Migration Flows and Capital Movements in Small Open Economies*

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Equipping Immigrants:

Migration Flows and Capital Movements in Small Open Economies

Abstract

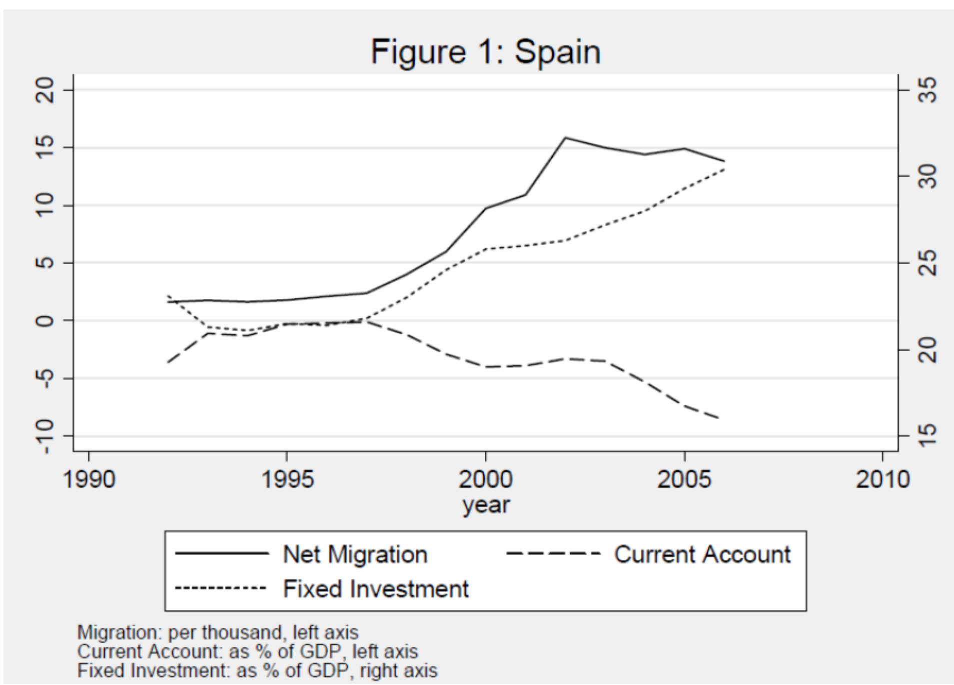
This paper explores the extent to which migration-related capital flows can explain the variation in investment rates and current and capital account imbalances across OECD countries. We begin with a model in which migration is exogenous. Migrants must be equipped with machines, and the resulting demands for capital will generate cross-border flows of capital. Next, we move to an empirical exercise in which we examine the predictions of a simple model in which both capital and labor flows are endogenous. We test this model using data from a panel of OECD countries. Finally, we consider data from a number of recent episodes of plausibly exogenous migration. Taken together, we conclude that migration flows do in fact generate substantial matching capital flows. We then ask how much immigration may have contributed to the increase in the US current account deficit since 1960. Between 1960 and 2000, the US current account declined by about 4% of annual GDP. We calculate that the increase in migration may have accounted for about one-fourth of this decline.

1 Introduction

Economists who study how production inputs flow across borders tend to be divided into two groups: those that study the flows of capital and machinery and those that study human migrations. There are of course good reasons to study capital flows and human migrations separately. The discussion of exchange rate mechanisms and trading regimes does not usually benefit in either clarity or insight if its scope is widened to include the determinants of human migrations. In turn, whether a country has a fixed or freely floating exchange rate is probably less relevant for determining human migrations than are immigration policies and local labor market conditions.

Nevertheless, capital and labor flows are conceptually linked through the production function. Both capital flows and labor migrations represent movements of production inputs, and both capital flows and labor migrations are jointly affected by changing production conditions. In addition, the productivity of capital is at least partially determined by the labor supply in a location; thus migrations can cause capital flows. Conversely, the supply of capital determines the productivity of labor and exogenous increases in capital can raise the incentives to migrate.

In this paper, we argue that the link between migrations and capital flows (and therefore trade balances) is quantitatively important. Neglecting this link, researchers will omit an empirically relevant factor that helps explain observed movements of labor and capital across countries and over time. The recent experience of Spain illustrates this point in a simple way. Figure 1 shows how the share of investment in GDP, the current account deficit and the migration rate in Spain evolved since the early 1990s. Since the mid 1990s, fixed investment and the current account deficit rose at the same time that net migration rates climbed to unprecedented levels. A researcher who ignores the interactions between capital and labor flows will omit a crucial component of the recent Spanish experience.



The Spanish experience suggests that capital flows and migrations may be connected in an important way. It is not clear, however, whether we can generalize from the experience of this particular country to a more general relationship between capital and labor flows.

In this paper, we ask to what extent the link between capital and labor flows is a general property of small open economies. First, we pose the question in the context of a simple overlapping generations model of capital flows and migrations.[1] Our OLG economy is built around a simple, parsimonious set of standard assumptions. For this reason the basic forces at play in the model are extremely transparent. Furthermore, the predictions of the model will likely be similar to those generated by more complex and comprehensive representations of the economy.[2]

In the model economy, we are primarily interested in how exogenous changes in the supply of migrant labor affect the demand for capital in an economy. The model predicts that exogenous increases in the supply of migrants and total factor productivity (TFP) growth will both raise investment and generate capital inflows (implying current account deficits). The model generates predictions not only for the sign, but also for the magnitude of this relation. We find considerable support, both qualitatively and quantitatively for these predictions of the model using OLS regressions of the investment rates and current accounts on the migration and TFP growth rates.

However, in the data, we are concerned that both labor and capital flows respond to variation over time in production conditions, so that labor flows (and hence migration) are endogenous. If they are, then the regressions described above are flawed. To address this problem, we first model what we perceive to be the main source of

[1]Our analysis is closely related to Hatton and Williamson (1996) who have analyzed capital needs in the face of demographic changes in a conceptual framework that has many of the same components as does our model. Hatton and Williamson (1996) found that demographic variation induced by changes in fertility and mortality rates contribute significantly to the observed patterns in international capital flows and investment rates. We instead focus on migration rates primarily because of empirical reasons. In Spain as in other developed countries, the short-run changes in the size of the population induced by changing migration rates are much larger than those induced by variations in fertility rates or mortality. Surges in migration rates can lead population sizes to increase rapidly and therefore lend themselves to empirically investigate the impact of demographic changes on capital needs and consequently the current account balance.

[2]An example of a more complex economy build to reproduce the conditions of the Spanish economy is (Izquierdo, Jimeno, and Rojas 2007). Their model reproduces various features of the Spanish economy but delivers a relationship between the current account balance and migration flows that is very similar to the one generated by our simpler model economy.

endogeneity: the possibility that economic conditions in the receiving country draw in new migrants. We therefore explicitly allow exogenous variations in production conditions to affect both the demand for capital and labor. In this model, both investment and labor are endogenous. We derive expressions that relate the variances and covariances of TFP growth, investment rates, and migration rates to the main parameters of the model.

We proceed to estimate the crucial parameters of the model: (i) the elasticity of the supply of migrant labor, (ii) the variation in TFP growth and (iii) the exogenous variation in net migration rates. We find that net migrations are very inelastic: temporary variations in production conditions do not induce large contemporaneous flows of migrant labor. We also find that the exogenous variation in the supply of migrant labor to OECD countries over time is large. Within countries over time, the standard deviation in the exogenous component of migration is about 0.2% of the resident population, about half the net (legal) migration rate into the US of about 0.4% around the year 2000. Finally, we find that the variation in TFP across time within countries has a standard deviation of about 0.5% annually.

Our results indicate that for most OECD countries, migration rates vary primarily because of changes in exogenous factors, rather than because of variation in local production conditions in the receiving countries.[3] Although this may seem at first

[3] We can not rule out that migration rates are endogenous to the investment equation and are not determined by local economic conditions. Our findings however suggest that most of the variation in migration rates is exogenous and that therefore OLS specifications can approximately recover causal relationships. This finding is corroborated by the results reported in Ortega and Peri (2009). Even though Ortega and Peri argue forcefully and convincingly that migration is endogenous (in the sense that incomes predict migration flows statistically), their own reported regression results also suggest that the impact of local economic conditions on migration flows is relatively small compared to the overall variation in migration rates and to the variation induced by migration policies.

To make this point, consider the following numerical illustration based on the estimated coefficients and summary statistics reported in their paper. Among destination countries in the year 2000, a standard deviation in annual GDP growth amounts to on average 250 dollars. Using their estimates from col. 2 in table 2, we find that this raises bilateral migration flows by 2.75 percent . Average gross migration rates in the population are typically less than 1 percent of the resident population, and therefore a 2.75% in migration flows raises migration rates by about 2.75 per 10,000 residents. Comparing this to the standard deviations in net migration rates reported in tables 2 and 3 in this paper, we find that a one standard deviation in GDP growth rates will raise migration rates by between 1/5 to 1/10 of a standard deviation. Their results are therefore consistent with both the statement that migration rates are partially determined by local economic conditions and that at the same time, the variation in migration rates generated by local economic conditions is small relative to the overall variation in migration rates.

glance to be counter-intuitive, the point is simply that international migration flows tend to be driven by differences in income levels (and geographic proximity), rather than by fluctuations in growth rates.[4] Investment rates, by contrast, are determined above all by variation in production conditions. The exogenous variation in migration rates contributes only 10-20% to the overall time-variation in investment rates. However, we also find that exogenous changes in migration rates can have a large impact on investment rates. A 0.1% increase in net migration rates does generate an increase in investment as a fraction of GDP of about 0.25%. If this additional capital is not financed through local savings, then the current account will decline by a similar amount.

