Germans from the adjustment costs imposed by the wage and exchange rate policy has, in fact, exasperated the problem and may produce worse long run conditions. We have also discussed two policies attempting to reverse the negative effects of redistribution and saw that both offer relief to the current situation.

The arguments we have presented hold for a closed economy, the present analysis could be relatively easily extended to an open economy framework. Such an extension would be important because the unification was associated with a considerable deterioration of the German trade balance. However, we doubt that out conclusions concerning output and investment dynamics would change but it is possible that the dynamics of consumption may be altered because "native" agents would be able to ensure their consumption using international financial markets.

Finally, it is worth mentioning that the situation we have described may turn out to be less gloomy than expected since, as we mentioned, the educational level of East German workers is on average higher than that of West Germans. It is therefore possible

that a large fraction of migrants may in fact become skilled very quickly, as they adapt to western style of management, increasing the productivity of labor and contrasting the negative long run effects we have described. The fact that in the 1992-94 period output growth in the East has been driven almost entirely by total factor productivity increase may be the first symptom of this switch in the composition of the German labor force.

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Appendix A

The steady-state capital-output ratio is determined exclusively by preferences and technology and given by:

$$\frac{k}{y} = \frac{(1 - \tau^s)(1 - \alpha)}{g^p/\beta - (1 - \delta)} \qquad (A.1)$$

The steady-state investment share is :

$$s(x) = \frac{k}{y}\left(g^p - (1 - \delta)\right) \qquad (A.2)$$

where $s(j)$ denotes the output share of component j.

Steady state unskilled hours is equal to θ^u. We assume that $\theta^u = \theta^s = \theta$. Hours worked for the skilled and the consumption share for the two groups of agents are determined by the following relationships:

$$(1 - \theta)\, s\,(c^s)\left(\omega\left(\gamma h^s\right)^{1-\rho} + \left((1 - \gamma)\,\theta\right)^{1-\rho}\right) = \alpha\theta\omega\left(1 - \tau^s\right)\left(1 - h^s\right)\left(\gamma h^s\right)^{-\rho} \qquad (A.3)$$

$$s(c^s) = \frac{1}{\gamma}(1 - (1 - \gamma)s(c^u) - s(x)) \qquad (A.4)$$

$$s(c^u) = \frac{\tau^s}{1 - \gamma} + (1 - \tau^s)\,\alpha\theta\frac{\left((1 - \gamma)\,\theta\right)^{-\rho}}{\left(\omega\left(\gamma h^s\right)^{1-\rho} + \left((1 - \gamma)\,\theta\right)^{1-\rho}\right)} \qquad (A.5)$$

When $\rho = 0$ the first of these conditions reduces to:

$$h^s = \frac{\alpha\theta\left(1 - \tau^s\right)\omega - (1 - \theta)\theta(1 - \gamma)s(c^s)}{\alpha\theta(1 - \tau^s)\omega + (1 - \theta)s(c^s)\omega\gamma} \qquad (A.6)$$

It also follows from the government budget constraint that, for a given τ^s, μ must be:

$$\mu = \tau^s + \frac{\tau^s}{(1 - \gamma)}\frac{\left(\omega\left(\gamma h^s\right)^{1-\rho} + \left((1 - \gamma)\,\theta\right)^{1-\rho}\right)\left((1 - \gamma)\,\theta\right)^\rho - \alpha\theta\left(1 - \gamma\right)}{\alpha\theta} \qquad (A.7)$$

Finally, the level of steady-state output is given by:

$$y = \bar{z}^{1/\alpha}\left(\frac{k}{y}\right)^{(1-\alpha)/\alpha}\left(\omega(\gamma h^s)^{1-\rho} + ((1 - \gamma)\theta)^{1-\rho}\right)^{1/(1-\rho)} \qquad (A.8)$$

Appendix B

In this appendix we show that when τ^s is zero, steady-state output will be increasing in the share of skilled workers. From appendix A steady-state output is given by:

$$y = \bar{z}\left(\frac{k}{y}\right)^{(1-\alpha)/\alpha}(\omega\gamma h^s + (1-\gamma)\theta) \qquad (B.1)$$

so that the steady-state output level, for given preferences and technology, is determined by the effective labor input per capita since the capital-output ratio exclusively depends on preferences and technology. When taxes are zero, steady-state high-skilled hours and consumption shares of the two groups of agents are given by:

$$h^s = \frac{\alpha\theta\omega - (1-\theta)\theta(1-\gamma)s(c^s)}{\alpha\omega\theta + (1-\theta)s(c^s)\omega\gamma} \qquad (B.2)$$

$$s(c^s) = \frac{1}{\gamma}\left(1 - (1-\gamma)s(c^u) - s(x)\right) \qquad (B.3)$$

$$s(c^u) = \frac{\alpha\theta}{\gamma\omega h^s + \theta(1-\gamma)} \qquad (B.4)$$

