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CROSSING THE RIO GRANDE: MIGRATIONS AND THE WELFARE STATE

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ABSTRACT

Crossing the Rio Grande: Migrations and the Welfare State*

This paper studies the macroeconomic effects of an inflow of low-skilled workers into an economy where there is capital accumulation, endogenous labour supply and heterogeneous workers. We find substantial dynamic effects, with adjustments that resemble those triggered by a sudden disruption of the capital stock and significant long-run changes. We examine the interactions between migration and three different redistribution systems and find that these schemes change the dynamics and lead to prolonged periods of adjustments. The aggregate welfare implications of migration are sensitive to the redistribution system. Without redistribution there are gains and when the state engages in redistribution gains disappear and different types of agents bear the costs.

JEL Classification: E32, E62, F20, H23
Keywords: migration, welfare state, business cycles, heterogeneous agents

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NON-TECHNICAL SUMMARY

Migrations from less developed areas into the OECD have been substantial in the past and continue to be non-trivial. For example, within the 16 member countries of the EU, (legal) net-immigration has accounted on average for 0.5% of the native population in each of the last ten years (see OECD, 1995). It is also predicted that these flows might get larger in the future, for example due to the establishment of the Schengen group in Europe. Moreover, it is well documented that migrants are, on average, less skilled, heavier users and more permanent receivers of welfare benefits relative to natives. Furthermore, these tendencies have become stronger over time, at least in the United States, with recent cohorts of migrants being less skilled and more frequent users of welfare provisions than older ones (see e.g. Borjas (1985)).

At the same time there has been political pressure to regulate the flow and qualifications of the migrants (e.g. Australia and Canada), to restrict the type of labour activities migrants can undertake and the benefits they enjoy. The latest example of this type is the US Illegal Immigration Reform and Immigration Responsibility Act, passed in 1996, which excludes even legal migrants from certain welfare benefits (Supplementary Security Income, food stamps and, in some cases, Medicaid) enjoyed by natives and naturalized citizens, disregarding the fact that these migrants might have paid social security taxes in the past. It has been estimated that such a change could affect 450,000–700,000 legal migrants in the United States, a little less than 0.5% of the population, with budget savings of about 1.5 billion dollars.

We investigate whether and to what extent migration flows induce substantial macroeconomic consequences in the receiving economies. In particular, we ask three questions: (a) What are the macroeconomic effects of an inflow of low-skilled migrants? (b) How do migrations affect the welfare of natives? Are different types of agents equally affected? (c) Does the kind of income redistribution system in place in the host country matters for welfare? We study these questions within a model with capital accumulation and endogenous labour supply. Besides these two aspects, our model has two other important ingredients. First, we consider migrations of low-skilled agents into an economy initially composed of low-skilled and high-skilled agents.

The existence of skill differentials is important for two reasons. First, when entering the labour market in the host countries, low-skilled migrants may contribute to widen the wage gap between high-skilled and low-skilled workers. Second, skill differentials will have important consequences for government transfer policies.

A second key ingredient of the model is the presence of a welfare state redistributing income between different types of agents. Most industrialized countries have developed extensive redistribution schemes over the last three decades and social insurance programmes have become one of the major sources of government budget outlays. We consider three different specifications. In the first the government taxes high-skilled agents at a fixed rate and redistributes the proceeds to low-skilled agents. This 'passive redistribution' scheme resembles the system in place in many countries before the welfare state was increasingly developed through the 1970s. In the second specification the government keeps the *distribution* of net-income constant over time, an egalitarian system that resembles the welfare state in place in, for example, the Scandinavian countries and in Canada. In the third system, which we call 'insurance' system, the government varies taxes to insure the net-income of low-skilled agents. This system is similar to the one used in Germany in the years following unification and is one of the systems currently under consideration by the fiscal authority of the EU.

Our three main results can be summarized as follows. First, the macroeconomic adjustments and the long-run changes brought about by low-skilled migrations are quite substantial and should not be ignored as a possible source of fluctuations in the economy. Second, the presence of a welfare state magnifies and distorts the adjustment process to the new steady state. Third, the interaction between migrations and the welfare state is crucial to understand the sign, the magnitude and relative welfare gains of different types of agents in the receiving economy.

Short-run adjustments are caused by a temporary decrease in the capital-labour ratio: such a change causes a redistribution between wage and capital income, which affects investments and labour supply. In the long run investment, consumption and output per-capita decreases because of the larger share of low-skilled agents in the economy. When taxes are held constant over the adjustment path and the two types of labour differ only in productivity, wages will be unchanged in the new steady state. In this situation migration is welfare improving: low-skilled workers are unaffected while high-skilled workers, who permanently own more capital per-head, are better off. If different types of labour are imperfect substitutes in production, migration will lead to a widening of the wage gap that will persist even in the long run. Thus an inflow of low-skilled workers will be harmful for the low-skilled workers in this situation.

When marginal taxes are varied in response to migrations, the macroeconomic outcome is altered because of the effects brought about by the variations in marginal taxes. With the egalitarian system, the decrease in low-skilled income and the larger number of welfare recipients forces higher marginal tax rates on skilled agents and reduces the amount of redistribution

funds available in the medium–long run per low-skilled worker. Thus, the welfare of both types of agents decrease. Under the 'insurance' programme only the high skilled bear the increased cost of the welfare system. Hence, in direct contrast to the case when taxes are constant, we find that low-skilled migrations produce substantial welfare losses for high-skilled agents.

1 Introduction

Migrations from less developed areas into the OECD have been substantial in the past and continue to non-trivial. For example, within the 16 member countries of the EU, (legal) net-immigration has accounted on average for 0.5 percent of the native population in each of the last ten years (see OECD, 1995). In many of these countries, overall population growth would have been negative had it not been for the inflow of migrants. It is also predicted that these flows might get larger in the future, for example due to the establishment of the Schengen group in Europe through which border controls are being scrapped (see the Economist, 1998). Moreover, it is well documented that migrants are, on average, less skilled, heavier users and more permanent receivers of welfare benefits relative to natives (see e.g. Chiswick (1986), OECD (1995) and Borjas and Hilton (1996)). Furthermore, these tendencies have become stronger over time, at least in the US, with recent cohorts of migrants being less skilled and more frequent users of welfare provisions than older ones (see e.g. Borjas (1985)).

At the same time there has been political pressure to regulate the flow and qualifications of the migrants (e.g. Australia and Canada), to restrict the type of labor activities migrants can undertake and the benefits they enjoy. The latest example of this type is the US Illegal Immigration Reform and Immigration Responsibility Act, passed in 1996, which excludes even legal migrants from certain welfare benefits (Supplementary Security Income, Food stamps and, in some cases, Medicaid) enjoyed by natives and naturalized citizens, disregarding the fact that these migrants might have payed social security taxes in the past. It has been estimated (see Super and Daskal (1997)) that such a change could affect 450,000-700,000 legal migrants in the US, a little less than 0.5% of the population, with budget savings of about 1.5 billion dollars. Such attempts to shield the welfare of natives suggest that migrations have a non-negligible macroeconomic effects on receiving economies and that there may be important interactions between migrations and the welfare state determining the magnitude of the impacts.

In this paper we investigate whether and to what extent migration flows induce substantial macroeconomic consequences in the receiving economies. In particular, we ask three questions: (a) What are the macroeconomic effects of an inflow of low-skilled migrants? (b) How do migrations affect the welfare of natives? Are different types of agents equally affected? (c) Does

the kind of income redistribution system in place in the host country matters for welfare ?

We study these questions within a general equilibrium model with capital accumulation and endogenous labor supply. Both features are crucial to discuss these issues from a dynamic point of view: capital accumulation is important because it leads to long-run effects which could be very different from short-run ones and endogenous labor supply gives room to the economy to adjust production opportunities even in the short run. Besides these two aspects, our model has two other important ingredients. First, we consider migrations of low-skilled agents into a heterogenous economy initially composed of low-skilled and high-skilled agents. The existence of a skill differential between the migrants and the average native is of potential macroeconomic importance for two reasons. First, when entering the labor market in the host countries, low-skilled migrants may put downward pressure on the low-skilled wage and contribute to widen the wage gap between high-skilled and low-skilled workers (see Katz and Murphy (1992) for some evidence on the wage premium in the US). Secondly, skill differentials will have important consequences for government transfer policies.

A second key ingredient of the model, which adds realism to our analysis, is the presence of a welfare state redistributing income between different types of agents. Most industrialized countries have developed extensive redistribution schemes over the last three decades and social insurance programs have become one of the major sources of government budget outlays. We consider three different specifications. In the first the government taxes high-skilled agents at a fixed rate and redistributes the proceeds to low-skilled agents. This "passive redistribution" scheme might be thought of the system in place in many countries before the welfare state was increasingly developed through the 1970's. In the second specification the government keeps the *distribution* of net-income constant over time, an egalitarian system that resembles the welfare state in place in e.g. the Scandinavian countries and in Canada. In the third system, which we call "insurance" system, the government varies taxes to insure the net-income of low-skilled agents. This system is similar to the one used in Germany in the years following the unification (see Schrettl (1992)) and is one of the systems currently under consideration by the fiscal authority of the EU. The three systems differ in the way migrations affect marginal taxes and since variations in tax rates change capital accumulation and labor supply, the macroeconomic outcome of migrations crucially depends on the which of the three systems is in place.

Our three main results can be summarized as follows. First, the macroeconomic adjustments and the long run changes brought about by low-skilled migrations are quite substantial and should not be ignored a as possible source of fluctuations in the economy. Second, the presence of a welfare state magnifies and distorts the adjustment process to the new steady state. Third, the interaction between migrations and the welfare state is crucial to understand the sign, the magnitude and relative welfare gains of different types of agents in the receiving economy.