As additional evidence, we examine the experience of Israel since the fall of the Berlin Wall. During the 1990s, following the collapse of the Soviet Union, Israel experienced a tremendous inflow of immigrants from the former Soviet Union. The Israeli experience presents an almost ideal experiment for our purposes: a well defined historical event exogenous to the Israeli economy led to a rapid and tremendous increase in the flow of migrants. We show that following this inflow, investment rates in Israel increased substantially and the current account balance declined rapidly. Only after about 2000, when the flow of immigrants from the former USSR abated, did investment rates and current account balances decline to more normal levels. When we compare the magnitude of the changes in investment rates and the amount of this investment financed through international capital flows with the magnitudes predicted by our regression model and by our theoretical model, we find that the decline in the current account is exactly as predicted by the model, but that the observed changes in the investment rate are about twice as large as predicted. Overall,

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In their paper, Ortega and Peri also estimate an instrumental variable specification that relates various destination country variables to migration flows. Their instruments are derived from an estimates of a gravity model of migration developed originally by Grogger and Hanson (2008). The results reported by Ortega and Peri (2009) for investment rates are consistent with the results reported in our paper and with the conclusion that endogeneity in migration rates might in fact not be a major problem for estimating the impact of migration flows on investment in this data. Indeed, the OLS and the IV estimates reported by Ortega and Peri are typically quite close together.

[4]More precisely, the extremely large differences in wages and production conditions between the developing and the developed world are large enough to drive the observed migration flows from the developing to the developed world, even if migration rates are relatively inelastic. In other words, migration is driven overwhelmingly by differences in income levels across countries; next to differences of this magnitude, the fairly minor variation in productivity within rich countries has a second-order effect, at best, on migration rates.

we find that the evidence from Israel, the evidence from the empirical model, and the predictions from the calibrated model are all in substantial agreement.

In a final quantitative exercise, we consider the US experience in the last half century. The evolution of the US current account balance has been widely discussed in the press and in policy circles, both nationally and globally. We ask how much of the observed increase in the current account balance over the last fifty years can plausibly be explained by migration during the same period. For this purpose we treat the observed increase in net migration rates as exogenous. We then simulate the counterfactual current account deficit that would have been observed if net migration rates had remained constant. We find that up to 25% of the increase in the current account deficit can be explained by the increase in migration rates.

Overall, we believe that this study further strengthens the case to consider demographic factors in the study of investment needs and current account balances.

2 Migrations and Capital Flows in Small Open Economies

In this section, we develop an analytic framework to guide the empirical work. To begin, we model a world in which migrations are exogenous and capital flows freely across borders. (We will later relax the assumption of exogeneity.) A calibrated version of the model produces a first quantitative estimate of the causal effect of exogenous migrations on investment rates, on capital flows, and consequently on current accounts. The model also provides an econometric specification on which we will base our empirical work, presented in later sections. This specification links TFP growth, migration rates, and population growth rates (net of migration) to investment rates as well as current accounts.

Having analyzed the model with exogenous migration rates, we then endogenize migration flows and consider what the model predicts for the second moments of TFP growth, migrations, and investment if migration flows respond to variation in economic conditions. In this formulation, there is exogenous variation in TFP. Migration rates vary both endogenously in response to this exogenous variation in TFP and because we allow for exogenous shifters in the supply of migrants. Based on this model of a small open economy with endogenous migration and investment, we derive the variance-covariance matrix of investment rates, TFP and migration rates as a matrix-function of the fundamental parameters of the model.

2.1 Population Dynamics

We consider a straightforward overlapping generations model in which individuals live for three periods of equal length: youth, middle age, and old age. Each cohort is indexed by its birth year, and in period t the cohorts born in t, $t-1$, and $t-2$ are alive simultaneously. As a notational convention, we will use the date subscripts to refer to the birth-cohort; the subscript j will index the country; and we will use superscripts to refer to the age of an individual. Variables for a child are superscripted with 0; the middle aged carry a superscript of 1, and the elderly have a superscript of 2. Death occurs with certainty at the end of old age. For example, $n^0_{t,j}$ represents the size of the cohort t in country j during youth. As this cohort ages, $n^1_{t,j}$ represents the size of this cohort during middle age and $n^2_{t,j}$ during old age.

In tracking the population dynamics of this economy, we allow for both fertility and migration. Between youth and middle-age, an additional $m_{t,j} > -1$ migrants arrive for each individual of cohort t already in the country. Thus, $n^1_{t,j} = n^0_{t,j}(1 + m_{t,j})$.[5] Let the fertility rate be $f > 0$, such that each individual has $1 + f$ children. We assume here that migrants are of working age when they arrive, and that they migrate before reproducing. For simplicity, we also assume that once they arrive in the destination country they adopt the same fertility as the resident population.[6] The growth rate of the middle age population is therefore:

$$\frac{n^1_{t+1,j}}{n^1_{t,j}} = (1 + f_{j,.t})(1 + m_{j,t+1}) \approx 1 + f_{j,t} + m_{j,t+1} > 0 \tag{1}$$

[5]For simplicity, we assume that there is no mortality until the end of each individual's natural lifespan.

[6]Considerable empirical evidence suggests that migrants often display fertility behavior that is partway between the prevalent patterns in their countries of origin and their countries of destination. For simplicity, we abstract from this pattern.

2.2 The Life-Cycle of Income, Consumption and Savings

Individuals make economically relevant decisions about labor supply, consumption and savings during their middle age. At t, the middle aged (i.e. cohort $t-1$) supply one unit of labor inelastically to the labor market and earn $w_{t,j}$. The old do not work. The middle aged allocate their income between own consumption, consumption for their children, and savings for old age. They provide $c^0_{t+1,j}$ units of consumption for each of their children, consume $c^1_{t,j}$ themselves, and save to provide $c^2_{t,j}$ units of consumption for old age.

Preferences over consumption in different generations are given by:

$$U\left(c^0_{t,j}, c^1_{t+1,j}, c^2_{t,j}\right) = \ln c^1_{t,j} + \rho\left(f_{t,j}\right) \ln c^0_{t+1,j} + \beta \ln c^2_{t,j} \tag{2}$$

Individuals are altruistic towards their children and therefore preferences are written over both own consumption in middle and old age and over the consumption of children. The altruistic weight function $\rho(f)$ on children's' consumption is positive and increasing. In addition, $\rho(0) = 0$.

Individuals can borrow against their own income but not against their children's incomes.

$$\left(1 + f_{t,j}\right) c^0_{t+1,j} + c^1_{t,j} + \frac{1}{1+r_t} c^2_{t,j} = w_{t,j} \tag{3}$$

All economies are small in the sense that they face elastic capital supply functions at the world interest r_t.[7]

We solve the first-order conditions together with the budget constraint to get consumption levels across generations:

$$\begin{aligned} c^0_{t+1,j} &= w_{t,j} \tfrac{\rho(f_{t,j})}{1+f_{t,j}} \tfrac{1}{1+\beta+\rho(f_{t,j})} \\ c^1_{t,j} &= w_{t,j} \tfrac{1}{1+\beta+\rho(f_{t,j})} \\ c^2_{t,j} &= w_{t,j} \tfrac{(1+r)\beta}{1+\beta+\rho(f_{t,j})} \end{aligned} \tag{4}$$

[7] We do not have a source of aggregate (world-wide) fluctuations and will therefore treat the interest rate as a constant for the remainder of the paper.

2.3 Production

The production technology is Cobb-Douglas:

$$Y_{t,j} = A_{t,j} K_{t,j}^{\alpha} n_{t,j}^{1-\alpha} \tag{5}$$

Capital depreciates at rate δ and the law of motion of capital is therefore:

$$K_{t+1,j} = (1-\delta) K_{t,j} + I_{t,j} \tag{6}$$

Countries differ in five characteristics: the population size $n_{t,j}$, the technology parameters $A_{t,j}$ and $A_{t+1,j}$, and the parameters $m_{t+1,j}$ and $f_{t,j}$ which describe population growth due to migration and fertility, respectively. Let the distribution of countries with respect to these parameters be $G(n, A, A', m, f)$. The support of this distribution is $R^{+} \times R^{+} \times R^{+} \times\ (-1, \infty)\ \times (-1, \infty)$.

Markets clear, and labor and capital are paid their marginal products. Standard algebra allows us to solve for the ratio of capital to GDP, which will play an important role in determining the strength of the relation between investment and migration rates:

$$\frac{k_{t,j}}{y_{t,j}} = \frac{\alpha}{r} \tag{7}$$

Small letters k and y denote per-worker quantities.

2.4 National Accounting

We can now aggregate the individual level variables on savings and investments to obtain aggregate net savings (S-I). Standard accounting identities relate the aggregate net savings rate to the balance of payment (BoP) consisting of net factor payments to foreigners (B) and net exports NX :

$$S - I = B + NX \tag{8}$$

Gross investment equals the change in capital stock plus the replacement of depreciated capital. Equation 9 expresses investment as a ratio of GDP:[8]

$$
\begin{aligned}
&\frac{I_{t,j}}{n^1_{t,j}y_{t,j}} = \frac{K_{t+1,j}-(1-\delta)K_{t,j}}{n^1_{t,j}y_{t,j}} \\
&= \frac{k_{t+1,j}}{k_{t,j}}\frac{k_{t,j}}{y_{t,j}}\frac{n^1_{t+1,j}}{n^1_{t,j}} - (1-\delta)\frac{k_{t,j}}{y_{t,j}} \\
&= \frac{\alpha}{r}\left(\frac{k_{t+1,j}}{k_{t,j}}\frac{n^1_{t+1,j}}{n^1_{t,j}} - (1-\delta)\right) = \frac{\alpha}{r}\left(\left(\frac{A_{t+1,j}}{A_{t,j}}\right)^{\frac{1}{1-\alpha}}(1+f_{t,j}+m_{t+1,j}) - (1-\delta)\right)
\end{aligned} \tag{9}
$$

This equation relating the investment rate to growth in TFP and in the population is the central equation of our analysis.