Combining (B.2)-(B.4) and defining $h^e \equiv \gamma\omega h^s + (1-\gamma)\theta$ gives:

$$\frac{1}{\omega\gamma}\left(h^e - \theta(1-\gamma)\right) = \frac{(\alpha\theta\omega\gamma - (1-\theta)\theta(1-\gamma)(1-s(x)))h^e + (1-\theta)\theta^2(1-\gamma)^2\alpha}{(\alpha\theta\omega\gamma + (1-\theta)\omega\gamma(1-s(x)))h^e - (1-\theta)\theta\omega\gamma(1-\gamma)\alpha}$$

This is a second order equation in effective labor input. It has one zero root and one positive root given by:

$$h^e = \frac{\alpha\theta((1-\gamma) + \omega\gamma)}{\alpha\theta + (1-\theta)\omega\gamma(1-s(x))} \qquad (B.5)$$

It follows immediately from (B.5) that:

$$\frac{\partial h^e}{\partial\gamma} = \frac{\alpha\theta}{\alpha\theta + (1-\theta)(1-s(x))}[\omega - 1] \qquad (B.6)$$

which is positive as long as $\omega > 1$. Hence, steady-state output is also increasing in γ as long as $\omega > 1$. It also follows that skilled hours also depends positively on γ.

Table 1. Steady-state effects: No taxes

	Base-line	Percentage changes relative to $\gamma = 0.50$									
γ	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40
y	0.69	-0.67	-1.33	-2.0	-2.67	-3.33	-4.0	-4.67	-5.33	-6.0	-6.67
h^e	0.40	-0.67	-1.33	-2.0	-2.67	-3.33	-4.0	-4.67	-5.33	-6.0	-6.67
k	1.77	-0.67	-1.33	-2.0	-2.67	-3.33	-4.0	-4.67	-5.33	-6.0	-6.67
$\frac{k}{y}$	2.57	0	0	0	0	0	0	0	0	0	0
$\frac{k}{h^e}$	4.37	0	0	0	0	0	0	0	0	0	0
c^s	0.70	0.08	0.17	0.26	0.35	0.45	0.55	0.66	0.78	0.89	1.02
h^s	0.25	-0.24	-0.50	-0.76	-1.04	-1.32	-1.63	-1.94	-2.27	-2.62	-2.98
c^u	0.33	0	0	0	0	0	0	0	0	0	0

Table 2. Steady-state effects: Egalitarian Taxes

	Base-line	Percentage changes relative to $\gamma = 0.50$									
γ	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40
y	0.67	-0.82	-1.65	-2.49	-3.33	-4.17	-5.03	-5.89	-6.76	-7.64	-8.53
h^e	0.40	-0.67	-1.33	-2.00	-2.67	-3.33	-4.00	-4.67	-5.33	-6.00	-6.67
k	1.63	-1.10	-2.21	-3.34	-4.49	-5.65	-6.83	-8.03	-9.26	-10.5	-11.8
$\frac{k}{y}$	2.44	-0.28	-0.57	-0.88	-1.20	-1.54	-1.90	-2.28	-2.67	-3.09	-3.53
$\frac{k}{h^e}$	4.04	-0.44	-0.89	-1.37	-1.87	-2.40	-2.95	-3.53	-4.14	-4.78	-5.46
c^s	0.64	-0.35	-0.72	-1.11	-1.52	-1.96	-2.41	-2.89	-3.40	-3.93	-450
h^s	0.25	-0.24	-0.50	-0.76	-1.04	-1.32	-1.63	-1.94	-2.27	-2.62	-2.98
c^u	0.37	0.08	0.15	0.21	0.28	0.33	0.38	0.42	0.45	0.48	0.49
τ^*	5.00	5.26	5.54	5.84	6.14	6.46	6.80	7.16	7.54	7.93	8.35
μ^*	21.1	21.6	22.2	22.7	23.3	23.9	24.6	25.2	25.9	26.6	27.4

*The numbers for tax rates are percentages and not percentage changes.

Table 3. Steady-state effects: Risk Insurance Taxes

	Base-line	Percentage changes relative to $\gamma = 0.50$									
γ	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40
y	0.67	-0.80	-1.61	-2.42	-3.24	-4.06	-4.90	-5.74	-6.59	-7.45	-8.32
h^e	0.40	-0.67	-1.33	-2.00	-2.67	-3.33	-4.00	-4.67	-5.33	-6.00	-6.67
k	1.63	-1.04	-2.09	-3.16	-4.24	-5.25	-6.47	-7.61	-8.78	-9.97	-11.2
$\frac{k}{y}$	2.44	-0.24	-0.49	-0.76	-1.04	-1.34	-1.65	-1.99	-2.34	-.273	-3.13
$\frac{k}{h^e}$	4.04	-0.37	-0.77	-1.18	-1.62	-2.08	-2.57	-3.09	-3.64	-4.23	-4.85
c^s	0.64	-0.29	-0.60	-0.93	-1.27	-1.64	-2.03	-2.45	-2.89	-3.37	-3.88
h^s	0.25	-0.24	-0.50	-0.76	-1.04	-1.32	-1.63	-1.94	-2.27	-2.62	-2.98
c^u	0.37	0	0	0	0	0	0	0	0	0	0
τ^*	5.00	5.23	5.47	5.72	5.99	6.27	6.57	6.89	7.59	7.59	7.98
μ^*	21.1	21.5	21.9	22.3	22.7	23.2	23.7	24.3	24.9	25.5	26.1