Short run adjustments are caused by a temporary decrease in the capital-labor ratio: such a change causes a redistribution between wage and capital income, which affects investments and labor supply. In the long-run the new steady-state features investment, consumption and output per-capita which are lower than those observed prior to the immigration flow because of the larger share of low-skilled agents in the economy. When taxes are held constant over the adjustment path and the two types of labor differ only in productivity, wages will be unchanged in the new steady state. Long-run wages depend on the capital-output ratio, which is not altered by immigration since it is determined by a modified golden rule relationship that involves preferences, technology and tax parameters. In this situation migrations are welfare improving: low-skilled workers are unaffected while high-skilled workers, who permanently own more capital per-head, are better off with gains of about 0.5% of per-capita consumption.

If different types of labor are imperfect substitutes in production, there will also be a gap in the relative wages of the two types of agents over the adjustment path that will persist even in the long-run. Thus an inflow of low-skilled workers is no longer Pareto improving since low-skilled workers will be permanently harmed while high-skilled workers will substantially benefit. In per-capita terms, gains are still sizable and of the order of 0.2% of per-capita consumption.

When marginal taxes are varied in response to migrations, the macroeconomic outcome is altered because variations in marginal taxes permanently distort capital accumulation and affect labor supply decisions. It turns out that the dynamics of aggregate variables under the latter two redistributive programs are very similar but the welfare consequences are different. With the egalitarian system, the decrease in low-skilled income and the larger number of welfare recipients forces higher marginal tax rates on skilled agents and reduces the amount of redistribution funds available in the medium-long run per low-skilled worker. Thus, the welfare of both types of agents decrease and, in per-capita terms, the receiving economy is now willing to devote 0.5%

of consumption to keep migrants out of the country. Under the "insurance" program only high-skilled bear the increased cost of the welfare system. Hence, in direct contrast to the case when taxes are constant, we find that low-skilled migrations produce substantial welfare losses for high-skilled agents with costs of the order of 0.5% of per-capita consumption.

The remainder of the paper is organized as follows: section 2 presents our model; section 3 discusses the dynamic effects of labor migrations; section 4 repeats the analysis under various welfare systems; Section 5 computes the welfare costs of migrations and section 6 concludes.

2 The Model

The model we choose to address the questions posed in the introduction has several important features. First, since we are concerned with the impact of migrations on a single and large economic unit such as Europe or the US, we consider an economy which is closed to movements of goods and capital and ignore the consequences on the sending country. This allows us to isolate the effects due to agent's mobility as a source of dynamic adjustments and provide a measure of overall gains/costs that a typical developed countries may incur as a consequence of migration flows. Considering a two-country version of the model would not add much to the qualitative conclusions once we take into account that most migrants come from large pools of unemployed in the sending economy and that production possibilities in these countries are unlikely to be altered as a consequence of the migration. Second, since we wish to examine the dynamic adjustment of macroeconomic variables we will employ a standard neo-classical growth model with capital accumulation and endogenous labor supply. Third, we assume that native agents are heterogenous along two dimensions. First, we assume that the receiving economy has two types of agents that differ in their productivity levels (as in Kydland (1984, 1995) and Rios-Rull (1993)). We consider an heterogeneous labor force since we are particularly interested in modelling migration flows whose skill composition differs from the one of natives. In setting up the economy we follow Kydland and model productivity differences as exogenous and constant over time. Second, we assume that the two types of agents have different access to financial and capital markets. In particular, high skilled agents have free access to asset and insurance markets which allow them to smooth consumption over time, while low-skilled agents face borrowing constraints. 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. A large proportion of migrants who move to Europe or the States owns little or no capital and are de-facto restricted from engaging in borrowing activities so they may be thought of as liquidity constrained.

In what follows, we go a step further and assume that low-skilled agents are unable to intertemporally smooth consumption. This assumption is a short-cut to modelling a more realistic credit constraint structure, is partly made for computational ease, but is reasonable in our context for at least three reasons. First, given the structure of the model and the shocks we consider, low-skilled agents will never save along the adjustment path and if they had initial wealth they would run it down to zero to shield consumption losses. Second, in the US about 25% of the households hold either negative or no wealth and the head of the household is typically low-skilled. In European countries this number varies from 5 to 20% but it is still true that, typically, the head of a household with no wealth has low skills. Third, first generation low-skilled migrants transfer a large portion of their income back to their home country at regular periods, tend to live close to the subsistence level and are typically unable to purchase insurance contracts or assets which would allow them to limit their income uncertainty.

We let the index $\imath = u, s$ denote the two groups of agents (s denotes high-skilled and u denotes low-skilled). The number (measure) of agents of type $\imath$ at time t is given by $N_t^\imath$ and we define γ_t as the time t population share of high-skilled agents.

We assume that there is a large number of 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. Hours in efficiency units is modelled as a CES-aggregate of the two types of labor with an elasticity of substitution of $1/\rho$. We assume that high-skilled hours are more productive than low-skilled hours and let $\omega \geq 1$ denote productivity differences. When the two factors are perfect substitutes $H^e = H^u + \omega H^s$, where $H^\imath$ denotes total number of hours of workers of type $\imath$.[1]

[1]Some authors (see Rios Rull (1993)) consider low-skilled workers a better substitute to capital than to high skilled workers in production. We do not follow this route since there is sufficient evidence, at least in European countries, that migrants take jobs which locals do not wish to do so no crowding out of capital occurs.

The maximization problem of the representative firm is given by:

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

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[2] Converting (1) in per-capita terms using our definition of γ_t, we obtain:

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

where all lower case letters denote per-capita variables and g_t^p the growth rate of the population. In competitive markets all factors are paid their marginal products so that:

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

The problem of low-skilled is the following:

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

subject to a sequence of budget and time constraints:

$$c_t^u \leq w_t^u h_t^u (1-\tau_t^u) \tag{4}$$

$$l_t^u + h_t^u \leq 1 \tag{5}$$

where c^u denotes consumption of goods, l^u is leisure, h^u is hours worked, τ^u is the net marginal income tax rate (including transfers), β is the subjective discount factor and where we have normalized the time endowment to one each period. Assuming that the utility function is of 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: $h_t^u = \theta^u$, $y_t^u = \theta^u \cdot w_t^u$, $c_t^u = (1-\tau_t^u) \cdot y_t^u$.

The optimization problem for high-skilled workers is:

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

[2]This implicitly assumes that all agents of the same type work the same number of hours. We write it like this, however, only to save on notation.

subject to a sequence of budget and time constraints:

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

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

and the capital accumulation equation:

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

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

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

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

where λ is the multiplier on the budget constraint (7), g_{t+1}^s is the growth rate of the high-skilled population, and θ^s is the share parameter that enters as the power of consumption in the utility function. The first of these conditions equates the marginal rate of substitution between consumption and leisure to the relative price, while the second gives a standard Euler equation.

We assume that there is a government whose 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. We assume that $\tau_t^u = \tau_t^s - \mu_t$, so that μ_t is a tax rebate on low-skilled workers, that τ_t^s is either a parameter or is endogenously chosen to target a certain redistributive policy, while μ_t is endogenously determined to satisfy the government budget constraint:

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

where y_t^s and y_t^u are the taxable incomes of the two types of agents.

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

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

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

[3]Equation (9) is derived using $k_t^s N_{t-1}^s = K_t$, $k_t = \frac{K_t}{N_{t-1}} = k_t^s \gamma_{t-1}$, and $\frac{\gamma_{t+1}}{\gamma_t} = \frac{g_{t+1}^s}{g_{t+1}^p}$

3 The Dynamic Effects of Labor Migration

We model low-skilled migrations as an exogenous temporary increase in the growth rate of low-skilled workers, N_t^u. While it is easy to endogenize migrations as a function of business cycle conditions, we neglect this possibility since migrations to OECD countries are primarily due to political and family reunification reasons (see OECD 1995)[4] The temporary increase in the growth rate of low-skilled workers has two demographic effects: first, it increases the aggregate population growth rate and this change produces short run dynamics. Second, there is a permanent effect on the composition of the population which alters long-run conditions.

These two effects can be worked out in the following way. Assume, without loss of generality, that the growth rate of the high-skilled population, g_t^s, is constant over time and equal to g^s and that the growth rate of the low-skilled population is given by $g_t^u = (1 + e_t)\, g^s$, where e_t is possibly an autocorrelated process. Define the following recursive variable: $\Pi_t \equiv \prod_{i=1}^{t} (1 + e_i) = (1 + e_t)\, \Pi_{t-1}$, $\Pi_0 = 1$. It then follows that:

$$g_{t+1}^p = \frac{(1 - \gamma_0)\, \Pi_{t+1} + \gamma_0}{(1 - \gamma_0)\, \Pi_t + \gamma_0} g^s \tag{13}$$

$$\gamma_{t+1} = \frac{\gamma_0}{(1 - \gamma_0)\Pi_t + \gamma_0} \tag{14}$$

Hence, the growth rate of population is stationary as long as e_t is stationary, while there is a permanent effect on the composition of the population regardless of the assumed process for e_t. This implies that migration flows create both short-term and long-run changes in the receiving economy with the latter changes due to the fact that skill differences are exogenous so that migrants can not invest to improve their skills.