In addition to investment (Equation 9), we also need to determine domestic savings to derive the current account balance. Total savings equals labor income today, net of the consumption of children and the middle aged today. Consumption of the old is financed out of capital income:

$$
\begin{aligned}
&\frac{S_{t,j}}{n^1_{t,j}y_{t,j}} = \frac{w_{t,j}-c^1_{t,j}-(1+f_{t,j})c^0_{t+1,j}}{y_{t,j}} \\
&= \frac{w_{t,j}-w_{t,j}\frac{1}{1+\beta+\rho\left(f_{t,j}\right)}-(1+f_{t,j})w_{t,j}\frac{\rho\left(f_{t,j}\right)}{1+f_{t,j}}\frac{1}{1+\beta+\rho\left(f_{t,j}\right)}}{y_{t,j}} \\
&= (1-\alpha)\frac{\beta}{1+\beta+\rho(f_{t,j})}
\end{aligned} \tag{10}
$$

Combining and simplifying delivers the following expression for excess savings (the capital account) as a ratio of GDP:

$$
\frac{S_{t,j}-I_{t,j}}{n^1_{t,j}y_{t,j}} = \frac{(1-\alpha)\beta}{1+\beta+\rho\left(f_{t,j}\right)} - \frac{\alpha}{r}\left(\left(\frac{A_{t+1,j}}{A_{t,j}}\right)^{\frac{1}{1-\alpha}}(1+f_{t,j}+m_{t+1,j}) - (1-\delta)\right) \tag{11}
$$

Our main empirical specifications are (almost) directly based on equations 9 and11, which link investment and current account balances to TFP and population growth.

Finally, for completeness, note that we already imposed the condition that con-

[8] Using $\frac{k_{t+1,j}}{k_{t,j}} = \left(\frac{A_{t+1,j}}{A_{t,j}}\frac{r_t}{r_{t+1}}\right)^{\frac{1}{1-\alpha}} = \left(\frac{A_{t+1,j}}{A_{t,j}}\right)^{\frac{1}{1-\alpha}}$ where the last equality follows from the assumption that the world interest rate is constant.

sumers' budget constraints must hold and that all of output is paid to the factors of production. Together these ensure that goods markets within the country clear.[9]

The problem simplifies further if we assume that the distribution of country characteristics in the world is constant and that therefore interest rates are constant. This delivers:

$$\frac{S_{t,j}-I_{t,j}}{n_{t,j}^{1}y_{t,j}}=\frac{(1-\alpha)\beta}{1+\beta+\rho(f_{t,j})}-\frac{\alpha}{r}\left(\left(\frac{A_{t+1,j}}{A_{t,j}}\right)^{\frac{1}{1-\alpha}}(1+f_{t,j}+m_{t+1,j})-(1-\delta)\right) \tag{12}$$

Equations 9 and 10 show how investments and savings depend on migration, fertility and TFP growth across countries and time. Equations 11 and 12 then use the expression for savings and investment to determine the relation between our variables of interest and the current account balance. Overall, these equations provide a simple account of how investment needs and consequently the current account balance are related to migration, fertility, and TFP growth.

2.5 Fertility and Migration

Equation 9 is the core equation in our analysis and shows how population growth – whether caused by migration or fertility – is related to investment needs. As is evident from the equation, population growth from either source raises the investment needs of the economy in the same way. Migration and fertility differ, however, in the magnitude of their impact on the current account. In our model, countries with greater fertility have higher investment needs *and* lower savings rates, whereas migration only affects the investment need. Countries with high fertility rates have low savings rates because altruistic parents with many children substitute consumption of children for old age consumption and therefore save less. Thus, while migration and fertility-induced growth in the work force has the same impact on investment rates, fertility induced growth will have a larger negative impact on the current account balance than will

[9] To close the model impose that the world market for investment goods clears by integrating over the distribution of country characteristics $G_t(n, A_t, A_{t+1}, m, f)$:
$\int_{n_{t,j}^{1}y_{t,j}\left(\frac{(1-\alpha)\beta}{1+\beta+\rho(f_{t,j})}-\frac{\alpha}{r}\left(\left(\frac{A_{t+1,j}}{A_{t,j}}\right)^{\frac{1}{1-\alpha}}(1+f_{t,j}+m_{t+1,j})-(1-\delta)\right)\right)dG_t=0}$

migration-induced changes.[10]

2.6 The Multiplier Relating Migrations and Capital Demand

This OLG economy provides a first indication on the quantitative relevance of migrations in determining capital flows. The investment equation 9 shows that variation in migration rates will be translated into variations of investment via the multiplier $\frac{\alpha}{r}\frac{k_{t+1,j}}{k_{t,j}}$. In a stationary world, with constant interest rates and productivity this multiplier reduces to $\frac{\alpha}{r}$, which, in steady state, equals the ratio of capital to output $\frac{k}{y}$.

A typical value for the capital-output ratio found in the macroeconomic literature (e.g. Manuelli and Seshadri, 2007) is 2.5, implying that a one percentage point exogenous increase in migration rates will cause an increase in total investment needs of about 2.5 percentage points of GDP.[11]

This provides a first indication of how much historically observed variations in migration rates can affect investment rates and current account balances. Historically, migration rates typically vary by less than 1 percentage point over medium length horizons. Only during exceptional periods (such as the last decade in Spain) have net migration rates exceeded 1% per annum. In the US during the second half of the 20^{th} century, net migration rates have fluctuated between 0.1 and 0.5 percentage points. Fluctuations in this range can however account for a substantial fraction of the variation in investment needs and current account balances observed over time.

2.7 Endogenous Migrations

So far we have only allowed for exogenous variation in migration rates. However, the empirical evidence available to us stems from observational data on a panel of

[10] In a similar conceptual framework, Hatton and Williamson (1996) analyze how demographic changes in the size of the working age population affect capital flows. Our paper extends this analysis and focuses on migrations. In OECD countries, birth rates typically change slowly over time, and variations in birth rates affect the size of the labor force only with a delay of several decades. By contrast, migration rates often vary substantially within reasonably short periods of time and have a more immediate impact on the size of the work force. Relative to birth rates, migration episodes arguably offer better opportunities for empirical identification of the relationship between investment rates and the growth of the workforce in developed countries.

[11] With a capital share on the production function of 0.35, this corresponds to a gross interest rate (including compensation for depreciation) of about 0.14.

OECD countries. These countries experience changes in migrations rates over time, some of which are exogenous. These countries also experience changes in production conditions over time and these changes in production conditions will induce endogenous flows of migrants. To allow for this possibility, we now allow migration rates to respond to changes in local wages induced by variation in local production conditions.

To keep the analysis tractable, we postulate that the supply of migrant labor is of constant elasticity:

$$N_{t,j} = \Psi^N_{t,j} w^{\theta_N}_{t,j} \tag{13}$$

The parameter $\Psi^N_{t,j}$ summarizes exogenous factors that affect the supply of migrant labor to a location j at time t. Such factors can include rules governing immigration, but also economic condition in sending countries.[12]

The supply function 13 and the input demand functions solve for the market clearing quantities of K and N:

$$N_{t,j} = \Psi^N_{t,j} \Phi_N A^{\frac{\theta_N}{1-\alpha}}_{t,j} \text{ with } \Phi_N = \left((1-\alpha) \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} \right)^{\theta_N} \tag{14}$$

$$K_{t,j} = \Psi^N_{t,j} \Phi_K A^{\frac{1+\theta_N}{1-\alpha}}_{t,j} \text{ with } \Phi_K = \Phi_N \left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha}} \tag{15}$$

These and equation 9 deliver the (gross) investment rate and the growth of the labor force as:

$$\tilde{i}_{t,j} = i_{t,j} + \frac{\alpha}{r}(1-\delta) = \frac{\alpha}{r} \left(\frac{A_{t+1,j}}{A_{t,j}}\right)^{\frac{1+\theta_N}{1-\alpha}} \frac{\Psi^N_{t+1,j}}{\Psi^N_{t,j}} \tag{16}$$

$$\tilde{m}_{t,j} = 1 + m_{t,j} = \left(\frac{A_{t+1,j}}{A_{t,j}}\right)^{\frac{\theta_N}{1-\alpha}} \frac{\Psi^N_{t+1,j}}{\Psi^N_{t,j}} \tag{17}$$

Denoting $\frac{A_{t+1,j}}{A_{t,j}} = 1 + a_{t,j}$, taking logs on eqs 16 and 17, and using the standard log approximation, we get:

[12] See Ortega and Peri (2009).

$$\log(\tilde{m}_{t,j}) \approx \frac{\theta_N}{1-\alpha} a_{t,j} + \log\left(\frac{\Psi^N_{j,t+1}}{\Psi^N_{t,j}}\right) \tag{18}$$

$$\log\left(\tilde{i}_{t,j}\right) \approx \left(\frac{1+\theta_N}{1-\alpha}\right) a_{t,j} + \log\left(\frac{\Psi^N_{j,t+1}}{\Psi^N_{t,j}}\right) \tag{19}$$

Equations 18 and 19 show how investment and migration rates[13] depend on changes in local production conditions and supply of migrants. We can think of the first term in Equation 18 as the "pull" factor determining migration rates and the second as the "push factor"[14].

The above relations specify the relation between investment rates, migrations and TFP growth as functions of log-growth in TFP as well as the push-factors driving the supply of migrant labor. These random variables, which each capture a different source of variation in the data are a_t and $\psi_t = \log\left(\frac{\Psi^N_{j,t+1}}{\Psi^N_{t,j}}\right)$. The variable a_t will be observed, but the variable ψ_t is latent.

If we assume that $a_t$and ψ_t are uncorrelated, then we arrive at the following second moments for log investment, migration and TFP:

$$V\left(\log\left(\tilde{i}_{t,j}\right)\right) = \left(\frac{1+\theta_N}{1-\alpha}\right)^2 V\left(a_t\right) + V\left(\psi_t\right) \tag{20}$$

$$V\left(\log(\tilde{m}_{t,j})\right) = \left(\frac{\theta_N}{1-\alpha}\right)^2 V\left(a_t\right) + V\left(\psi_t\right) \tag{21}$$

$$V\left(a_t\right) = V\left(a_t\right) \tag{22}$$

[13]For the empirical work, it is important to keep in mind that $\tilde{i}_{t,t}$, is not observed directly. To obtain $\tilde{i}_{t,t}$, one needs to adjust the observable net investment rate $i_{t,j}$ as shown in equation (11): $i_{t,j} + \frac{\alpha}{r}(1-\delta)$. Similarly one needs to make the adjustment in eq. 12 ($\tilde{m}_{t,j} = 1 + m_{t,j}$) to the reported net migration rates $m_{t,j}$.