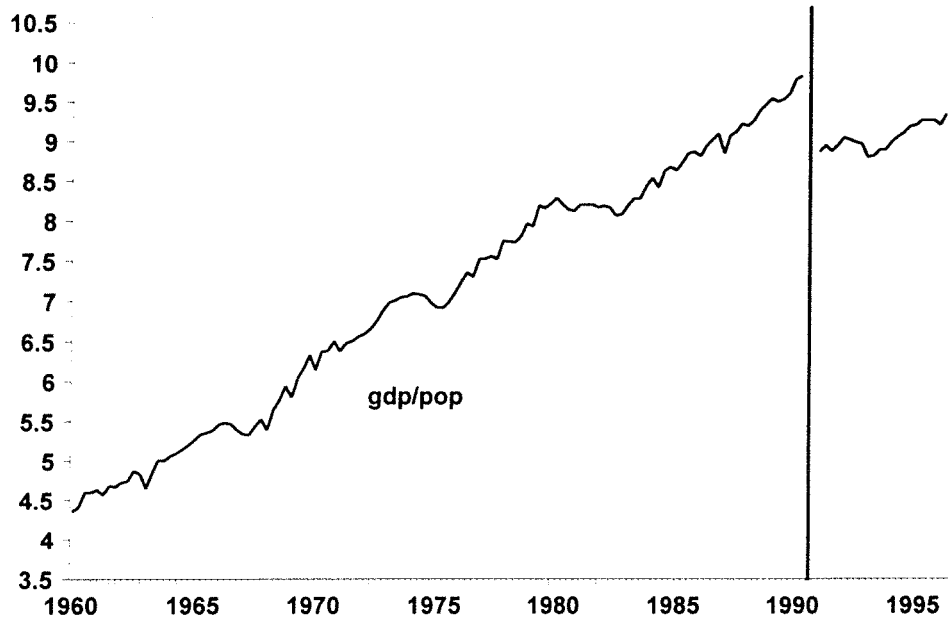*The numbers for tax rates are percentages and not percentage changes.
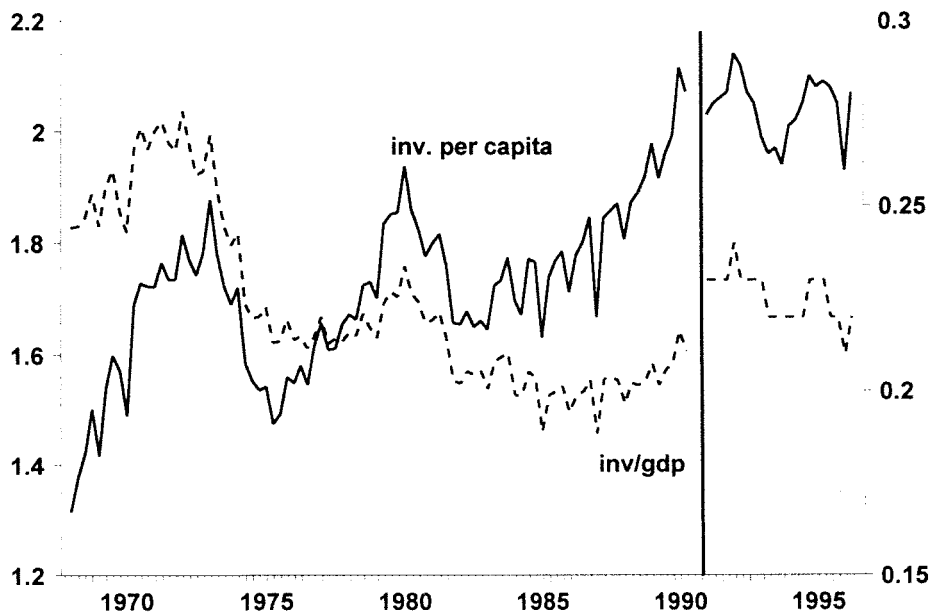