3.1 Long Run Effects

As mentioned, a temporary inflow of low-skilled workers permanently decreases the share of high-skilled workers in the population and this decline, in turn, alters hours in efficiency units and may affect the capital-output ratio. In appendix A we examine how the endogenous variables change as a function of the parameters. To summarize the main points: steady-state levels of

[4]Endogenous migrations would probably dampen the quantitative effects we will describe without altering the qualitative pattern.

output, efficiency hours and the capital-output ratio are given by:

$$y = z^{1/\alpha}\left(\frac{k}{y}\right)^{(1-\alpha)/\alpha}\left(h^e\right)^{1/(1-\rho)}$$

$$h^e = \omega\left(\gamma h^s\right)^{1-\rho} + \left((1-\gamma)\theta\right)^{1-\rho}$$

$$\frac{k}{y} = \frac{\beta g^p\left(1-\alpha\right)\left(1-\tau^s\right)}{1-\beta\left(1-\delta\right)}$$

where variables without time subscripts denote steady-state levels.

Note that the capital-output ratio is determined by the parameters of preferences and technology and by the tax-rate levied on high-skilled agents. Thus, if taxes on skilled agents are held constant, the capital-output ratio is not affected by the inflow of low-skilled workers and changes in aggregate activity are exclusively determined by the changes in efficiency hours.

When there are productivity differentials and the two types of labor are perfect substitutes, an inflow of low-skilled agents (a decrease in γ) lowers efficiency hours, per-capita output, investment and consumption in the long run. Efficiency hours decline as high-skilled hours decrease because of a positive wealth effect. Native low-skilled hours and income are unaffected by migrations in the long-run because the wage rate is constant.

When the two types of labor are imperfect substitutes the results depend crucially on the values of ρ and γ. In the Appendix we show the following two results. First, independently of ω, skilled hours decrease (increase) with migrations when the elasticity of substitution exceeds (is below) 1. With unitary elasticity of substitution, skilled hours do not depend on γ. Second, for a sufficiently high share of skilled workers, hours in efficiency units increase following migrations for all $\rho \geq 0$. When γ is moderately low, hours in efficiency units increase with migrations only if the elasticity of substitution between the two types of labor is sufficiently small.

In the cases we consider more reasonable (either high elasticities of substitution and/or high initial shares of skilled workers) the steady-state capital stock and output per-capita decrease following low-skilled migrations; high-skilled workers work fewer hours, invest less but have higher capital income and consumption; low-skilled workers earn lower income and consume less in the long-run because their relative wage declines.

When taxes respond to migrations, the steady-state capital-output ratio is altered since marginal taxes distort the accumulation of capital. Hence when an inflow of low-skilled workers

increases the size of the welfare state, there will be a second source of negative long-run effects on output in addition to those coming through changes in hours in efficiency units.

3.2 Calibration

We calibrate the model to match annual data and try to use standard parameter values whenever possible. The depreciation rate is set equal to 10% and the interest rate to 4%. The labor share of income α is set to 64%. We also assume that the population growth is stationary in the steady-state. For moderate values of the income tax parameter these values imply a capital-output ratio close to 2.5. 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. In general, high-skilled workers will not use 30% of their time on market activities because they are more productive, own the capital stock and face a different tax rate.

The productivity differential ω is a parameter for which we have less information. Kydland (1984) and Rios-Rull (1993) suggest a value of 2. Here we use $\omega = 1.3$ in order not to exaggerate the difference between the two types of workers since low-skilled agents hold no capital. We assume that the share of low-skilled agents is 25%. This is consistent with our estimates of low-skilled agents holding negative or zero wealth from the PSID and informal calculations performed on some European countries.

There are many estimates of the elasticity of substitution between high and low-skilled workers, $1/\rho$, in the literature depending on how workers are divided. For example, Katz and Murphy (1992) classify workers as having a college or a high school degree and obtain a point estimate of 0.7 with a standard error of 0.15. The classification closer to ours is probably the one of Bean and Pissarides (1991) who divide workers into manual and non-manual in UK manufacturing industries. They find that the point estimates of the elasticity of substitution varies between 0.2 and 2, with large standard errors, so that one can not reject the hypothesis that it is equal either to zero or to one. Because of this large range we examine two cases: one where the two types of workers are perfect substitute ($\rho = 0$) and another where the degree of substitutability is moderate ($\rho = 0.25$) and discuss what happens when ρ increases.

In what follows, we examine the dynamic adjustments following a temporary but persistent migration shock which changes the composition of the population in the steady-state from 75%

to 73%. We model e_t as an autoregressive process: $e_t = \psi_e e_{t-1} + \upsilon_t$ where υ_t is i.i.d. $N(0, \sigma_\upsilon^2)$ and ψ_e, which measures the persistence of the migration process, is set to 0.6 so that current inflows signal future inflows of the same sign.

In our basic simulations we set all taxes and redistributive parameters to zero. This step is useful in order to understand how migration disturbances affect the business cycle properties of an economy in isolation from issues of redistribution and welfare. Since most of the migrations in the 1950's and the 1960's occurred in a situation where the welfare state was small or non-existent, our comparative analysis may highlight why public perception toward migrations has changed dramatically over the last 10-15 years and why countries have engaged in active policies designed to curb or select the type of migrants allowed in the country.

Baseline parameters values are summarized in the table 1.

Table 1: Baseline Parameters

α	ρ	δ	θ	σ	β	τ^s	μ	g^p	γ	ψ_e	ω
0.64	0	0.1	0.3	2	0.96	0	0	1	0.75	0.6	1.3

The adjustments in the endogenous variables following a migration disturbance are in Figure 1 for the case of perfectly substitutable labor, and in Figure 2 for the case of imperfectly substitutable labor.

3.3 Dynamics with perfect substitutability

The response of aggregate variables is similar, in some respects, to the adjustments brought about by a sudden disruption of the capital stock. On impact an inflow of low-skilled labor decreases the capital-labor ratio (measured in efficiency units) and this causes the interest rate to increase and the wage rate to decrease. Since the return to capital is high, investments increase. Aggregate consumption decreases and high-skilled agents work more and lower their consumption in order to rebuild the capital stock. Output (per-capita) decreases on impact because the rise in skilled hours is not sufficient to counteract the decrease in the capital-labor ratio. The magnitude of these changes is significant: for example, output and consumption per-capita drop 0.75% and 1% below their steady state values within the first five years of the adjustment, while investment increases up to 2% on impact.

Over the adjustment path, the wage per efficiency unit decreases (because of the initial drop

in the capital-labor ratio) and then returns to its original steady-state value and the interest rate increases and then returns to the initial level in the long run from above. The process is relatively slow with significant adjustments still taking place ten years after the shock. The differential behavior of the rental rates of the two factors of production induces a substantial redistribution of income across classes of agents over the adjustment path. In fact, low-skilled workers' income and consumption decline. However, high skilled income increases while their consumption drops more than that of low-skilled agents initially, as they attempt to reconstruct the (per-capita) capital stock, to rise above the pre-migration level after 16 years.

In sum, there are two highly intertwined effects following a low-skilled migration. First, there is redistribution over the business cycle with holders of capital benefitting and workers being worse off as competition from the migrants decreases the wage rate. Second, there is a strong wealth 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, combined with their willingness to work more, produces substitution from high-skilled to low-skilled labor in production.

The model of Ambler and Paquet (1994) with stochastic capital depreciation also generates responses which are qualitatively similar to ours. Two differences, however, can be noted. First, a temporary disturbance to the depreciation rate of capital does not change the steady-state so none of the long-run effects we describe are present in their paper. Second, our model can also be interpreted as one with stochastic depreciation with the main difference being that now there is a stochastic adjustment cost to investment as well. Because such adjustment cost is stochastic and countercyclical, the responses of investment and output following a migration disturbance are smaller in magnitude and less persistent than those presented by Ambler and Paquet.

It is worth noting that our set-up leads to dynamics which are different than those typically encountered in models with a fixed capital stock (see e.g. Benhabib (1996)) or in open economy models with the domestic interest rate fixed at a world level. In models with fixed capital stock an inflow of labor typically leads to a once-and-for-all change in the capital-labor ratio: if migrants carry less capital than the average native the capital-labor ratio decreases, thereby making capital owners better off and workers worse off and vice versa if the migrants carry more

capital than the average native. These are roughly the effects we have found at impact in our set-up. However, because we allow for capital accumulation, the adjustment process and the long-run effects will be more interesting in our model.

3.4 Dynamics with imperfect substitutability

The dynamics of aggregate variables when labor is imperfectly substitutable in production are not substantially altered and only investment shows a sizable change, with the impact increase now being smaller. With sufficiently low substitutability, the relationship between hours in efficiency units and γ_t can change sign and this indeed happens here; long run output, investments and the capital stock are now higher than in the original steady state.

The major difference in the dynamics between the perfect and imperfect substitutable cases is that now there is a wedge between high and low-skilled wages. The reason for this is clear: unless high-skilled agents increase their labor supply substantially, an inflow of low-skilled labor must increase their relative wage. Whether this also leads to an absolute increase in high-skilled wages depends on the exact value of, among other parameters, the elasticity of substitution between the two types of labor. In Figure 2, the absolute wage of high-skilled agents decreases on impact but increases over the adjustment path and in the long-run therefore reproducing the skill premium observed in many OECD countries in the 80's (see Gottschalk and Joyce (1991)). For lower elasticities ($\rho \approx 1$) high-skilled wages even increase on impact.

Over the business cycle, the presence of a wage gap produces an additional source of redistribution of income across the two types of agents. The redistribution from low to high-skilled agents is now substantial because it occurs in conjunction with the redistribution from labor to capital previously discussed, making low-skilled agents much worse off. This redistribution takes place not only in the short-run but also in the long-run since low-skilled (high-skilled) wages will be permanently below (above) their initial level. Thus, low-skilled consumption decreases more than in the previous case while high-skilled consumption rises above the initial level much faster and increases more in the long-run.