[14]In our analysis, the push factors remain unspecified. Ortega and Peri (2009) by contrast examine the determinants of migration in a gravity model that allows them to generate instruments for these push factors using economic and social conditions in "sending countries". The data requirements for estimating gravity models include having data on bilateral migration flows, which restricts the sample and the time-period that Ortega and Peri (2009) can consider. Their analysis is based on 14 OECD countries (a subset of our sample over the shorter time-period 1980-2005. Interestingly, their results on investment (they also study employment and productivity) are largely consistent with our results.

$$Cov\left(\log\left(\tilde{i}_{t,j}\right), \log\left(\tilde{m}_{t,j}\right)\right) = \frac{\theta_N\left(1+\theta_N\right)}{\left(1-\alpha\right)^2} V\left(a_t\right) + V\left(\psi_t\right) \tag{23}$$

$$Cov\left(\log\left(\tilde{i}_{t,j}\right), \log\left(a_{t,j}\right)\right) = \frac{1+\theta_N}{1-\alpha} V\left(a_t\right) \tag{24}$$

$$Cov\left(\log\left(\tilde{m}_{t,j}\right), \log\left(a_{t,j}\right)\right) = \frac{\theta_N}{1-\alpha} V\left(a_t\right) \tag{25}$$

We calibrate the parameter α using the observed share of capital in national income to equal 0.35. This leaves us with six moments (eqs. 20-25) to identify three parameters: $\left(V\left(a\right), V\left(\psi\right), \theta_N\right)$.[15] We are over-identified.

In this Section, we have first considered a model with exogenous variation in migration rates and TFP growth and derived a specification of the conditional mean function of investment rates that allows us to estimate how investment rates and current accounts depend on exogenous migration rates and variation in TFP growth. Concern about the endogeneity of migrations lead us to formulate a model with endogenous migration rates that we can estimate using the full set of second moments on migration rates, investment rates, and TFP growth. We will now consider the empirical evidence on both the regression specification for the model with exogenous migrations and on the model with endogenous migrations.

For this purpose, we will discuss in the next Section the available data from a panel of OECD countries covering the period between 1970 and 2004. We will then lay out the empirical evidence in the same manner as we developed the theoretical model, starting with the regression evidence on model with exogenous migrations and then moving to estimate the parameters of the model with endogenous migrations.

Equations 9 and 11 generate predictions for regressions of investment rates on net migration rates and a suitable power transformation of TFP growth. According to eq. 9 and 11, the regression coefficients on both migration rates and the transformation of TFP are estimates of the causal impact of migration on investment rates and are predicted by the model to be equal to $\frac{\alpha}{r}$, which in turn equals the capital-output ratio in steady state. As we will show, the estimates from the regression model both quantitatively and qualitatively conform to the predictions of the model.

[15] In addition, we get a set of additional set of testable restrictions because (V_A, V_Ψ, θ_N) are positive.

Having considered the regression evidence, we examine the matrix of second moments in migration rates, investment and TFP to estimate and test the model allowing for endogenous migration. We find that migration rates are inelastic; international labor flows are not responding in a large manner to production conditions in the receiving countries. We also find that there is significant variation in the exogenous supply of migrants to receiving countries, maybe due to variation in how immigration is regulated in receiving countries or because production conditions in sending countries are varying over time.[16] We also find that variation in TFP growth rates account for the majority of the variation in investment rates and current account flows within countries, over time. Nevertheless, migrations account for a non-negligible component to the variation in investment rates and current accounts.

3 A Panel of OECD Countries

In this Section, we describe the data we use to estimate the parameters and test the restrictions imposed by the model. Our analysis is based on a panel of OECD countries between 1970 and 2004. All data sources are publicly available and widely used in the literature. We exclude from the panel the former communist countries because we only have data for short periods for these countries. We drop South Korea and Mexico, because we lack data on migration rates for these countries. This leaves us with 24 economies over 34 years.

We obtain net migration rates from the OECD statistical fact-books for years 1970 to 2004.[17] For the USA, we use statistical yearbooks[18] to obtain a longer time-series of net migration rates covering the 1955-2004 period. Importantly, these data do not include illegal immigration, which are likely to make up a significant component of US immigration in recent years, as well as some fraction of migration in other OECD countries. We suspect that we are underestimating net immigration rates, rather than overestimating them, for most OECD countries. Native population growth rates are calculated (based on the growth in total population less net immigration) rates and

[16]See Ortega and Peri (2009) and Grogger and Hanson (2008) for studies of the push factors determining migration flows.

[17]The data lacks an observation of net migration rates from Greece for 1972. We interpolate this number as the average of the 1971 and 1973 observations.

[18]Years: 1972,1979,1981,2000,2007.

are likewise based on OECD data. The native population growth rate provides a rough proxy for natural growth of the labor force.

The data on investment rates and current account balances are taken from the Penn World Tables, release 6.1. Our TFP estimates are drawn from the UNIDO World Productivity Database, which is described in Isaksson (2009). This data set reports estimates of Total Factor Productivity levels and growth rates for a large number of countries from 1960 to 2000. It is only consistently available from 1974. The underlying data in this source are drawn from a number of different sources, including the Penn World Tables and various measures of output, investment, labor force inputs, etc. The idea behind the WPD is to provide internationally comparable measures of TFP for many countries.[19]

Appendix Table 1 summarizes the OECD data by country and shows that investment rates, current account balances, population growth rates, net migration rates and TFP growth rates vary widely across countries. A cursory look at the data suggests that the average differences in these variables are not systematically related across countries, and this cursory look is confirmed in our regression analysis. There are clearly large differences in investment rates and current account balances across countries that are not related to migration and population growth rates.

In our empirical work, we control for these differences using year and country fixed effects. We therefore analyze variation within countries over time. Table 1 displays summary statistics for the residuals from regressions of the variables of interest on year and country effects. By construction, the means of these variables are zero and the interest here is on the variation of these variables.

The observed variation in investment rates and current accounts is substantially larger than that in net migration rates and population growth net of migration and of about the same order of magnitude as the variation in TFP growth.

[19]Like any estimates of TFP, the WPD draws on measures of output and inputs from various sources. Based on these measures, the WPD calculates TFP levels and growth rates using a number of different approaches, including several different growth accounting techniques, regression techniques, and both parametric and non-parametric methods of frontier analysis. The database can be accessed at https://www.unido.org/data1/wpd/Index.cfm (last accessed October 10, 2009). The data used here are taken from the WPD using the option of Long Memory Data Envelopment Analysis (LMDEA) , which is a non-parametric estimator of technical efficiency that can generate values for TFP. One of the advantages of LMDEA over regular Data Envelopment Analylsis (DEA) is that LMDEA is constrained not to allow negative growth in technology.

Table 1: Dispersion statistics in residualized variables of interest

Variables	Current Account % of GDP	Investment % of GDP	Pop. Growth (in %)	Net Migration (in %)	ΔTFP (in %)
Standard Deviations	1.59	2.04	0.20	0.16	1.60
Min, Max	-22.42, 14.93	-9.23, 14.18	-2.90, 1.59	-1.67, 3.78	-9.66, 8.97

We are now in a position to start confronting the model developed in Section 2 with empirical evidence.

4 The Empirical Relation between Migration Rates, TFP Growth, Investment, and Current Accounts

We begin the empirical analysis by estimating a slight modification of Equation 9, which, for convenience, we restate here:

$$i_{t,j} = \frac{\alpha}{r}\left((1+a_{t,j})^{\frac{1}{1-\alpha}}(1+f_{t,j}+m_{t+1,j})-(1-\delta)\right) \tag{26}$$

Since$a_{t,j}$ is observed and α is calibrated, we can substitute $1+\tilde{a}_{t,j}$ for $(1+a_{t,j})^{\frac{1}{1-\alpha}}$, where $\tilde{a}_{t,j}$is an adjusted TFP growth rate that can be treated as an observed variable. This adjusted TFP growth rate $\tilde{a}_{t,j}$ will be distributed tightly around 0, because TFP growth itself is clustered around 0.We find that $\tilde{a}_{t,j}$ has a mean of 0.012 with a standard deviation 0.035. The smallest and largest observed values of $\tilde{a}_{t,j}$ are -0.158 and 0.154 respectively.

Rewrite Equation 9 to read:

$$i_{t,j} = \frac{\alpha}{r}\left(\tilde{a}_{t,j}+f_{t,j}+m_{t+1,j}\right)+\tilde{a}_{t,j}\left(f_{t,j}+m_{t+1,j}\right)+\frac{\alpha}{r}\delta \tag{27}$$

Because TFP growth rates, population growth rates, and fertility rates in the data are all in the low percent range, the second term in Equation 27 is two orders of magnitude smaller than the first term. We will therefore employ the following approximation as our empirical specification:[20]

$$i_{t,j} = const + \beta_1 \tilde{a}_{t,j} + \beta_2 f_{t,j} + \beta_3 m_{t+1,j} + \varepsilon_{it} \qquad (28)$$

From Equation 27 we have the prediction that $\beta_1 = \beta_2 = \beta_3 = \frac{\alpha}{r}$. The value of $\frac{\alpha}{r}$depends on the interest rate. This interest rate is a risky return on capital gross of depreciation. If we take historical stock-market returns between 5-7.5% as the cost of capital, set depreciation rates between 5-10% and use a share of capital of 0.35, then $\frac{\alpha}{r}$is predicted to lie between 2 and 3.5. An alternative way to calibrate $\frac{\alpha}{r}$is to set $\frac{\alpha}{r}$ equal to the capital-output ratio, because $\frac{\alpha}{r}\frac{k_{t+1,j}}{k_{t,j}} \approx \frac{\alpha}{r} = \frac{k_{t,j}}{y_{t,j}}$. The macroeconomic literature typically sets the capital-output ratio to about 2.5. Either way, we predict all three coefficients in Equation 28 to be identical and between 2 and 3.5.

Much of the regression evidence, displayed in Table 2, supports these predictions. The table presents results from regressions of investment share in GDP on net migration rates, population growth net of migration, and the adjusted TFP growth rate. All specifications include year and country fixed effects and columns (2), (4), and (5) also include country-specific time-trends.

The results from OLS specifications estimated on annual data (1)-(5) are all roughly consistent with each other. Net migration and natural population growth have sizeable impacts on investment shares with estimates ranging between 1.39 and 3.44 for net migration rates and 1.21 and 3.37 for the natural population growth rate.[21] Our point estimates from the demographic variables are therefore consistent with the plausible range for $\frac{\alpha}{r}$ based on the calibrated macro-economic values. This is a striking result.