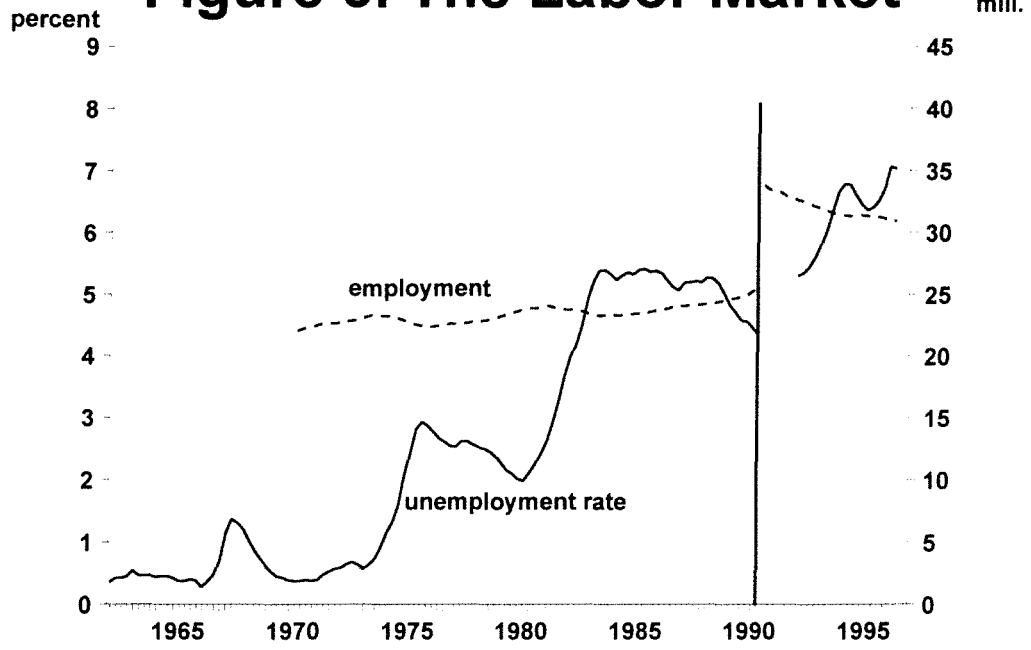
Figure 1. Population in Germany
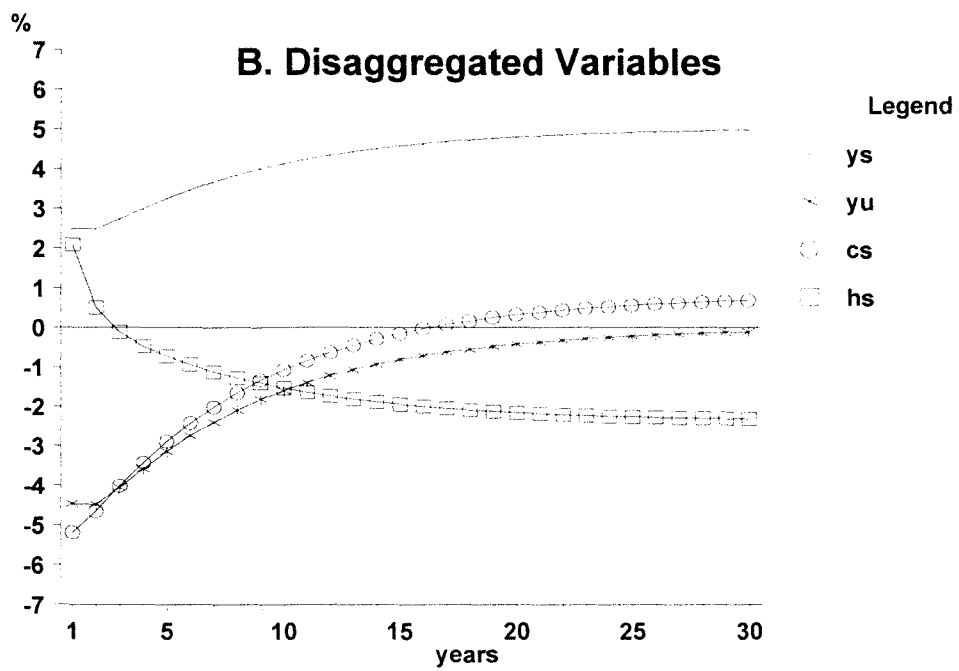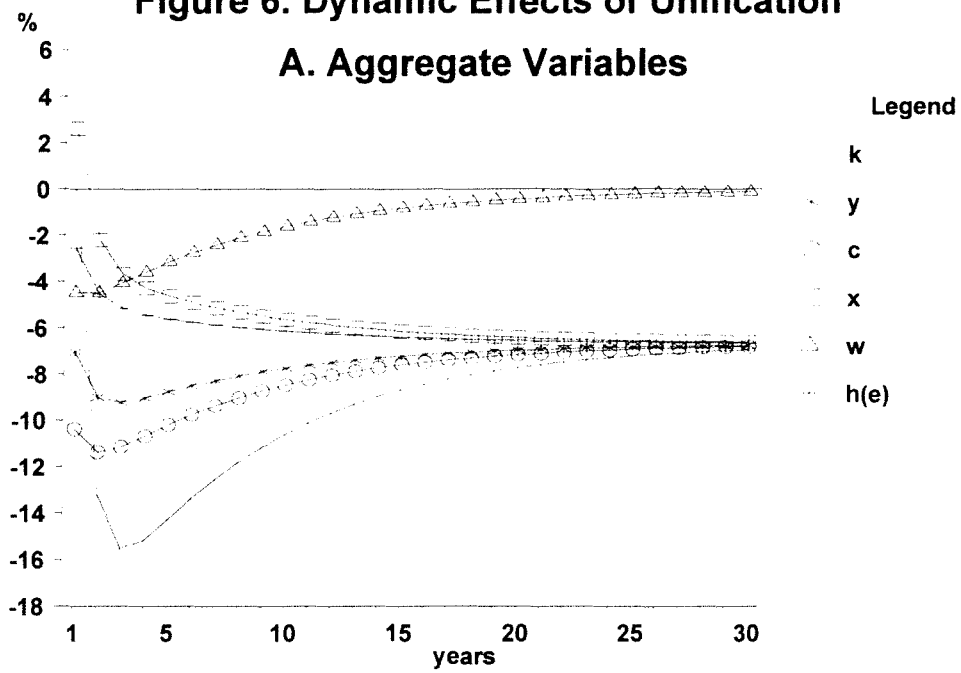