In conclusion, we find that moderate flows of low-skilled agents which change the composition of the population by 2% over thirty years have substantial macroeconomic consequences which trigger dynamic adjustments in aggregate variables similar to those obtained with a sud-

den disruption of the capital stock. The adjustments occur in conjunction with a sizable income redistribution between classes of agents: there is redistribution between wage earners and capital owners as the real rate increases while the wage rate declines, and there may also be a redistribution between low and high-skilled wage earners if the two types of labor are imperfect substitutes in production. Because relative wage changes dominate in magnitude relative changes in the prices of capital and labor both over the business cycle and in the long-run whenever $\rho \geq 0.25$, the conclusion that low-skilled migration will be strongly encouraged by high-skilled agents is also valid in situations where either the interest rate is tied down to world market conditions or the capital stock is fixed [5]

4 Dynamics with a Welfare State

In this section we study whether the presence of a government, which either passively or actively pursues redistributive policies, changes our conclusions about the dynamic effects of low-skilled labor migrations. In all cases we analyze we assume that government policy is exogenous. The endogenization of these policies, for example, through voting over the redistributionary policies is possible but we believe our exogeneity assumption is reasonable since here we consider only marginal changes in the population composition.

We consider three different redistribution schemes:

- *a passive rule* (**PR**) in which the income tax rate is taken parametrically;
- *an egalitarian rule* (**ER**), where the income tax rate on high-skilled workers is chosen so as to keep the ratio of after-tax income of high to low-skilled agents constant;
- *an insurance rule* (**IR**) where the government insures the consumption of low-skilled agents

[5] We have examined the sensitivity of our results to various changes in the parameters of the model. In particular we have considered altering the persistence of the migration disturbance, we have examined transient migrations, in the sense that after the initial disturbances there will be another shock of similar or smaller magnitude in the opposite direction, and we have studied what would happen with migrations of high-skilled agents. In general, when migration flows have low persistence the business cycle/redistribution consequences are reduced since in deciding their optimal response agents heavily discount future migration developments. With transient migrations the compositional effect is smaller so long-run changes are smaller. In addition, over the business cycle the magnitude of the responses of aggregate and sectorial variables is smaller since changes in the population are expected to be reversed. Finally, when migrants are more skilled than the average native but they carry the same per-capita capital stock and when e_t is an iid shock we obtain the opposite of our basic results: we observe a decrease in investment and interest rates and an increase in the wage rate and in activity in the long run. Thus, low-skilled natives will favor migration flows of high-skilled agents who carry relatively large amounts of capital with them.

from any type of fluctuations.

Under **PR**, the government sets $\tau_t^s = \tau^s$, $\forall t$, and varies μ_t period-by-period so as to satisfy the government budget constraint (10). In the **ER**-system, it chooses the income tax rate on high-skilled agents (τ_t^s) and the transfer rate (μ_t) to satisfy its budget constraint and to target a given income difference between the two groups of agents, i.e.:

$$(1 - \tau_t^s)\, y_t^s = \eta\,(1 - (\tau_t^s - \mu_t))\, y_t^u \tag{15}$$

where η is the wedge between the after-tax income of the two types of agents.

Under **IR**, taxes and transfers are chosen to satisfy the government constraint and to make:

$$(1 - (\tau_t^s - \mu_t))\, y_t^u = \bar{y}^u \tag{16}$$

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

The reason for studying these three redistribution rules is simple. The first one is chosen as a benchmark: we would like to know how the responses of endogenous variables are altered when a government, without an explicit objective function, is present in the economy. The second rule is very common both in theoretical studies examining the static effects of migration (see Razin and Sadka (1995)) and in the real world (see, e.g., Canada and the Scandinavian countries). Egalitarian rules are also 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 third rule has been designed keeping in mind both the structure of the model, where low-skilled agents are unable to insure income fluctuations, and some of the concerns of European policy makers, who foresee the provision of public insurance over the business cycle as a future task for a European fiscal unit (see e.g. Padoa-Schioppa (1987)). Note that the **ER** rule allows for fluctuations in low-skilled workers' income over the business cycle as long as they are proportional to high-skilled income, while this is not permitted with the **IR** rule.

We assume that before the experiments take place the income tax rate on skilled agents is 5%, a value close to those observed in many countries once it is taken into account that our tax rate relates only to the parts of the government budget associated with redistribution. To save space we concentrate on the case $\rho = 0$. When $\rho > 0$ the redistributive effects of a migration

disturbance are simply exagerated so that the qualitative features of the dynamics are similar, but the quantitative changes are more dramatic.

4.1 Parametric Tax Rule

The impulse responses obtained under the PR rule are in Figure 3 and, in the case of aggregate variables, display are no major qualitative changes relative to those of Figure 1. Moreover, the decisions of high-skilled agents are unchanged relative to the baseline model. The reason is that when τ_t^s is constant over the cycle, high-skilled agents behave as if the tax rate were zero (except for the change in the elasticities due to variations in the capital-output ratio).

The major difference relative to the responses of Figure 1 is for low-skilled agents. Because the tax rate on high-skilled workers is constant and the number of low-skilled workers increases, the per low-skilled worker transfers decrease. This is clear from the dynamics of μ which not only declines, but is negative, implying higher taxation for low-skilled agents. Hence their consumption drops over the business cycle making them worse off relative to the baseline case.

Thus, a passive redistribution scheme does not shield low-skilled agents over the business cycle from the negative consequences of low-skilled migrations. On the contrary, with a parametric tax rule, low-skilled workers are penalized in two ways. First, immigrant competition in the labor market makes their wage, income and consumption decline. Second, because the amount that high-skilled workers contribute to the welfare system shrinks and the share of low-skilled workers increases, low-skilled agents are taxed more heavily to make up for the loss of government revenue and the larger number of potential recipients of the transfers.

4.2 Egalitarian Tax Rule

In this exercise we treat η as a parameter and the benchmark value corresponds to the value implied by a 5% income tax rate on high-skilled agents. Given the parameters of the model, this implies that the low-skilled after-tax income is 31% of the after tax income of the high-skilled before any shock takes place[6]. The impulse responses following a migration disturbance appear in Figure 4. The most important change in per-capita variables relative to the baseline case

[6]We have also experimented with a set-up where η is a deterministic function of γ_t. This might be relevant in terms of political economy based determination of redistribution. The dynamics generated are qualitatively similar to those obtained with parametric tax rules but the effects are magnified. We do not report this case because such effects are likely to take place over longer horizons than those that we are mainly concerned with.

occurs because the marginal tax rate for high-skilled agents increases discouraging investments both on impact and over the business cycle and leading to a more pronounced negative long-run effect on output, investment and the capital stock.

At the sectorial level changes are substantial. Because an inflow of low-skilled migrants alters the income distribution in favor of capital holders, the government taxes high-skilled workers/capital owners more heavily. This makes their consumption decrease on impact and be persistently lower over the business cycle. The higher tax rate increases the pool of revenues available for redistribution and this has beneficial effects on low-skilled consumption on impact. However, the favorable outcome is only temporary and low-skilled consumption decreases over the business cycle. The increase in taxes also adversely affect high-skilled income over the business cycle and this limits the amount of redistribution that the welfare state can engage in. Low-skilled agents will therefore also bear higher tax rates over the adjustment path which, combined with a lower wage, make their consumption lower than in the two previous cases. Finally, because the composition of the population permanently changes in the long run, tax rates on both types of agents will permanently increase.

In sum, this redistribution scheme has important side effects in the presence of migrations. With an inflow of low-skilled agents, the "size" of the welfare state increases and skilled agents, which are a smaller fraction of the population must contribute to a larger percentage of total government revenues. Because they are taxed more heavily they contract investments and this in turn generates a reduction of per-capita income that exceeds that observed in the two previous cases. Notice that this occurs despite the fact that the after tax real rate of interest is positive over the business cycle. Thus, this redistributive system shifts a substantial portion of the costs from low-skilled to high-skilled agents both over the business cycle and in the long run.

4.3 Insurance Tax Rule

The responses of the variables following a migration disturbance are in Figure 5. In general, aggregate dynamics are very similar to those obtained with an egalitarian tax rule.

The responses of sectorial variables are more dramatic because of the associated tax effects: an inflow of low-skilled agents leads to higher marginal tax rates on high-skilled agents and this increase is now larger than in the previous case. Hence, investments will be discouraged and the

negative effect on the long-run capital stock is larger. This process is somewhat self-enforcing: tax rates must increase along the business cycle because of the negative effect that such an increase has on capital accumulation, and this leads to magnified effects both over the business cycle and in the long run.

By eliminating short run fluctuations in low-skilled consumption, this rule heavily penalizes high-skilled workers in the presence of migrations since low-skilled income declines while at the same time there is a larger number of people that needs to be insured. Compared with an egalitarian rule, the burden of the short run adjustment is now totally tilted toward high-skilled agents which now bear up to an 18% increase in their marginal tax rate over the business cycle.

4.4 Summary

To summarize, the qualitative and quantitative macroeconomic effects of labor migrations are altered when there is a government redistributing income across classes of agents and the magnitude of the changes depends on whether tax rates vary or not over the adjustment path. With low-skilled migrations, the size of the welfare state increases. When high-skilled agents' taxation is insensitive to business cycle conditions, redistribution policies harm low-skilled agents who are now worse off because there is a smaller pool of resources to be redistributed to a larger number of agents. When high-skilled workers contribute with varying amounts to the welfare state over the business cycle, the cyclical consequences may be more dramatic as the tax disincentives depress capital accumulation and per-capita income. With egalitarian taxes both classes of agents are penalized. With insurance taxes, the full burden of the increase in the welfare state falls on high-skilled agents and the depressing effects on economic activity are significantly larger.