The model also predicts that the coefficient on TFP growth should be equal to the coefficients on the demographic variables. Instead, we observe in columns (1)-(5) that the coefficient on adjusted TFP growth is much smaller than the coefficients on the net migration rate or on the natural population growth rate. Even though the estimated TFP-coefficients are of the right sign, they are much smaller than the 2-3.5

[20]It is important to note that the approximation error relegated to the residual in equation (21) contains terms endogenous in equation (20). The ensuing endogeneity bias will be small due to the fact that this approximation error is two orders of magnitude smaller than the main variables in the regression.

[21]In all of these specifications, we can not reject the hypothesis that the coefficient on migration and other population growth are of the same magnitude.

Table 2: Investment, population growth, and TFP growth in OECD countries, 1970-2000

	(1) GDP-weighted	(2) GDP-weighted	(3) GDP-weighted	(4) Raw Data	(5) Restricted data	(6) 5-Year Averages	(7) 5-Year Aver. (restricted)
Net Migration Rates	2.80	2.05	1.40	1.39	3.44	1.98	1.16
	[0.63]***	[0.56]***	[0.62]**	[0.47]***	[0.92]***	[1.78]	[0.25]***
Natural Population Growth Rates	3.37	1.46		1.21	2.02	3.57	1.16
	[0.57]***	[0.64]**		[0.61]**	[0.92]**	[1.38]**	[0.25]***
ΔTFP	0.27	0.23		0.17	0.22	1.02	1.16
	[0.04]***	[0.03]***		[0.03]***	[0.04]***	[0.23]***	[0.25]***
Country-Time trend		Yes		Yes	Yes		
Observations	710	710	821	710	339	137	137
R-squared	0.89	0.94	0.83	0.85	0.92	0.89	0.88

All specifications include year and country fixed effects. Heteroskedasticity robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. Columns 1-3 on data weighted with GDP. Column 4 on the raw data (up to 2005) and column 5 on data excluding countries with less than 1% of GDP as well as excluding the US. Columns 6 and 7 report results using 5 year averages of the independent variables. For these specifications, the years of analysis are limited to 1975, 1980, 1985, 1990, 1995 and 2000 to avoid overlap in the periods of analysis. Column 7 restricts the coefficients on the main independent variables to be identical; this restriction can not be rejected at any conventional level. The F-statistic is 1.70 (df. 2, 106).

range predicted by the model.

We believe that we find much smaller coefficients on the adjusted TFP growth rate because or model unduly restricts the timing of the adjustment in investment. The specifications in columns (1)-(5) are estimated on annual data and thus assume that all adjustments to the capital stock in response to adjusted TFP growth or migration occur almost instantaneously. The model presented in Section 2 does in fact not impose any frictions, and these specifications are therefore appropriate for this model. A more realistic model would however account for adjustment costs and thus for delayed impacts of migration rates or TFP growth on investment.

It exceeds the scope of this paper and the quality of the data to fully model the frictions present in the investment process, but we can empirically investigate the role of adjustment lags. For this purpose, we first regressed investment rates on lags in TFP growth rates as well as on the other independent variables. And, indeed we found[22] that lags in TFP growth rates did affect current investment rates significantly, with the size of the coefficients on lagged TFP growth rates declining steadily for about 5-8 years.

Another approach is to enlarge the definition of a time-period. Column (6) displays results from widening the horizon of the analysis. We averaged the main independent variables over five lagged years and regressed investment shares on these averages (as well as the year and country fixed effects).[23] The coefficients on the averaged net migration and natural population growth rates are of the same magnitude as those reported for annual data in columns (1)-(5). The main difference is in the estimate of the effect of the adjusted TFP growth rate. The coefficient estimate is now significantly larger. The estimates obtained in this manner imply that a 1% increase in TFP will over the course of five years lead to a 1% increase in total investment.

A first glance, it might seem puzzling that the coefficient estimates on the adjusted TFP growth rate are relatively sensitive to the horizon considered, while those on the natural population growth rate and the net migration rate do not change as we expand the time-horizon. The time-series properties of the independent variables

[22]These results are not reported in Table 5, but are available from the authors upon request.

[23]In order to avoid overlapping 5 year periods to artificially inflate the standard errors, we restricted the analysis to non-overlapping 5 year periods, estimating the specification in the years 1975, 1980, 1985, 1990, 1995 and 2000.

account for this pattern. Net migration rates and natural population growth are relatively persistent variables, with auto-correlations of 0.74 and 0.87 respectively. By contrast, the auto-correlation between growth in adjusted TFP growth is only 0.23 implying that across more than two periods, TFP growth is essentially uncorrelated. Thus, annual net migration rates and annual population growth rates capture a lot of the information on net migration rates and population growth rates over the last five years, while annual TFP growth rates do not. For this reason, the coefficient estimates on averaged TFP growth are much more sensitive to lengthening the horizon of analysis, than are the estimates on the net migration rates or the population growth rates.

In column (7), we impose the restriction implied by the model that the coefficients on (TFP) growth, net migration and population growth rates are identical. We fail to reject this restriction at any conventional level; the F-statistic (df: 2, 106) is 1.70 with a p-value of 0.1868. The restricted coefficient estimate is 1.16, below the predicted range of 2-3.5, but not dramatically so.

Overall, we believe that the results from the investment equation are roughly consistent with the basic model, qualitatively and quantitatively. The result that the coefficient estimates on net migration are not just of the right sign, but indeed of exactly the magnitude predicted by standard calibration exercises is, to our mind, a stunning finding.

Table 3 repeats the analysis of Table 2 using the current account balance instead of investment rates. The structure of the table is the same as that of Table 2. Again, we find that the sign and size of the estimated coefficients on net migration rates and natural population growth are consistent with the predicted coefficients from the model. The estimates in Table 3 from the demographic variables are consistent with the model: an increase in the work-force increases the demand for capital by an amount equal to the per-capita amount of capital employed in the economy and this demand for capital is not met locally, but rather through importing capital from abroad.[24]

Again, we find much smaller impacts of the adjusted TFP growth – indeed they

[24]The model implied that the impact of population growth on the current account should exceed the impact of migration on the current account. The point estimates in table 7 do not support this hypothesis, but the standard errors in these estimates are too large to rule out that the coefficient on natural population growth is in fact as larger or larger than the coefficient on migration rates.

are even smaller than those reported in Table 2. We do however not find that the size of the TFP-estimates increases if we extend the time-horizon of the analysis. At this point, we can only speculate why TFP growth do not affect the current account balance significantly, even at the 5 year horizon. Current account balances are, by construction, the difference between domestic savings and investments. Variation in TFP growth is likely to affect savings at the same time as investments, because TFP growth affects permanent income. Models with life-cycle consumption decisions might very well generate off-setting responses in savings as TFP growth varies because individuals spread the consumption response over their entire life-cycle. Our model does allow for a consumption-savings decision, but this consumption decision only captures intergenerational transfers of consumption. The model is simply not rich enough to consider the impact of TFP growth on consumption patterns over the life-cycle. Nevertheless, we would expect that any TFP growth should lead to increased investment to equalize the marginal products of capital in the world market. This prediction of the model is – because consumption and production decisions are separated – independent of the particular formulation of the savings decision and the empirical findings in Table 2, columns (6) and (7), and to a lesser extent columns (1)-(5) indeed support this prediction of the model.

Empirically our results are consistent with the notion that at least some of the increased demand for capital associated with fluctuations in migration and natural population growth rates are met by importing capital from abroad. Migration rates and natural population growth rates are consistently negatively correlated with the current account balances. This relationship is however not as robust as the relation documented in Table 2. This should not be surprising, since the variation in investment rates will only translate into equivalent variation in the current account balance if we assume that economies are sufficiently open that all capital needs are met by importing capital, rather than through domestic savings.

Having examined the conditional mean functions, we now turn to analyze matrix of the second moments and use these to estimate the parameters of the model with endogenous migrations. The parameters of this model that need to be estimated are the elasticity of migrations to local economic conditions, the variance of TFP growth and the variance of net migration rates. Equations 20-25 show how these parameters are related to the observed covariances in (log)-investment rates, migration rates, and

Table 3: Current Accounts, Population Growth, and TFP Growth in OECD Countries, 1970-2000

	(1) GDP-weighted	(2) GDP-weighted	(3) GDP-weighted	(4) Raw Data	(5) Restricted data	(6) 5-Year Averages	(7) 5-Year Averages (restricted)
Net Migration Rates	-2.23	-1.52	-0.39	-1.14	-2.72	-4.3	-0.22
	[0.39]***	[0.46]***	[0.39]	[0.47]**	[0.65]***	[1.56]***	[0.18]
Natural Population Growth Rates	-1.99	-0.92		0.01	-2.32	-2.99	-0.22
	[0.38]***	[0.55]*		[0.56]	[0.66]***	[0.95]***	[0.18]
ΔTFP	-0.08	-0.07		0.03	-0.08	-0.01	-0.22
	[0.03]***	[0.03]**		[0.03]	[0.03]**	[0.16]	[0.18]
Country-Time trend		Yes		Yes	Yes		
Observations	710	710	821	710	339	137	137
R-squared	0.65	0.74	0.58	0.78	0.79	0.65	0.60

All specifications include year and country fixed effects. Heteroskedasticity robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. Columns 1-3 on data weighted with GDP. Column 4 on the raw data (up to 2005) and column 5 on data excluding countries with less than 1% of GDP as well as excluding the US. Columns 6 and 7 report results using 5 year averages of the independent variables. For these specifications, the years of analysis are limited to 1975, 1980, 1985, 1990, 1995 and 2000 to avoid overlap in the periods of analysis. Column 7 restricts the coefficients on the main independent variables to be identical; this restriction is rejected at the 0.01 percent level with an F-statistic of 7.71 (df. 2, 106).

Table 4: Standard deviations and correlations of log(Gross Investment rates), log(1+Net Migration rates), and log(TFP Growth), five-year averages.