Millions
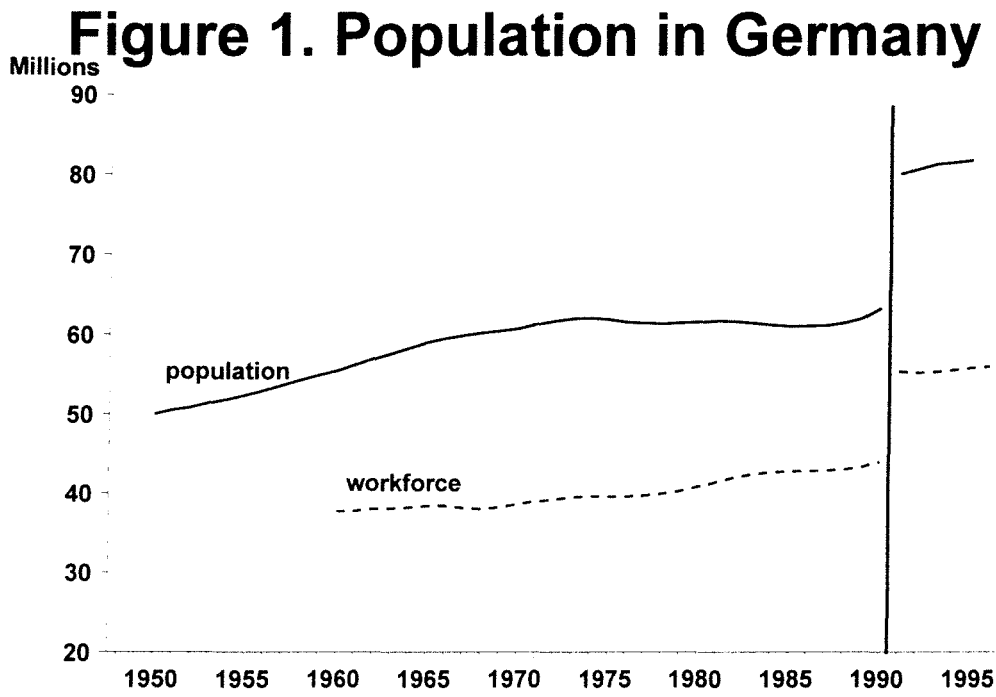
Figure 2. Real GDP
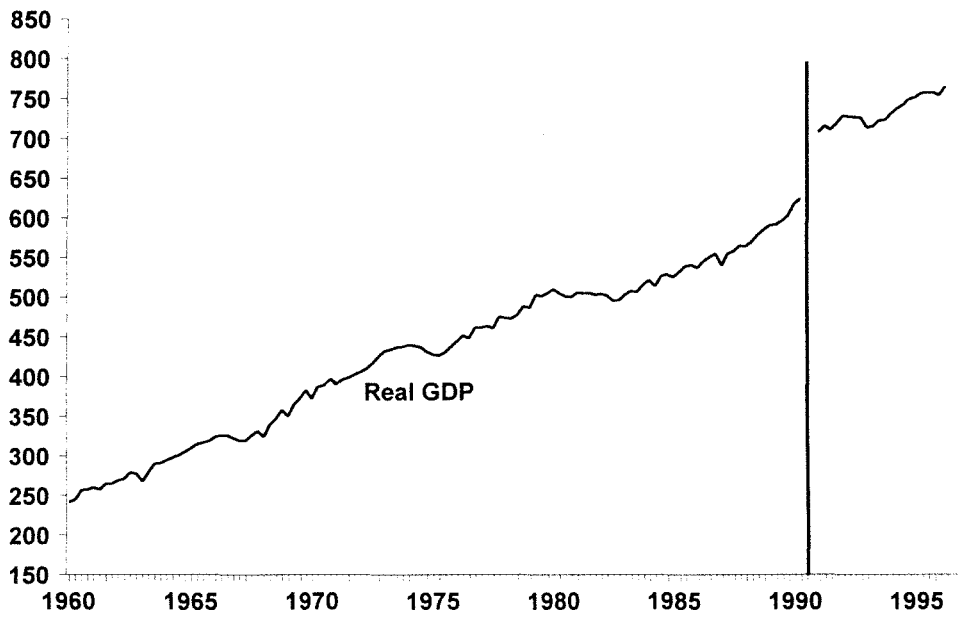
Figure 3. GDP per capita