5 Quantifying the Welfare Consequences of Migrations

The analysis so far has demonstrated that low-skilled migrations may have very different implications for the income distribution of the receiving country depending on the type of redistributive policy pursued by the government. Without taxes, skilled agents/capital holders benefit from migrations. With redistributive taxes the burden of migration costs is shifted in part or completely onto high skilled workers and capital owners.

In this section, we ask: how much are natives willing to pay in terms of consumption in order

to keep migrants out of the country? In other words, we ask how much a country is willing to devote to programs which would restrict the flow of migrants in exchange for foreign aid programs to countries with a potential pool of migrants. This question is not purely academic. Several countries, e.g., Italy in the case of Albania, have engaged in active foreign aid policies to curb massive inflows of migrants responding to political and economic changes occurring in the sending countries. Others, e.g. the Scandinavian countries, where well developed welfare states are in place, might find themselves burdened by the potential costs of admitting migrants into the country. To avoid this the US has diverted funds from welfare provision of migrants to programs controlling borders easily penetrable by migrants.

We compute welfare measures along the lines of Lucas (1987) and focus on long-run welfare comparisons. In particular, we compute the percentage change in consumption such that the utility of the native population is the same before and after low-skilled migration [7] Because native population is heterogeneous, we compute two such measures. The first imputes all the costs or gains to skilled workers/capitalists. The other measure assumes that the two different groups of native households share the costs or gains and weights the two groups by their initial share of the population in the social welfare function [8] This gives us the following two welfare measures:

$$\lambda_0 = 1 - \frac{c_1^s}{c_0^s}\left(\frac{1-h_1^s}{1-h_0^s}\right)^{(1-\theta)/\theta} \tag{17}$$

$$\lambda_1 = 1 - \left(\frac{W_0}{W_1}\right)^{1/\theta(1-\sigma)} \tag{18}$$

where $c_0^s(c_1^s)$ denotes high-skilled consumption prior to (after) the inflow of low-skilled workers, $h_0^s(h_1^s)$ are hours worked prior to (after) the inflow and

$$W_0 \equiv \gamma_0 \left(c_0^s\right)^{\theta(1-\sigma)} \left(1-h_0^s\right)^{(1-\theta)(1-\sigma)} + (1-\gamma_0)\left(c_0^u\right)^{\theta(1-\sigma)} \left(1-h_0^s\right)^{(1-\theta)(1-\sigma)} \tag{19}$$

$$W_1 \equiv \gamma_0 \left(c_1^s\right)^{\theta(1-\sigma)} \left(1-h_1^s\right)^{(1-\theta)(1-\sigma)} + (1-\gamma_0)\left(c_1^u\right)^{\theta(1-\sigma)} \left(1-h_1^u\right)^{(1-\theta)(1-\sigma)} \tag{20}$$

We consider: (i) zero taxes, (ii) a constant income tax rate equal to 5 percent, (iii) an egalitarian tax-system, and (iv) an insurance tax-system. In all cases we assume $\gamma_0 = 0.75$ and

[7] It is possible also to evaluate the welfare effects taking the dynamic adjustment path into account, but we choose to abstract from this in order to get a welfare metric that is more easily interpreted.

[8] Since there is not unique welfare function for the case of heterogeneous agents, the proposed measure is a simple utilitarian function that gives equal weights to local agents.

compute λ's for 1 to 5 percent changes in the composition of the population.

In each case we look at the welfare effects for three relative productivities parameters: $\omega = 1.0$, so that the only difference is due to the ownership of the capital stock; $\omega = 1.3$, and $\omega = 2.0$ which is the parameterization of Kydland (1995). As ω increases, the productivity difference between the average natives and the migrants increases. Also, we examine results for two different values of the elasticity of substitution, $\rho = 0.0$ and $\rho = 0.25$.

Before discussing the results, it is worth stressing that our calculations may be affected by several mechanisms not modelled in the paper. In particular, we have assumed that the skill differences are exogenous. It has been observed that second generation immigrants do not differ significantly from natives in terms of skills. However, it is also true (see Felderer (1994)) that human capital accumulation of migrants is slow. While we believe that skill acquisition is an important issue one needs to model before taking a firm view of the welfare costs of migrations, we also believe that, as a first approximation, it is interesting to compute these costs disregarding this issue (Storesletten (1995) considers a model where these effects are taken into account).

Part A of Table 2 examines the case where there is no redistribution: it is clear that in this case migrations increase welfare. For example, when $\omega = 1.3$ a migration flow that changes the composition of the population by 2% in the long run increases consumption of high skilled by 0.4% and aggregate native consumption by 0.25%. Furthermore, the welfare gain is increasing in the size of the migration flow and decreasing in the productivity differential. The intuition is straightforward: an inflow of low-skilled labor unambiguously leads to a welfare gain for the capitalists. If the capital stock were kept constant, capitalists would enjoy a higher income because of the higher return to capital. This is the case investigated by Berry and Soligo (1969), Borjas (1994a,b) in a model with homogenous natives, and Benhabib (1996) in a model with heterogeneous agents. However, since here there is an incentive to accumulate capital, the economy ends up in a situation where capitalists hold per-household more capital in the new steady-state. Hence, they will unambiguously be better off and the magnitude of the gains is proportional to the size of the inflow. When the productivity differences increase, the change in the initial effective capital-labor ratio is smaller, less new capital will be accumulated and the amount of capital per-head is lower in the new steady state. Clearly, welfare gains are smaller when the two groups share the benefits.

In Panel B the income tax is constant but the effective redistribution to the low-skilled agents is varied so that the government budget constraint is satisfied. Note that the welfare gains for high-skilled agents are exactly the same as in Panel A. This is because a income tax different than zero lowers the capital-output ratio and output but not labor in efficiency units. Hence, in percentage terms, the consumption of high-skilled agents increases exactly by the same amount as in the case of zero taxes. Low-skilled workers welfare, however, declines substantially since fewer resources are available for redistribution and high-skilled workers cannot compensate low-skilled agents for the loss. Hence, aggregate welfare declines and the economy will be willing to give 0.2% of per-capita consumption to keep migrants away. Once again, welfare losses are increasing in ω and decreasing in γ.

The results obtained with an egalitarian rule (Panel C) differ from the previous two cases because the marginal income tax rate changes in the new steady state. Once again, when the ratio of the after tax income levels of the two groups is kept constant and equal to η, an inflow of low-skilled labor increases the before tax income of high-skilled agents. This implies a welfare loss for high-skilled workers, which again is decreasing in γ and increasing in ω since the tax distortions are larger the more productive high-skilled workers are. Because low-skilled agents benefit from this program, the economy wide losses are smaller than those suffered by high-skilled agents for each value of ω and γ.

With an insurance system (Panel D), the welfare effects of migrations are very similar to those in Panel C. In this case taxes need to be increased in order to maintain the after tax income that the welfare state promised to the low-skilled. The costs for skilled agents/capital owners increase with ω, because when productivity differences are sufficiently small, the redistribution from wage to capital income is small. Note that in this latter case, since tax rates are slightly higher than those experienced with an egalitarian rule for each level of ω and γ, costs are significant for high skilled workers while low-skilled agents welfare is unchanged.

When the two types of labor are imperfect substitutes in production the qualitative effects are similar. The only significant difference occurs for $\omega = 2.0$ in the case of no taxes: now there are aggregate welfare losses while before there were gains. This is due to the fact that when the productivity parameter is high, the wage premium between the two types of labor is large leading to larger losses for the low-skilled component of the population. Two other facts need to

be noticed. First, tax rates with ER and IR rules are larger than in the perfectly substitutable case because the before tax income differential between the two types of agents is much larger here. Second, the magnitude of the gains and losses in the four different schemes is magnified. For example, when there are no taxes high-skilled agents would be willing to give up 1.4% of annual consumption to admit low-skilled migrants which change the composition of population by 2% but they are willing to pay up to 0.6% of their consumption when there are insurance taxes to keep the same flow of migrants away. For even higher values of ρ, the magnitude of the welfare gains/losses is dramatic. For example, when $\rho \approx 1$ high skilled tax rates permanently increase to 7.7% in the case of insurance taxes with an aggregate loss of about 1% of per-capita consumption.

To sum up, the quantitative welfare effects of low-skilled labor migration crucially depend on the size of the immigration flow, the relative productivity difference between migrants and natives and the redistribution system in place in the receiving country. When the receiving country does not engage in redistribution, migrations are unambiguously welfare improving for high-skilled agents and the country as a whole and, notwithstanding the possible short-run costs associated with adjustments of the capital stock, they should encourage migration of this type of agents. However, if the receiving country does engage in redistribution, as is common in most OECD countries, there are large welfare costs, which, depending on the exact redistribution scheme, are born by different classes of agents.

6 Summary and Conclusions

This paper analyzed the quantitative effects of low-skilled migration in a dynamic model with endogenous labor supply and capital accumulation. Immigration to OECD countries has been substantial over prolonged periods of time and it seems natural to investigate whether the macroeconomic consequences of such flows are significant or not. Two characteristics emphasized in the literature are that migrants to OECD countries are less skilled and use welfare provisions more than the average native and these aspects were included in our analysis.

We find that an inflow of low-skilled workers induces substantial macroeconomic adjustments, important redistributive effects and significant welfare changes. The macroeconomic adjustments resemble, to some extent, those that would take place if the capital stock were

suddenly disrupted: we in fact observe higher investments over the adjustment path, and if all agents were identical, this would be the only change taking place. However, with a heterogeneous workforce there is also a composition effect which induces both long-run changes and differential impacts on high and low-skilled agents. In the long-run, migrations decrease per-capita capital, output and investment if the two types of workers are perfect substitutes in production. High skilled agents are better off both in the short run and in the long run because their capital income increases while low skilled agents are worse off in the short run because wages fall, but are unaffected in the long run. When the two types of agents are imperfect substitutes the income gap between high and low-skilled agents is more pronounced both over the business cycle and in the long run. Finally, when taxes are varied over the business cycle they distort capital accumulation and labor supply decisions and lead to prolonged periods of adjustments and more pronounced declines in the standards of living.