	Investment Rates	Net Migration Rates	Total Factor Productivity
Investment rates	0.0081		
Net migration rate	0.087	0.0010	
Total Factor Productivity Growth	0.455	0.119	0.0066

TFP growth rates. Using the 5-year averaged time-series, we show the correlation matrix in table 7. On the diagonal we display the standard deviations of log investment, migration, and TFP growth rates and on the off-diagonal we show the correlations between these variables.

Table 5 reports the parameters obtained by fitting the moments in Table 4 using minimum distance and Equations 20-25. Row 1 shows the unrestricted point estimates for the 3 parameters of interest. The point estimate of θ_N is essentially zero. There is no evidence in the data that temporary TFP growth attracts large labor migration. Instead, the data is probably best summarized by observing as saying that migration rates are quite inelastic with respect to variation in TFP. The upper-boundary of a 95%-CI around the point estimate for θ_N is 0.08, suggesting that a 10% increase in wages only raises labor supply (through migration) by about 1%.[25]

The model only allows for two sources of variation in migration, the endogenous response to wage growth and the exogenous variation in the supply of migrant. We find little evidence for the former and therefore the relatively sizeable variation in migration rates documented in Table 4 needs to be generated by exogenous variation in the supply of migrant labor. Indeed, we find variation in the exogenous supply of labor that is larger than what is needed to fit the observed variance in migration rates. The parameter estimates documented below generate a predicted standard deviation of migration rates of about 0.2% of the total population, twice the observed standard

[25] Because the theory predicts that migration rates should be positively related to wages, we also estimate the model while restricting θ_N to be weakly positive. We report results for this case in row 2.

Table 5: Estimates of Endogenous Migration Model Parameters Using 2^{nd} Order Moments of Migration and Investment Rates

	Wage Elasticity of Migration (θ_N)	Standard Deviation of TFP Growth Std[(A)]	Standard Deviation of Migration Supply Std[(ψ)]
(1) Unrestricted	-0.068	0.0053	0.0022
	(0.073)	(0.0018)	(0.0025)
(2) Restricting $\theta_N \geq 0$	0	0.0050	0.0015
	(.)	(0.0019)	(0.0036)

deviation of 0.1% in net migration rates (within countries over time). We also find a sizeable degree of variation in TFP growth. The standard deviation in TFP growth can of course be directly measured in the data, and our estimates are close, even if not exactly equal to the direct measure. The estimates differ from the standard deviation of TFP growth observed in the data, because the model is over-identified.

Overall, the parameter estimates from the endogenous migration model suggest that most variation in migration rates observed in OECD countries is exogenous, maybe because regulations governing immigration or economic conditions in sending countries vary over time. Prima facie, our finding that net migration rates are inelastic to economic conditions in the receiving countries seems to contradict a large literature (eg. Blanchard and Katz (1992), Bound and Holzer (2001), Card (2001)) that has found migrations to respond to economic conditions. Most of the evidence in this literature is however based on variation in economic conditions across US locales. It is plausible that migrants and within the US will be responsive to variation in economic conditions across local labor markets. There is however no reason to expect the same to be true for international migrations. Most importantly, the persistence of extremely large economic differences between the developed and the developing world with only moderate migration flows make it likely that variation in economic conditions in the receiving countries play only a minor role in the migration flows from the third to the first world. Our findings indeed suggest that variation in net migration rates into developed countries is more likely to be due to factors exogenous to medium term economic fluctuations in the destination countries. Such factors might for instance include push factors of migration and also variation in regulation of migration in the destination countries.

Comparing the importance of variation in migration flows and TFP for investment rates, we find that the variation in TFP growth explains a much bigger share of the variation in investment then does the variation in migration rates. In our data, TFP growth varies substantially over time and this generates much of the variation in investment rates. One way to see this is to use the estimated parameters to decompose the predicted variation in investment rates. If we use the estimates for *Std(A)* and *Std(ψ)* reported in row 1 of Table 5 and impose a share of capital of 0.35 as well as an inelastic supply of labor, then we obtain from equation (14) a predicted variance in annual investment rates of about 1.45% per year. Only about 1/6 of this variance in investment rates can be explained by migration rates, with the remainder due to TFP growth.

In summary, the evidence from the conditional mean functions as well as from the 2^{nd} moments of investment rates, migration rates and TFP growth suggests that migration rates and investment rates and international capital flows are linked. The empirical correlations between investment rates and migration rates, natural population growth and TFP growth quantitatively and qualitatively support the predictions of a simple (and therefore hopefully robust) model. The estimated parameters of the model however also suggest that much of the variation in investment rates occurs in response to variation in TFP growth, rather than migration rates.

We next augment this evidence from the panel of OECD countries with a case study that isolates a migration that is clearly caused not by economic conditions in the destination country but by an historic event exogenous to the development of the receiving country: the migration of Jews from the former USSR to Israel during the 1990s.

5 A Case Study: Israel, 1980-2009[26]

In the early 1990s, Israel experienced a migration event whose size and abruptness is unparalleled among developed economies. As the former Soviet Union disintegrated, formerly restrictive policies towards emigration of Jews were lifted and large numbers chose to leave the country. The obvious destination countries were either the US or Israel, but at the beginning of 1990, the United States closed its borders to migrants from the former USSR. Consequently, Israel became the primary recipient country for a large migration wave. Between 1989 and 1990, the annual net flow of migrants rose from about 0.52% to 4.15% of the resident population. None of the OECD countries that we analyzed in Sections 3 and 4 experienced such a migration event of equal abruptness or magnitude.[27, 28]

The sudden onset and the magnitude of the flow of migrants into Israel is apparent from Figure 2.

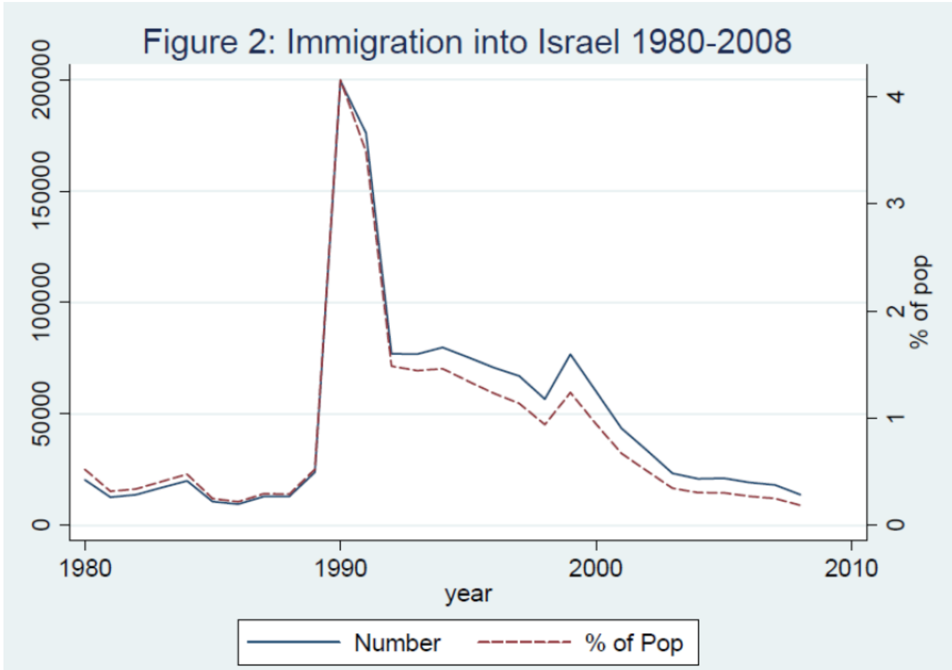
The flow of migrants into Israel peaked in 1990 at about 200,000. In 1991, another 176,000 migrants entered the country. This number declined in 1992 to 77,000, still about 6 times as many than had arrived prior to 1989. Until 2000, the immigrants continued to arrive at a very high rate of between 55,000 and 70,000. The rate of arrival has since declined back to the levels experienced prior to 1990. The overwhelming majority of the new arrivals during the 1990s came from the former Soviet Union and in particular from Russia.

The size of the migration and its exogenous nature as well as the fact that Israel is a small open economy, well integrated into the world economy, make this episode an ideal episode to test the conceptual framework developed above. We expect this arrival of migrant to be followed by a sizeable increase in the investment rate and a

[26]The statistics in this Section were obtained from the Central Bureau of Statistics (CBS) of Israel and the Bank of Israel (BoI). The migration rates available from both sources are not in complete agreement. We present those provided by BoI because the migration rates from BoI are available annually whereas those from the CBS are reported in 5 year bins prior to 1994. The discrepancy in the two series after 1994 is small. The data is available upon request from Fabian Lange (fabian.lange[at]yale.edu).

[27]Israel is not a member of the OECD and did not contribute to the econometric analysis presented above. The evidence in this case study is therefore independent from the evidence previously presented.

[28]The only country that comes close is Portugal between 1974 and 1975, when net migration rose from -0.9% to about 2% and then again to 3.8% in 1976 as an estimated 800,000 Portugues settlers return to Portugal following the loss of the African colonies.



substantial decline in the current account balance.

Figure 4 shows how investment co-moved with the inflow of migrants. Between 1989 and 1992, the migrant flows rose dramatically, the investment rate increased by 7 percentage points, followed by a further increase of 5 percentage points until 1996. Over the remainder of the decade, the investment rate declined gradually. By the year 2000, it fell back to the levels experienced during the 1980s. The investment rate therefore follows the pattern expected given the inflow of migrants.

At the same time, Israel also experienced a substantial decline of the current account.

Between 1989 and 1995, the current account declined by about five and a half percent of GDP and then improved continously during the remainder of the period. The decline in the current account observed in 1990 is not quite as abrupt as the increase in the investment rate shown in Figure 4, but overall the pattern in the current account follows the patterns in the investment rate.