Figure 4. Fixed Investment

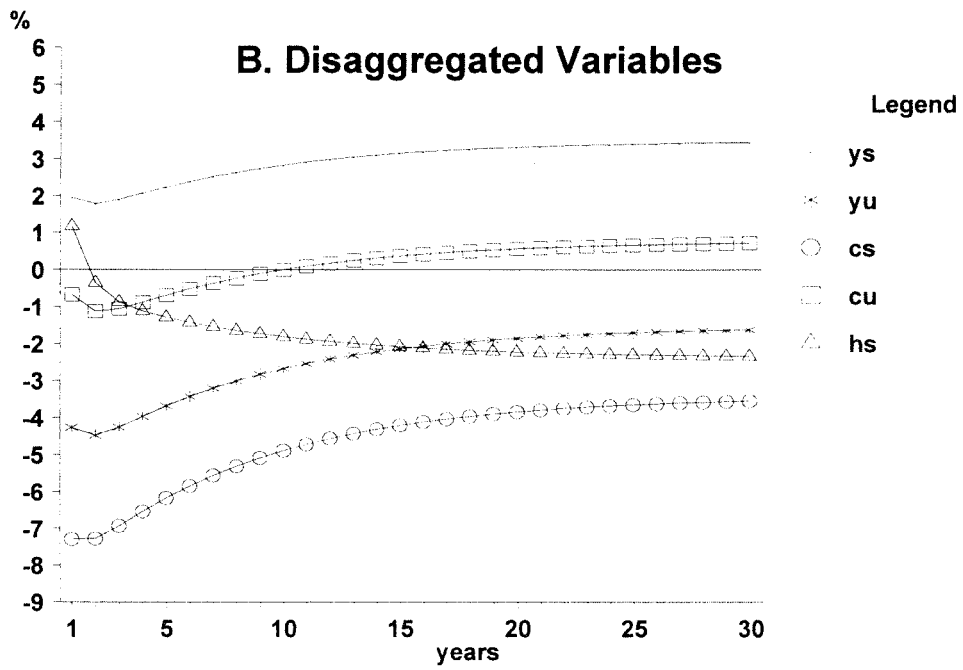# Figure 5. The Labor Market

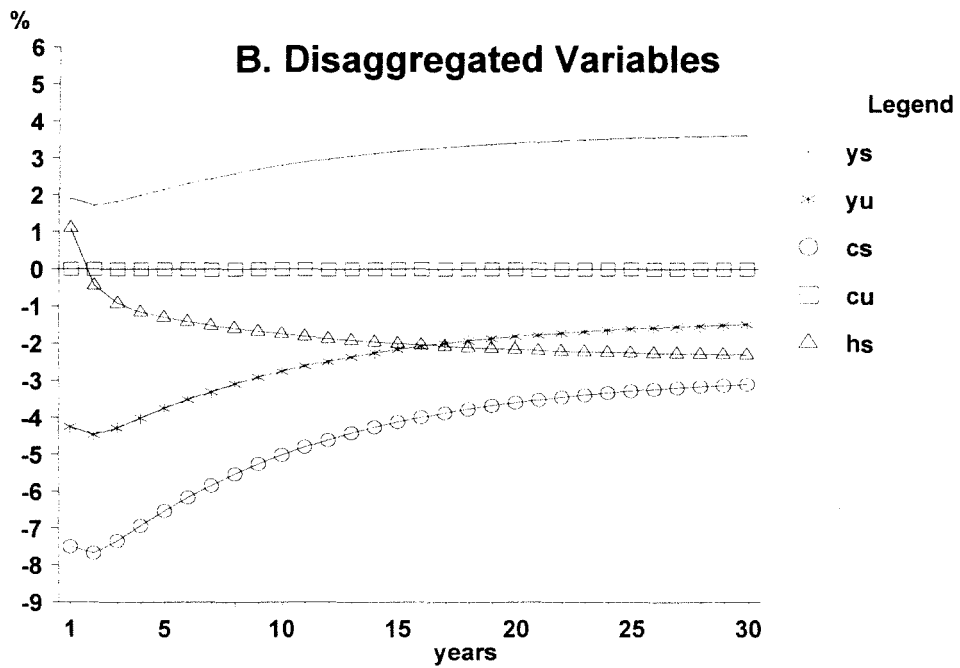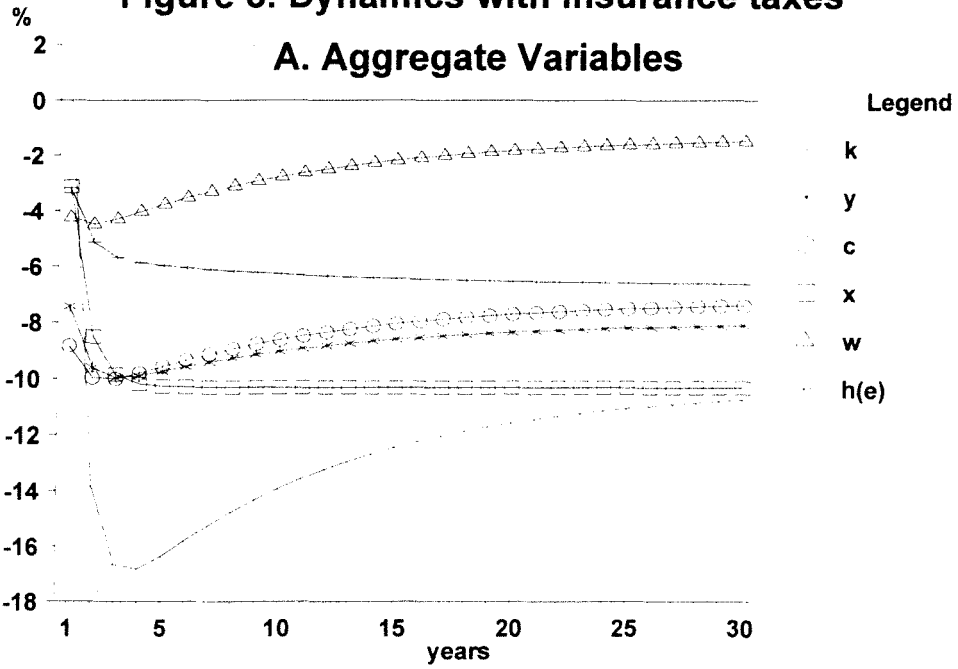percent   mill.

employment

unemployment rate

Figure 6. Dynamic Effects of Unification

A. Aggregate Variables

Legend