An inflow of low-skilled labor produces significant redistribution of income from wage to capital income along the adjustment path since competition in the labor market depresses the wage rate while the return to capital increases. In addition, if the two types of workers are imperfect substitute in production, an inflow of low skilled workers induces a wage premium, which produces a further redistribution from low-skilled to high-skilled agents.

Some of our conclusions change when the government redistributes income among classes of agents. With a passive redistribution rule low-skilled agents are worse off in the long run even when the two types of labor are perfect substitutes in production because there are more agents to share a fixed pool of government revenues. With an egalitarian scheme, both types of agents are negatively affected since a flow of low-skilled agents forces high skilled agents to finance a larger welfare state. Finally, when the government insures low-skilled consumption over the business cycle, high skilled agents bear the entire cost of migrations. Overall, these last two redistribution schemes shift the costs from low-skilled to high-skilled/capitalists providing additional depressive effects on capital accumulation both over the business cycle and in the long run.

We attempt to quantify the welfare costs of immigration by computing the percentage change in consumption, evaluated from one steady-state to another, which keeps utility unchanged before and after the low-skilled migration flow takes place. When the economy does not engage

in redistribution, we find that there are aggregate gains. For example, the economy would be willing to give up 0.2-0.4% of annual consumption to encourage low-skilled labor migrations which change the composition of population by 2%. This result is well-known in models with fixed capital stocks, reappears in our model and is due to the gains for capital owners induced by the inflow of low-skilled workers. With a welfare system in place these gains can be turned into substantial costs (up to 0.5% of annual consumption) with the quantitative features of the results depending on the size of migration flows, the skill differential in native population and the elasticity of substitution of the two types of labor in production.

It is important to stress that our analysis constitutes only a first look at the complex problem of the macroeconomic effects of migrations and it would probably be important to endogenize skill formation before we can give a definite answer to the questions posed in the introduction. Empirical evidence suggests that skill differences between natives and migrants disappear over time, although at a very slow rate, and this may modify, in particular, the results of our welfare calculations. Another interesting idea to investigate is whether international repercussions are important and whether international aid schemes lead to improved conditions, in particular, in the sending country. Finally, issues connected with optimal migration policies in dynamic settings offer interesting avenues for future research.

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Appendix A: Steady-State Effects

In this appendix we discuss the steady-state effects of changes in the share of skilled agents. Given a tax rule, the model delivers the following steady-state conditions:

$$\frac{1-\theta}{\theta}\frac{c^s}{1-h^s} = (1-\tau^s)\,w^s \tag{21}$$

$$c^u = (1-\tau^u)\,\theta w^u \tag{22}$$

$$w^s = \alpha\left(\frac{y}{h^e}\right)\omega\left(\gamma h^s\right)^{-\rho} \tag{23}$$

$$w^u = \alpha\left(\frac{y}{h^e}\right)\left((1-\gamma)\,\theta\right)^{-\rho} \tag{24}$$

$$y = \gamma c^s + (1-\gamma)\,c^u + x \tag{25}$$

$$y = z^{1/\alpha}\left(\frac{k}{y}\right)^{(1-\alpha)/\alpha}\left(h^e\right)^{1/(1-\rho)} \tag{26}$$

$$\frac{k}{y} = \frac{g^y(1-\alpha)}{r} \tag{27}$$

$$r = \frac{1-\beta(1-\delta)}{\beta(1-\tau^s)} \tag{28}$$

$$s_x = \frac{x}{y} = \left(1-(1-\delta)/g^y\right)\frac{k}{y} \tag{29}$$

$$\gamma\tau^s y^s = -(1-\gamma)\,\tau^u y^u \tag{30}$$

$$h^e \equiv \omega\left(\gamma h^s\right)^{1-\rho} + \left((1-\gamma)\,\theta\right)^{1-\rho} \tag{31}$$

A.1 No Taxes

In order to analyze the issues of interest it is convenient to start by setting all taxes to zero. In this case it follows from (27) and (28) that the capital-output ratio is:

$$\frac{k}{y} = \frac{\beta g^y(1-\alpha)}{1-\beta(1-\delta)} \tag{32}$$

which is unaffected by changes in γ. Hence from equation (26) it follows that the effects on aggregate activity are solely determined by the effect on h^e, which from (31), depends on skilled hours, the productivity parameter ω, and the shares of the two types of agents. Because skilled hours is the only endogenous variable, we first concentrate on the determination of h^s.

Combining (21) with (23) and (22) with (24), inserting into (25) and rearranging gives us:

$$(1-s_x-\alpha)\left(1+\frac{1}{\omega}\left(\frac{(1-\gamma)\,\theta}{\gamma h^s}\right)^{1-\rho}\right) = \alpha\frac{\theta-h^s}{(1-\theta)\,h^s} \tag{33}$$

This relationship defines h^s as an implicit function of γ. Note that since $s_x+\alpha<1$, that $h^s<\theta=h^u$ In general we cannot explicitly solve (33) for h^s. We can, however, analyze the properties of skilled hours viewing (33) as a function implicitly defining h^s as a function of γ. The right hand side of (33) does

not involve γ and defines a function $f(h^s)$. f is decreasing in h^s; $f(\theta) = 0$; $\lim_{h^s \to \theta_+} f(h^s) = \infty$. Denote the left hand side of (33) by $g(h^s, \gamma)$. Then $\frac{\partial g(h^s,\gamma)}{\partial h^s} = (\rho - 1)(1 - s_x - \alpha)\frac{1}{\omega}\left(\frac{(1-\gamma)\theta}{\gamma}\right)^{1-\rho}(h^s)^{\rho}$ and $\frac{\partial g(h^s,\gamma)}{\partial \gamma} = (\rho - 1)(1 - s_x - \alpha)\frac{1}{\omega}\left(\frac{1-\gamma}{\gamma}\right)^{-\rho}\left(\frac{\theta}{h^s}\right)^{1-\rho}\frac{1}{\gamma^2}$. Hence, $g(h^s, \gamma)$ is an increasing function of h^s for $\rho < 1$ and a decreasing function of h^s for $\rho > 1$. Moreover, $\lim_{h^s \to \theta_+} \frac{\partial g(h^s,\gamma)}{\partial h^s} = 0$, $\forall \rho \geq 0$; $\lim_{h^s \to \theta_+} g(h^s, \gamma) = l < \infty$, and $g(\theta, \gamma) > 0$, $\forall \gamma > 0$.

Thus, f and g will have a unique intersection for $h^s \in]0, \theta[$ and at this equilibrium g will cut f from below so that the response of skilled hours to changes in the skill composition can be determined from the changes in $g(h^s, \gamma)$ due to γ. Since h^s is increasing in γ for $\rho < 1$ and decreasing in γ for $\rho > 1$, an inflow of low-skilled agents will decrease skilled hours if the two types of labor are relatively good substitutes and increase skilled labor supply if the two types of labor are relatively poor substitutes.

To determine the effect on hours in efficiency units and therefore output per-capita consider

$$\frac{\partial (h^e)^{1-\rho}}{\partial \gamma} = (h^e)^{-\rho}\left[\omega (h^s)^{-\rho}\gamma^{-\rho}\left(h^s + \gamma\frac{\partial h^s}{\partial \gamma}\right) - \theta^{1-\rho}(1-\gamma)^{-\rho}\right] \tag{34}$$

In general, this expression cannot be signed. We can, however, say that when γ is sufficiently high, the derivative is negative since the last term in the square bracket will dominate for $\forall \rho > 0$ and this is effect is stronger the smaller is the elasticity of substitution. Thus, a large share of high-skilled agents, together with a low elasticity of substitution, means that an inflow of low-skilled agents increases in hours in efficiency units and aggregate activity.

When γ is sufficiently low the above effect is small and steady-state results crucially depend on the elasticity of substitution. If the elasticity is high, we know that $\partial h^s / \partial \gamma > 0$. Thus, it is especially likely that an inflow of unskilled agents will decrease activity and the likelihood of this event is higher the larger is ω. If the elasticity of substitution is low, decreasing γ will probably have positive effects on activity but the sign depends critically on other parameters.

Two special cases, for which an analytic solution exists, are when the two types of labor are perfect substitutes, i.e. $\rho = 0$ and when there is a unitary elasticity of substitution, i.e. $\rho = 1$. In the first case we have

$$h^s = \frac{\alpha\theta - (1 - s_x - \alpha)\frac{1}{\omega}\frac{1-\gamma}{\gamma}\theta(1-\theta)}{\alpha + (1 - s_x - \alpha)(1-\theta)} \tag{35}$$

$$h^e = \frac{\alpha\theta\left((1-\gamma) + \omega\gamma\right)}{\alpha + (1-\theta)(1 - s_x - \alpha)} \tag{36}$$

so that an inflow of low-skilled labor decreases skilled hours and "effective" hours for $\omega > 1$.

In the second case (33) reduces to:

$$h^s = \frac{\alpha\theta\frac{\omega}{\omega+1}}{(1 - s_x - \alpha)(1-\theta) + \alpha} \tag{37}$$

so that h^s is independent of γ. Thus, the effect on aggregate activity is determined completely by the effect of γ on $(h^e)^{1-\rho}$. Note that: $sign\left(\frac{\partial (h^e)^{1-\rho}}{\partial \gamma}\right) = sign\left(\frac{\omega}{1+\omega} - \gamma\right)$. Thus, for large enough skill

differences, or large enough shares of low-skilled agents, an inflow of low-skilled agents increases aggregate activity and vice versa for low skill differences and high share of high-skilled agents.