How do the relative magnitudes of the changes in investment, current account and migration rates compare to the changes predicted by the model in Section 2 and the regressions reported in Tables 5 and 6? To answer this question, we will first need to determine how much additional migration Israel received over this time-period

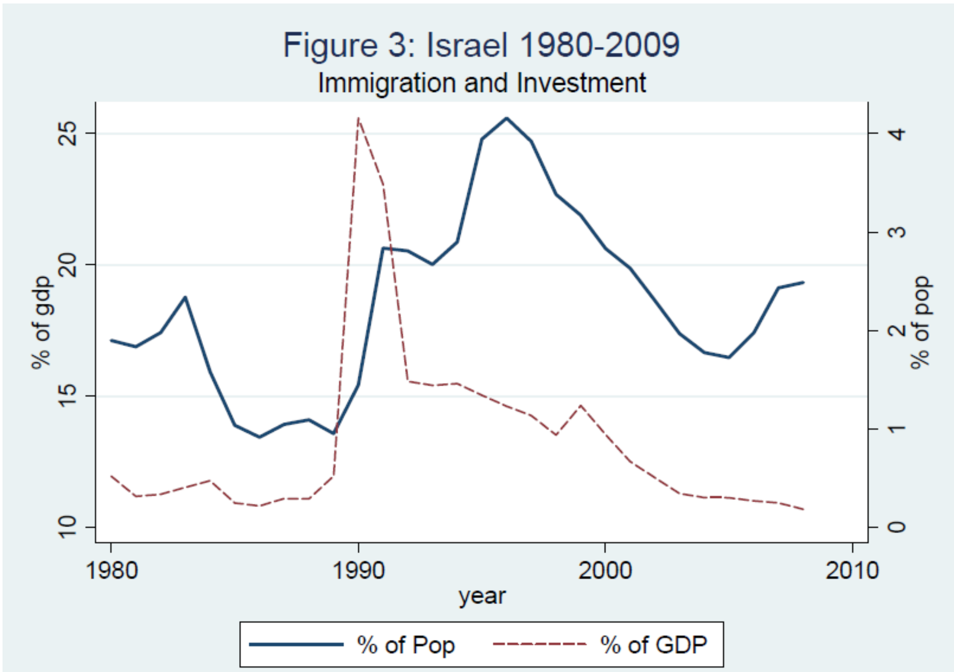


Figure 3: Israel 1980-2009
Immigration and Investment
% of gdp
% of pop
year
10
15
20
25
0
1
2
3
4
1980
1990
2000
2010
% of Pop
% of GDP

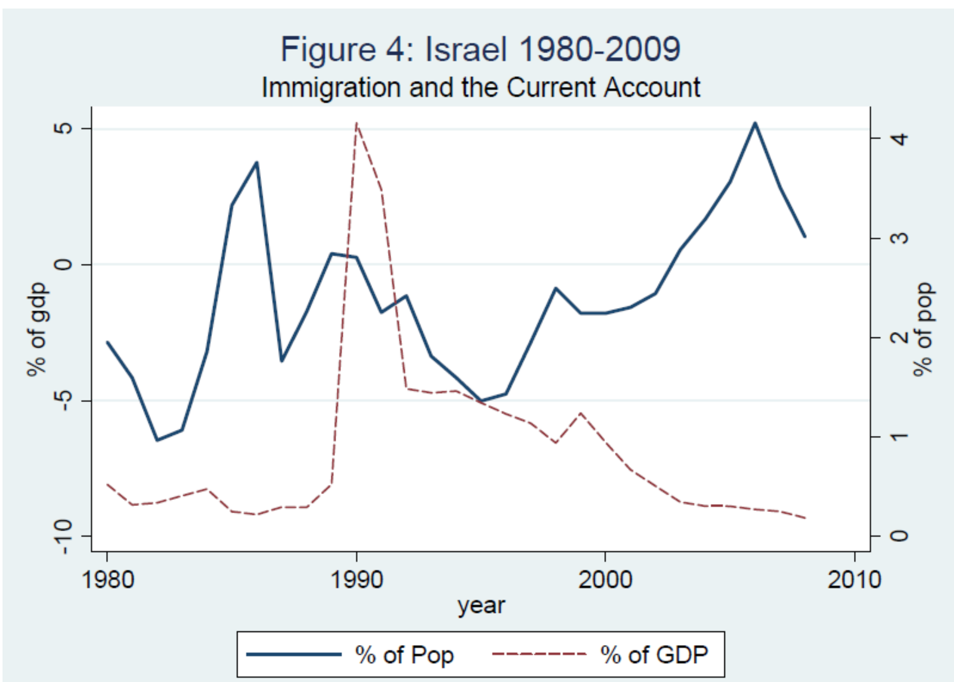


Figure 4: Israel 1980-2009
Immigration and the Current Account
% of gdp
% of pop
year
-10
-5
0
5
0
1
2
3
4
1980
1990
2000
2010
% of Pop
% of GDP

and will need to compare this with the changes in investment and current account observed during the same period.

During the 1980s, Israel received a total of 153,000 immigrants. This compares to a total of 955,000 immigrants received by Israel during the 1990s. The difference of 800,000 will be interpreted by us as the excess migration received by Israel due to the collapse of the Soviet Union. The resident population of Israel in 1989 was 4.8 million, suggesting that the additional migration made up $1/6^{th}$ of the resident population of Israel in 1989.

To gauge the increase in investment experience during the 1990s, we measure investment in each year as a fraction of the 1989 economy adjusted for normal GDP-growth.[29] We difference this level of investment from the 1989 level of investment and obtain thus a rough estimate of the additional investment that took place during the 1990s compared to 1989. We find that during the 1990s, the additional investment amounted to about 1.2 times the growth adjusted GDP of 1989. We follow a similar procedure for the current account balance and find that the accumulated additional current account deficit during this period amounts to about $1/3$ of the growth adjusted GDP of 1989.

We can now compare these numbers with the numbers predicted by the regressions presented in Tables 5 and 6 as well as the numbers predicted by the model. We have argued above that the regression estimates are close to the calibrate predicted effect and we will therefore use for this back-of-the envelope calculation the regression estimates in column 1 of Tables 5 and 6. These estimates suggest that each additional percent in the net migration rate raises the investment rate (lowers the current account) in an economy by about 2.8% (2.2%) of GDP.

Using these estimates, we would have predicted the additional inflow of migrants of about $1/6^{th}$ of the resident population in 1989 to have raised total investment in this period by 47% and to have lowered the current account by approximately 37%. The regression estimates therefore would have predicted an increase in investment of about half the size observed during the 1990s. The predicted increase in the current account deficit is close to the increase actually observed.

Naturally these calculations can only give an approximate indication of the size

[29] We assume that GDP in the absence of immigration would have grown at a rate of 3%, close to the growth rate observed during the 1980s.

of the response in investment and current account to the changes in migration rates. However, we do find that overall, the observed changes in investment rates in Israel are consistent with the predictions of the model and with the regression evidence presented above. And, we find that the magnitudes are roughly comparable, even though our model only predicts the increse in the investment rate to be about half the size of the increase actually observed during the 1990s.[30]

Clearly, evidence from individual historic episodes can always be explained by random, unaccounted, or unrelated events taking place at the same time. Nevertheless, we do believe that the experience of Israel in this period does provide a good test of the theory and we do find that the theory in Section 2 passes this test, strengthening the regression evidence presented in the previous Section.

6 An Empirical Application: The US experience since 1960

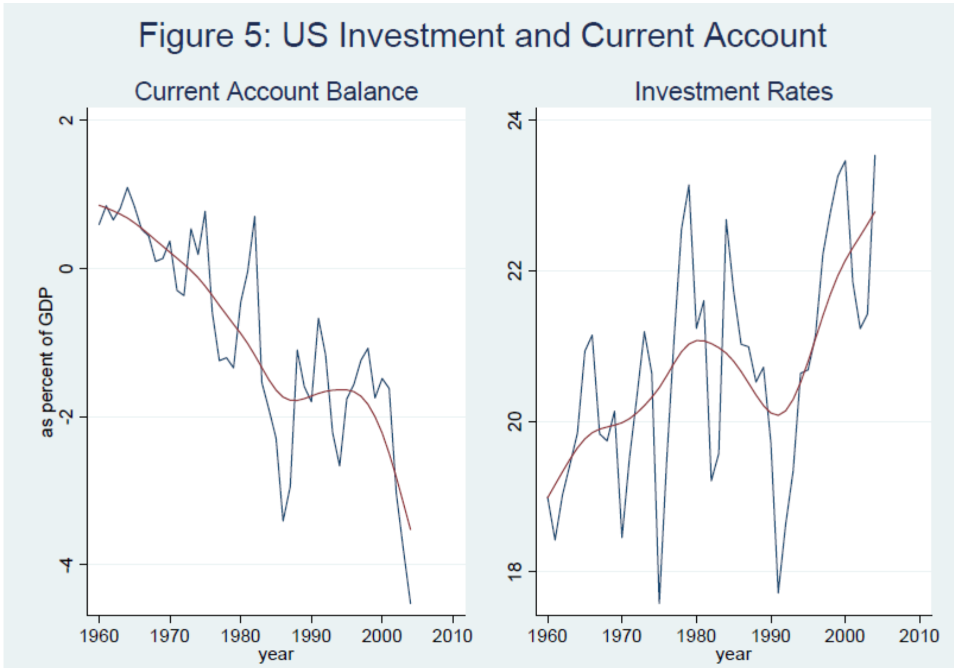
We now apply our findings to a question that has received considerable attention among policy makers, the general public and researchers: the emergence of a large current account deficit in the US over the last 50 years. We ask, whether the increase in immigration into the US over this time period can explain a large share of the observed deterioration of the current account and increase in the investment rate that was observed in the US. We find that immigration has indeed contributed to the decline of the US current account and to the increase in the rate of investment that is evident in US data. By no means, however, does it explain the entire variation observed over this time-period.

To begin, we examine the data on US investment rates and the current account balance from 1960 to 2004. The trends in investment as a share of GDP and of the current account[31] are displayed in the two panels of Figure 6. Figure 6 also displays the trend components for both time-series obtained by filtering the data.[32]

[30]This might be due to underlying trends in the investment rate in Israel at this time, an interpretation bolstered by the observation that investment rates after 2005, when migration rates have fallen back to the levels observed during the 1980s are about 2-4 percentage points large than investment during the late 1980s.

[31]Penn World Tables v.6.2

[32]Hodrick-Prescott using a smoothness parameter of 100.