k

y

c

x

w

h(e)

B. Disaggregated Variables

Legend

ys

yu

cs

hs

Figure 7. Dynamics with egalitarian taxes

A. Aggregate Variables

Legend

k
y
c
x
w
h(e)

B. Disaggregated Variables

Legend

ys
yu
cs
cu
hs
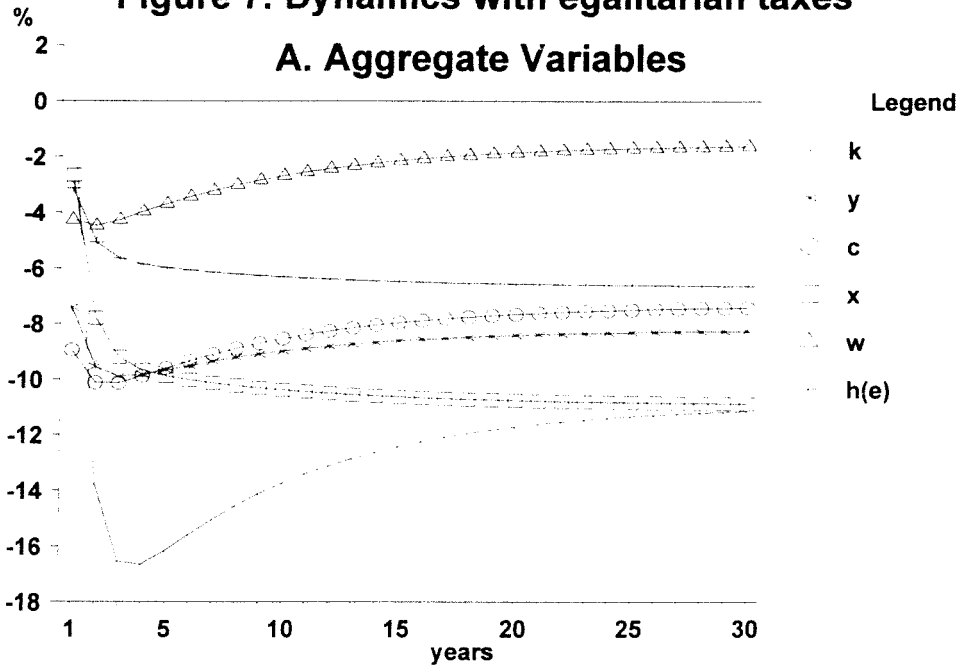
Figure 8. Dynamics with insurance taxes