A.2 Taxes

The addition of taxes creates additional problems in signing the derivatives and does not allow us to deliver many straight insights. We can, however, note the following two principles:

(a) Aggregate distortions are caused solely by changes in the capital income tax rate.

(b) Hours worked are not distorted by marginal taxes.

The second principle follows from the homotheticity of preferences. For example, for low-skilled agents at an optimum, using their budget constraint, we have that $\frac{h^u}{1-h^u} = \frac{\theta}{1-\theta}$. Hence the income and substitution effects of changes in marginal taxes cancel out and this result holds at any point in time so that labor supply is not even adjusted to temporary changes in taxes. For high-skilled agents the result only holds at the steady-state. Inserting (21) through (24) and (27) and (28) into (25) and rearranging gives us:

$$1 - \frac{\beta g^p (1-\alpha)}{1-\beta(1-\delta)} \left(1 - (1-\delta)/g^p\right) = \alpha \frac{\theta - h^s}{(1-\theta)h^s} \frac{\omega (\gamma h^s)^{1-p}}{h^c} + \alpha \tag{38}$$

This relationship is independent of $(1-\tau^s)$, involves h^s as the only endogenous variable and establishes that high-skilled hours in the steady-state do not depend on the marginal income tax rate.

Since steady state hours worked are unaffected by changes in the marginal tax rate, steady state output will change only if the capital-output ratio responds to marginal income taxes. Under the two alternative redistribution schemes where τ^s is adjusted following a migration, any changes in this tax rate will therefore affect capital accumulation and aggregate activity.

Table 2. Welfare Costs of Migrations

A. Without Taxes

	$\rho = 0.0$						$\rho = 0.25$					
	$\omega = 1.0$		$\omega = 1.3$		$\omega = 2.0$		$\omega = 1.0$		$\omega = 1.3$		$\omega = 2.0$	
γ	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1
0.74	-0.25	-0.16	-0.19	-0.13	-0.12	-0.08	-0.69	-0.21	-0.55	-0.07	-0.38	0.11
0.73	-0.50	-0.34	-0.39	-0.26	-0.25	-0.16	-1.38	-0.43	-1.12	-0.16	-0.77	0.22
0.72	-0.76	-0.52	-0.59	-0.39	-0.38	-0.25	-2.09	-0.67	-1.68	-0.25	-1.16	0.31
0.71	-1.03	-0.71	-0.79	-0.53	-0.52	-0.33	-2.81	-0.91	-2.26	-0.36	-1.56	0.39
0.70	-1.31	-0.90	-1.01	-0.68	-0.66	-0.42	-3.54	-1.17	-2.85	-0.48	-1.97	0.45

B. Parametric Income Tax

	$\rho = 0.0$						$\rho = 0.25$					
	$\omega = 1.0$		$\omega = 1.3$		$\omega = 2.0$		$\omega = 1.0$		$\omega = 1.3$		$\omega = 2.0$	
γ	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1	λ_0	λ_1
0.74	-0.25	0.09	-0.19	0.21	-0.12	0.41	-0.69	-0.08	-0.55	0.10	-0.38	0.38
0.73	-0.50	0.15	-0.39	0.39	-0.25	0.79	-1.38	-0.17	-1.12	0.18	-0.77	0.74
0.72	-0.76	0.20	-0.59	0.54	-0.38	1.15	-2.09	-0.29	-1.68	0.24	-1.16	1.07
0.71	-1.03	0.23	-0.79	0.68	-0.52	1.47	-2.81	-0.42	-2.26	0.29	-1.56	1.37
0.70	-1.31	0.24	-1.01	0.80	-0.66	1.77	-3.54	-0.57	-2.85	0.31	-1.97	1.66

C. Egalitarian Tax-System

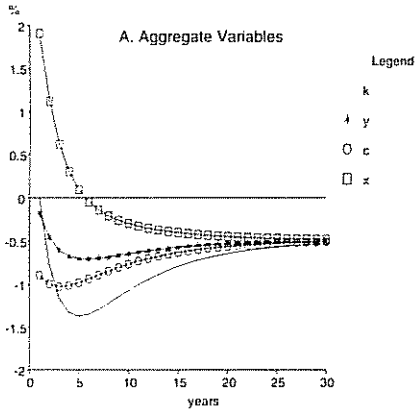
	$\rho = 0.0$									$\rho = 0.25$								
	$\omega = 1.0$			$\omega = 1.3$			$\omega = 2.0$			$\omega = 1.0$			$\omega = 1.3$			$\omega = 2.0$		
γ	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1
0.74	5.3	0.23	0.17	5.3	0.26	0.20	5.3	0.29	0.25	5.6	0.25	0.20	5.5	0.27	0.22	5.4	0.30	0.27
0.73	5.6	0.48	0.34	5.6	0.52	0.41	5.5	0.59	0.51	6.2	0.54	0.43	6.0	0.57	0.47	5.8	0.62	0.55
0.72	5.9	0.73	0.53	5.8	0.79	0.62	5.8	0.90	0.77	6.8	0.85	0.68	6.5	0.88	0.74	6.3	0.96	0.85
0.71	6.2	0.99	0.72	6.1	1.07	0.84	6.1	1.21	1.04	7.4	1.18	0.96	7.1	1.22	1.03	6.7	1.32	1.17
0.70	6.6	1.26	0.92	6.4	1.35	1.06	6.3	1.53	1.32	8.0	1.54	1.26	7.6	1.58	1.34	7.2	1.69	1.51

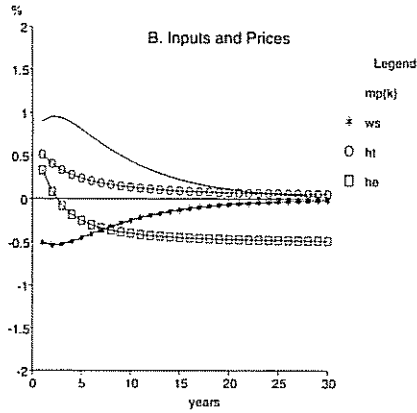
D. Insurance Tax-System

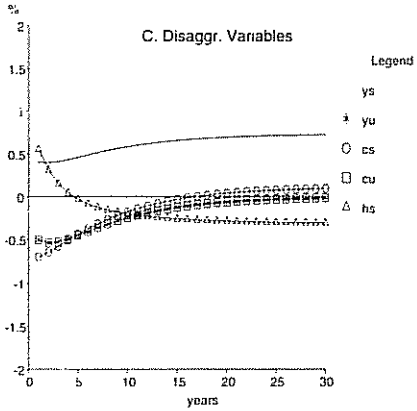
	$\rho = 0.0$									$\rho = 0.25$								
	$\omega = 1.0$			$\omega = 1.3$			$\omega = 2.0$			$\omega = 1.0$			$\omega = 1.3$			$\omega = 2.0$		
γ	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1	τ	λ_0	λ_1
0.74	5.3	0.24	0.17	5.3	0.29	0.20	5.3	0.35	0.23	5.6	0.29	0.21	5.5	0.33	0.23	5.5	0.37	0.26
0.73	5.6	0.49	0.35	5.6	0.59	0.41	5.6	0.71	0.48	6.2	0.64	0.46	6.1	0.70	0.50	5.9	0.78	0.53
0.72	5.9	0.75	0.53	5.9	0.90	0.63	5.9	1.09	0.73	6.9	1.04	0.75	6.7	1.12	0.79	6.4	1.22	0.84
0.71	6.3	1.03	0.73	6.2	1.23	0.86	6.2	1.47	0.99	7.6	1.50	1.08	7.3	1.59	1.12	7.0	1.70	1.17
0.70	6.6	1.33	0.94	6.6	1.58	1.10	6.5	1.88	1.27	8.3	2.02	1.45	8.0	2.11	1.49	7.5	2.22	1.52

Notes: A negative sign indicates gains and a positive sign losses, ω is the productivity differential between high and low skilled workers, τ the tax rate on skilled agents which either keeps the income distribution or low-skilled consumption constant, λ_0 and λ_1 are defined in equations (18) and (19).

Figure 1. Dynamic Effects of Migration without a Welfare State

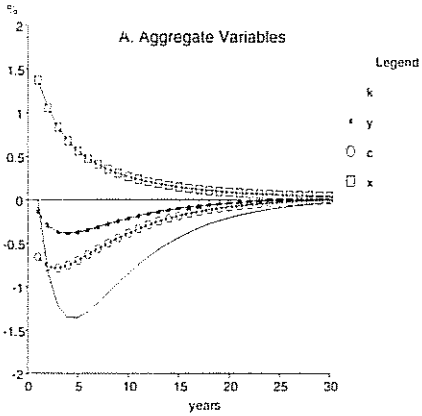


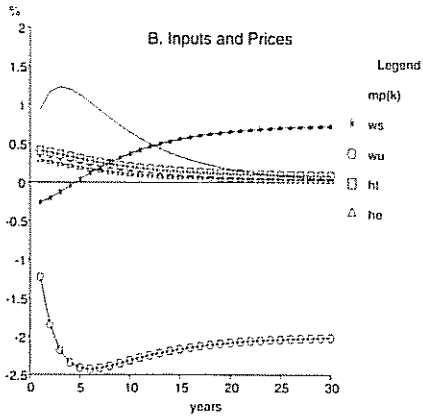


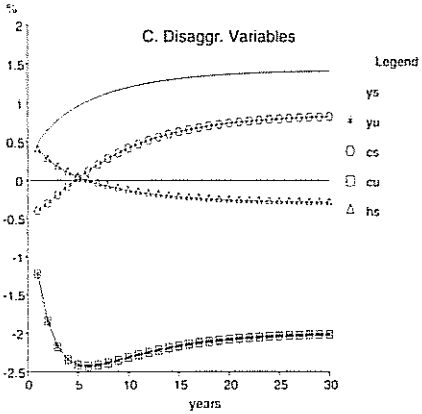


Note: The figures illustrate the percentage deviations from the initial steady-state. Aggregate variables are in per-capita terms. Parameter values are listed in Table 1.