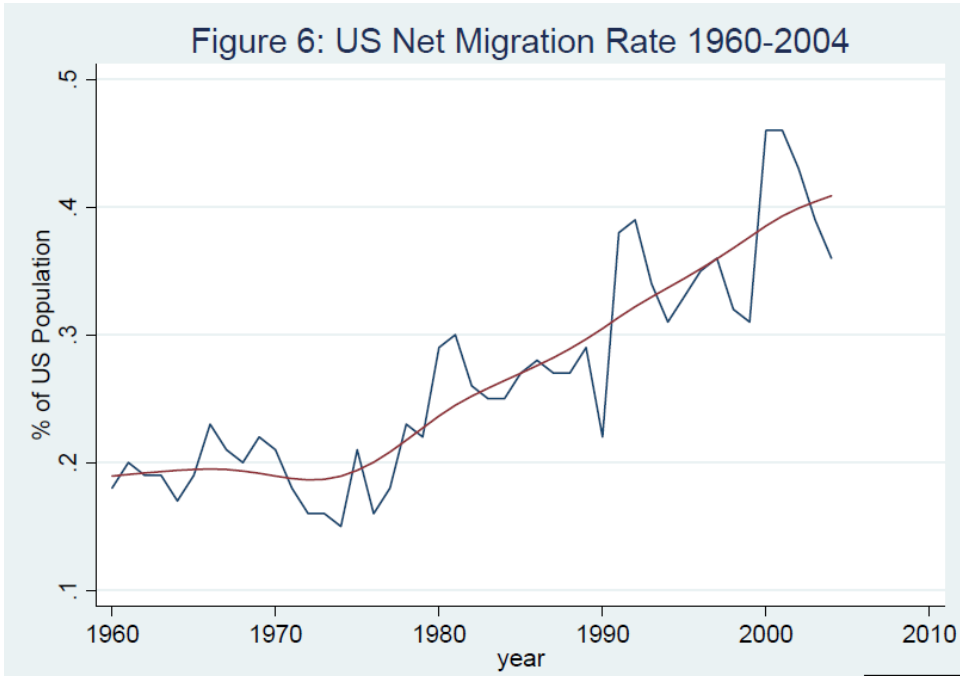


Between 1960 and 2004, the share of investment in US GDP has increased by about 5 percentage points and at the same time the current account deficit has increased by an equivalent amount. These trends were however not uniform as is evident by the substantial variation of the detrended time-series as well as in the trend line. Around 1990, for example, the trend towards an increasing share of investment and higher current account deficits was temporarily interrupted. Overall however, during the period between 1960 and 2004 investment rates and current account deficits were both increasing by substantial amounts.

During the same time-period, the US experienced a sustained increase in net migration rates. As Figure 7 documents, the net migration rate in the US fluctuated around or just below 0.2 percent throughout the 1960s and 1970s, started to increase towards the end of the 1970s, and reached about 0.4 percentage points between 2000-2004.[33]

How much did the increase in the net migration rate contribute to the trends in investment rates and current account balances? To answer this question we interpret the increase in the net migration rate as exogenous and assume that the capital supply

[33]This increase in the net migration rates is likely understated by Figure 3, since the data from the statistical abstracts captures illegal migration only imperfectly.



to the US is elastic at the world interest rate. We then apply the calibrated value of $\frac{\alpha}{r} = 2.5$ to the net migration rate to generate a counterfactual investment and current account series. This series corresponds to the increase in the investment share of GDP and the current account balance that would have pertained if the net migration rate would have remained at its 1960 level.

In Table 6, we summarize the long run increases in the investment rates and current account balance both observed and under the counterfactual assumption that net migration rates had remained at their 1960 values. We have split the data into two time-periods, the 1960-1980 and the 1980-2000 period. The total changes are obtained by summing across these two time-periods.

Shown are the initial values of migration rates, investment share and current account balance for 1960 as well as the 1960-1980 and 1980-2000 values in those measures. Furthermore, we show the contribution of the migration component to these changes. This contribution is positive for the investment rate and negative for the change in the current account balance.

Clearly, the increase in net migration rates does not represent the main driver in the increase in investment rates or current account deficits. Its contribution is however not insignificant. Our calculations suggest that about 15% (0.975 out of

Table 6: U.S. Current Account Balance, Investment Rates, and Migration Rates

	1960	Δ(1960-1980)	Δ(1980-2000)	Total
Net Migration Rate (% of Pop.)	0.18	0.11	0.28	0.39
Investment Share (% of GDP)	18.99	1.52	5.17	6.69
Current Account Balance (% of GDP)	0.59	-1.32	-2.68	-4.00
Migration Contribution	-	0.275	0.7	0.975

6.69%-points) of the increase in the investment rate since 1960 and about 25% (0.975 out of 4%-points) of the increase in the current account deficit can be attributed to the increase in net migration rates over the same time-period.

7 Conclusion

Capital and labor flows are related phenomena and reinforce each other. In this paper, we used a simple conceptual framework to assess the causal impact of labor migrations on investment rates. This allows us to answer the question of how much investment rates would increase if the supply of migrants to an economy increased by 1 percentage point. The simple framework developed in this paper accounts both quantitatively and qualitatively for much of the time-series variation in investment rates, migration rates, TFP growth, and international capital flows and it indeed suggests that migration flows can significantly affect investment rates and international capital flows.

This is illustrated by the US experience over the last 50 years. During the last half-century, capital investments as a share of GDP rose by almost 7 percentage points and the US has become a major importer of both labor and capital. Towards the end of the period considered, the US current account stood at about 3.5% of GDP annually. Our counterfactual analysis assumes that the increase in the net migration rate is exogenous and then asks how much of the increase in investments and capital inputs can be explained by the increase in immigration. We find that 15 - 25% of the overall increase in investment rates and the current account deficit can be explained by the increase in net migration rates.

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Appendix Table 1: Means and Standard Deviations of Variables in OECD Countries

Country	Year Range	Current Account % of GDP	Investment % of GDP	Pop. Growth %[1]	Net Migr. Rate % of Pop	ΔTFP (in %)	Share in OECD GDP
Australia	1970-2003	-3.70	25.78	0.78	0.55	0.73	0.02
		(1.72)	(1.85)	(0.22)	(0.20)	(2.06)	
Austria	1970-2004	-0.74	25.80	0.06	0.22	1.18	0.01
		(1.60)	(2.14)	(0.23)	(0.31)	(1.86)	
Belgium	1970-2000	2.49	23.85	0.13	0.09	1.12	0.01
		(2.83)	(2.24)	(0.09)	(0.10)	(1.93)	
Canada	1970-2004	-0.96	24.95	0.63	0.51	0.37	0.03
		(2.04)	(1.56)	(0.32)	(0.31)	(2.56)	
Denmark	1970-2004	0.17	23.91	0.14	0.13	0.52	0.01
		(3.27)	(2.97)	(0.19)	(0.13)	(2.36)	
Finland	1970-2004	-0.00	29.95	0.35	0.03	1.48	0.01
		(4.34)	(6.42)	(0.17)	(0.18)	(3.27)	
France	1970-2004	0.62	24.82	0.39	0.12	0.82	0.06
		(1.76)	(2.06)	(0.09)	(0.07)	(1.61)	
Germany	1970-2003	-0.73	26.41	-0.22	0.38	Missing	0.09
		(1.70)	(3.54)	(0.32)	(0.44)		
Greece	1970-2003	-4.59	26.55	0.34	0.35	0.82	0.01
		(2.40)	(6.70)	(0.36)	(0.39)	(3.22)	
Iceland	1970-2004	-3.14	26.11	1.10	-0.04	1.37	0.00
		(3.38)	(5.05)	(0.36)	(0.32)	(3.20)	
Ireland	1970-2003	-3.71	23.28	0.87	0.09	2.37	0.00
		(5.21)	(3.83)	(0.27)	(0.56)	(2.91)	
Italy	1970-2003	-0.01	24.85	0.09	0.13	1.28	0.06
		(1.80)	(3.41)	(0.34)	(0.22)	(2.04)	
Japan	1970-2000	1.85	34.13	0.65	-0.01	0.99	0.13
		(1.39)	(2.52)	(0.40)	(0.02)	(2.05)	
Luxembourg	1970-2004	6.71	26.29	0.20	0.68	2.29	0.00
		(9.15)	(2.51)	(0.37)	(0.43)	(3.55)	

Appendix Table 1: Means and Standard Deviations of Variables in OECD Countries

Country	Year Range	Current Account % of GDP	Investment % of GDP	Pop. Growth %[1]	Net Migr. Rate % of Pop	ΔTFP (in %)	Share in OECD GDP
Netherlands	1970-2004	4.18	24.35	0.39	0.25	0.90	0.02
		(1.98)	(3.20)	(0.19)	(0.14)	(1.58)	
New Zealand	1970-2004	-4.69	22.76	1.03	0.01	-0.13	0.00
		(2.72)	(2.60)	(0.49)	(0.58)	(2.70)	
Norway	1970-2004	2.73	30.49	0.34	0.17	1.39	0.01
		(7.00)	(6.09)	(0.15)	(0.10)	(1.79)	
Portugal	1970-2004	-10.21	23.09	0.42	0.13	1.45	0.01
		(3.98)	(3.16)	(0.85)	(0.90)	(3.11)	
Spain	1970-2003	-1.69	25.17	0.49	0.20	0.97	0.03
		(1.81)	(2.37)	(0.41)	(0.41)	(2.77)	
Sweden	1970-2004	1.65	22.38	0.13	0.21	0.69	0.01
		(2.95)	(2.64)	(0.16)	(0.17)	(2.15)	
Switzerland	1970-2004	7.67	29.95	0.26	0.22	-0.02	0.01
		(3.21)	(2.95)	(0.39)	(0.40)	(2.78)	
Turkey	1973-2004	-2.47	15.75	1.84	0.15	0.26	0.01
		(2.10)	(4.42)	(0.44)	(0.15)	(3.46)	
UK	1970-2002	-0.91	19.10	0.18	0.06	0.92	0.06
		(1.71)	(1.44)	(0.09)	(0.11)	(2.07)	
USA	1970-2003	-1.54	20.85	0.72	0.32	0.64	0.36
		(1.26)	(1.59)	(0.07)	(0.12)	(2.21)	

[1]Population growth rates are measured net of the migration rate.