A. Aggregate Variables

Legend

k
y
c
x
w
h(e)

B. Disaggregated Variables

Legend

ys
yu
cs
cu
hs

Figure 9. Dualitarian Taxes
A. Aggregate Variables

Legend
k
y
c
x
w
h(e)
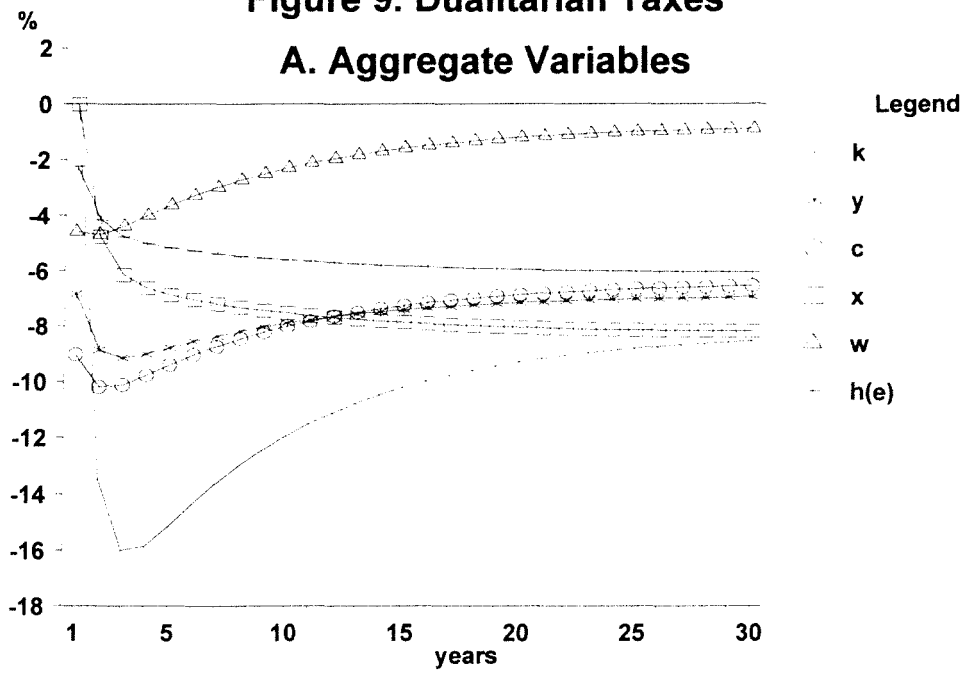
B. Disaggregated Variables

Legend
ys
yu
cs
cu
hs
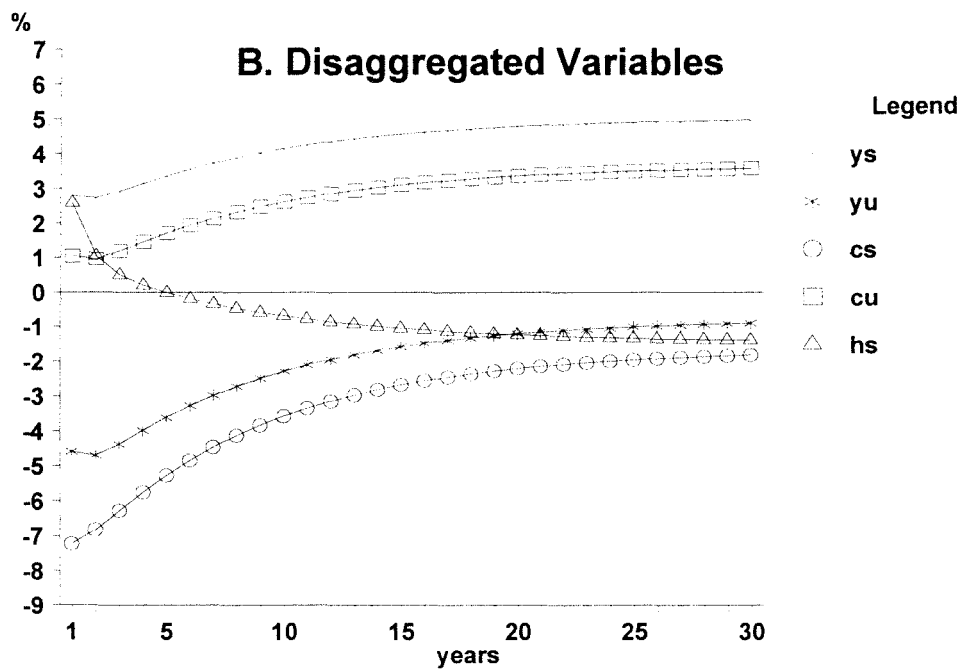
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