Figure 2. Imperfect Substitutes

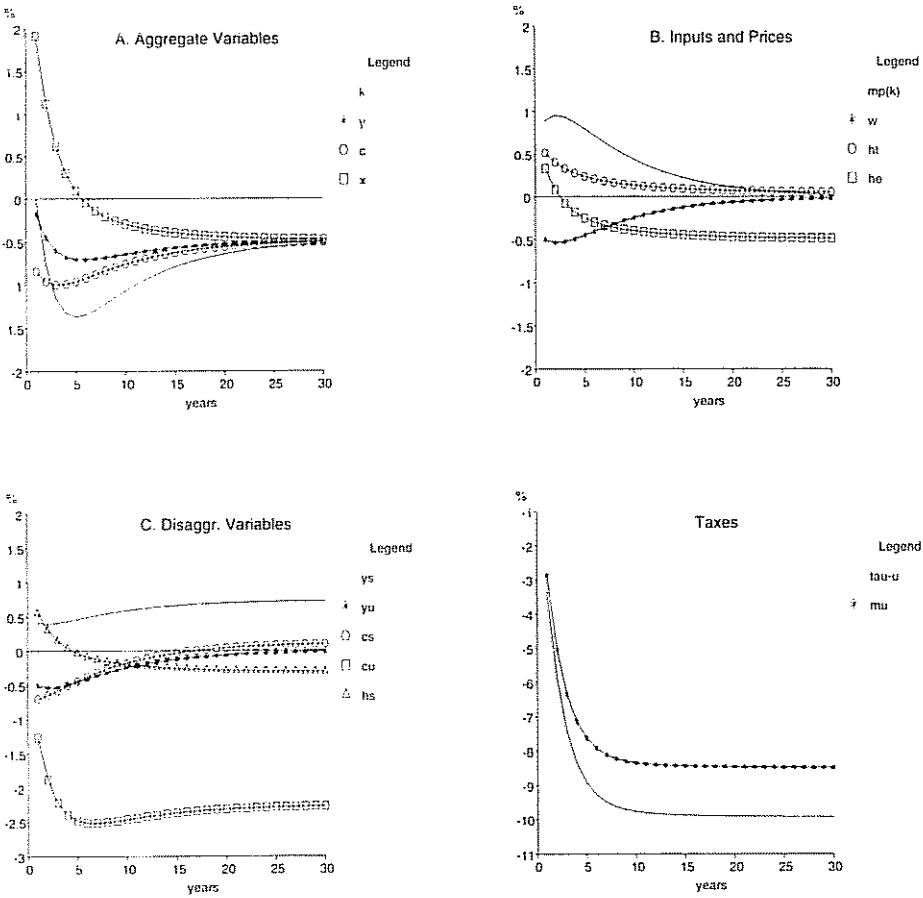






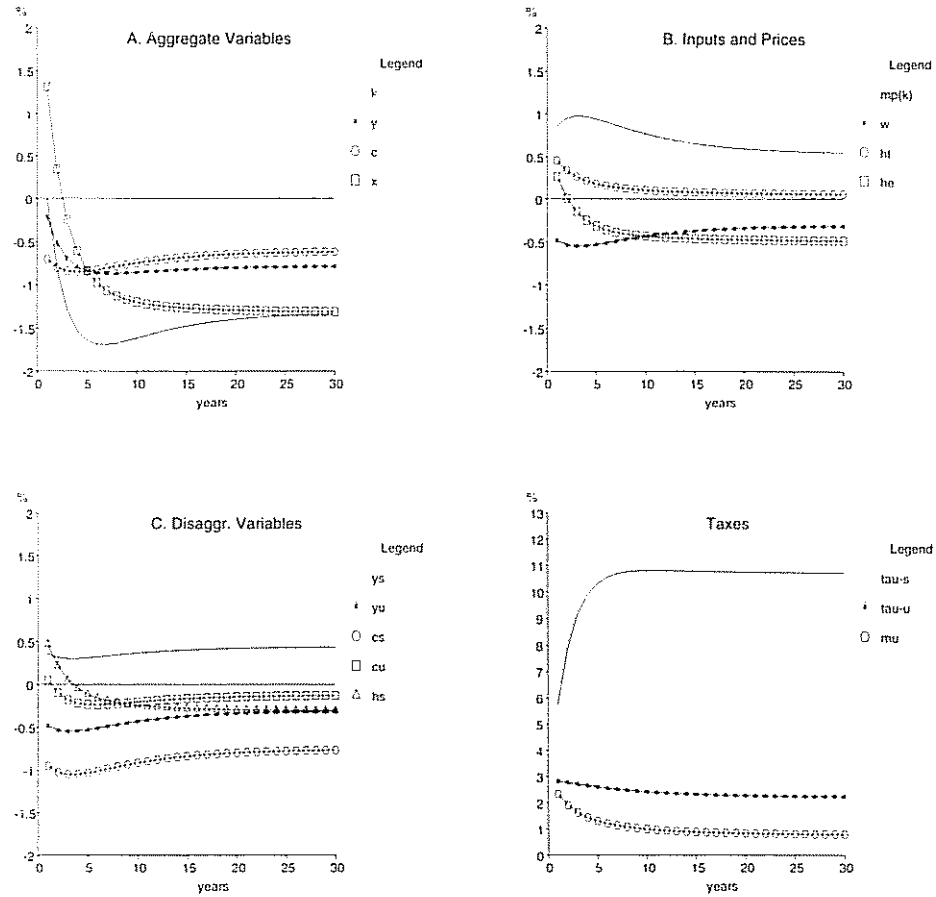
See notes to Figure 1. The above figure assumes that $\rho = 0.25$.

Figure 3. Passive Redistribution



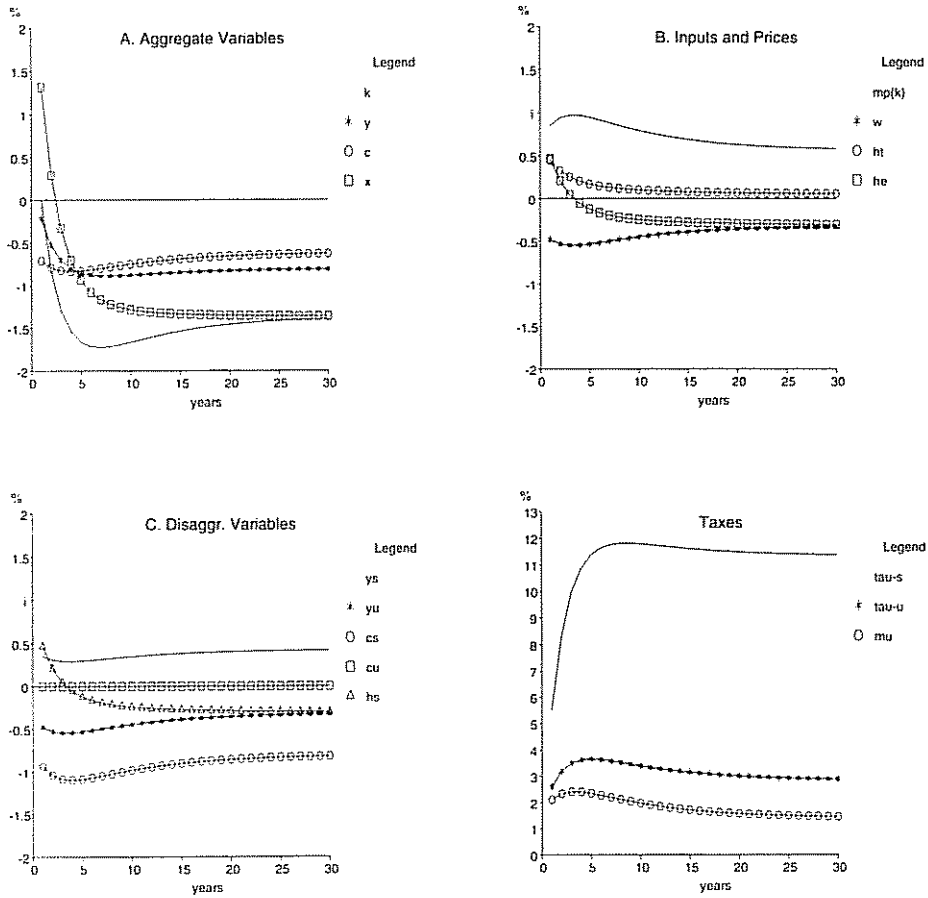
Note: See notes to figure 1. The above figures assume that τ^s is held constant at 5%. μ is varied to satisfy the government budget constraint. The two types of labor are assumed perfect substitutes.

Figure 4. Egalitarian Taxes



Notes: See Notes to Figure 1. The above figures assume that η is kept constant over the adjustment path and equal to the pre-migration value for a baseline high-skilled tax rate of 5%.

Figure 5. Insurance Tax System



Notes: See notes to figure 1. The above figure assumes that unskilled after tax income is kept constant over the adjustment path and equal to the pre-migration level for a skilled tax rate of 5%.