Fertility Changes and Replacement Migration*

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Abstract

We study OECD countries that differ in immigration policies but share a high level of human capital. We find significant negative statistical relationship between 16 years lagged fertility and the rate of immigration in a panel of 23 countries, which indicates that immigration compensates for low fertility in the labor market.

Keywords: Fertility, replacement migration.

JEL Classification Codes: J13, J61

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1. Introduction

There is an ongoing global shift in the demographic age structures that has implications for innovation, saving, investment and growth (see e.g. Aksoy, Basso, Smith, and Grasl (2019)). This evolution is driven by significant declines in total fertility and mortality rates in almost every country leading to aging populations (see e.g. de Silva and Tenreyro (2020) and references therein). We explore to what extent immigration mitigates the effects of declining fertility in OECD countries, which differ in their migration policies but share a high level of human capital by world standards.[1]

2. A Simple Model

Enter the Solow growth model. Production is given by a Cobb-Douglas production function $Y = K^{\alpha}(AL)^{1-\alpha}$where Y is output, K capital, L labor and A productivity. We let n be the rate of local population growth and m the ratio of (net) immigrants to the population. Immigration is a function of the difference between the present discounted value of future wages at home and abroad B and the private cost of immigrating $\Psi(m)$, which is assumed to be increasing in the rate of immigration $\Psi'(m) > 0, \Psi''(m) < 0$. The level of immigration is then determined by the equality of the marginal private benefit and the marginal private cost of immigrating

$$B(t) = \Psi(m(t)), \tag{1}$$

so that the number of immigrants goes up until the marginal cost of moving to the destination country is equal to the marginal benefit

$$m(t) = \Psi^{-1}(B(t)) = \Phi(B(t)), \Phi'(\cdot) > 0, \tag{2}$$

where Φ is the inverse function of Ψ. In addition, we assume that there is a direct effect of fertility on immigration that goes through labor shortages in the transition to a new steady state.

Profit maximization with respect to labour in a competitive labour market gives wages as the difference between output and rent paid to the owners of physical capital: $w(t) = (1-\alpha)A(t)(k^*)^{\alpha}$,where k is the stock of capital per augmented labor unit AL, δ is the rate of

[1]For a detailed survey on immigration policies, see e.g. Clemens (2011). For an excellent survey on immigration implications on human capital and development in sending countries see Docquier and Rapoport (2012)).

depreciation and the rent or the real rate of interest is: $r = \alpha(k^*)^{\alpha-1}$. We assume that only a part of the capital stock c can be used as collateral for foreign borrowing, $D = cK$ and capital is therefore not perfectly mobile[2]. Investment can be funded through both domestic saving and borrowing from abroad while a part of income has to be diverted to pay interest on foreign debt. At the steady state there is continuous borrowing from abroad so that the stock of debt to augmented labor units $d = D/AL$ remains constant and there is further borrowing when the capital stock per augmented labor unit k is growing. The dynamics of the capital stock k are the following:

$$(1-c)\dot{k}(t) = s\left((k(t))^{\alpha} - (r_f + p)\, ck(t)\right) - (\delta + n + m(t) + g)\, k(t) + ck(t)\,(n + m(t) + g) \quad (3)$$

where r_f is the foreign rate of interest, p the risk premium and g is the rate of productivity growth. Solving for $\dot{k}$ gives;

$$\dot{k}(t) = \frac{s(k(t))^{\alpha}}{1-c} - k(t)\left(\frac{sc\,(r_f + p) + \delta}{1-c} + (n + m(t) + g)\right). \quad (4)$$

This is a Bernoulli equation with the following steady-state solution

$$k^* = \left(\frac{s}{sc\,(r_f + p) + \delta + (n + m^* + g)\,(1-c)}\right)^{\dfrac{1}{1-\alpha}} \quad (5)$$

where $'*'$indicates steady-state values.There is a corresponding equation for the foreign capital. The steady-state rate of immigration is given by the following implicit function in m;

$$m = \Phi\left(B\left(t\right)\right) + \Gamma\left(k\left(t\right) - k\left(t-1\right)\right) = \Phi\left(\left(1-\alpha\right)\left[\frac{A\left(t\right)}{r-g}k^{*^{\alpha}} - \frac{A_f\left(t\right)}{r-g_f}(k_f^*)^{\alpha}\right]\right) + \Gamma\left(k\left(t\right) - k\left(t-1\right)\right),$$

where the letter f to indicates the rest of the world and the function Γ (with $\Gamma'(\cdot) > 0$ and $\Gamma(0) = 0$) captures the direct effect of a rising stock of capital per augmented labor unit – $k(t) - k(t-1) > 0$ – on the demand for immigrants.The rate of immigration is a function of the local population growth rate n in addition to the saving rate, the interest rate and the extent to which the country can borrow in international markets in comparison to other countries. In addition, there is the direct effect of a fall in fertility due to labor shortages. It follows that a fall in the rate of fertility has both an indirect positive effect on immigration going through the discounted wage differential captured by the function $\Phi(\cdot)$ and a direct effect in the transition

[2]See Barro, Mankiw, and Sala-i Martin (1995).

to a new steady state captured by the function Γ.

3. Empirical Evaluation

Our model predicts that labor will migrate from countries with low productivity to countries with high productivity, from countries with high population growth rates to those with low population growth rates, from those with low saving rates to those with high saving rates and finally, when capital is mobile between countries, from countries with high interest rates (risk premium) to those with low interest rates. In this empirical section we aim to address these in turn and provide reduced form panel data evidence to back up our theoretical claims.

3.1. Data

We use unbalanced panel data from a sample of 23 OECD countries. Annual immigration inflow rate (IIR) is calculated as the ratio of (INFLOW) to population (POP) where data are collected from the OECD. The total fertility rate (TFR) is collected from The *Human Fertility Database* and computed as a sum of age-specific fertility rates for a certain calendar year across all ages from 12 to 55+. The synthetic indicator TFR represents the mean number of children a woman would have by the end of her reproductive life if she experienced at each age the age-specific fertility rates observed in a given year.[3] [4] Our data for gross capital formation to real GDP (I/Y) is collected from the World Bank, World Development Indicators. Real GDP per hours worked, wages in USD using 2018 base year and purchasing power parities (PPPs) for private consumption of the same year, long term nominal interest rates i and consumer price inflation CPI are all collected from the OECD. In a 5-years specification we use total years of educational attainment for the total population as a measure of human capital (Barro and Lee (2013)).

3.2. Econometric Specification

We first provide visual evidence for the three-way interaction between lagged fertility, wages and immigration inflows. Our model suggests that there are both direct and indirect channels

[3]Our unbalanced panel includes Austria, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Italy, Japan, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, England-Wales and the US.

[4]Given data availability on immigration inflows our longest sample is 1975-2014 for the US and only 2007-2014 for Slovenia.

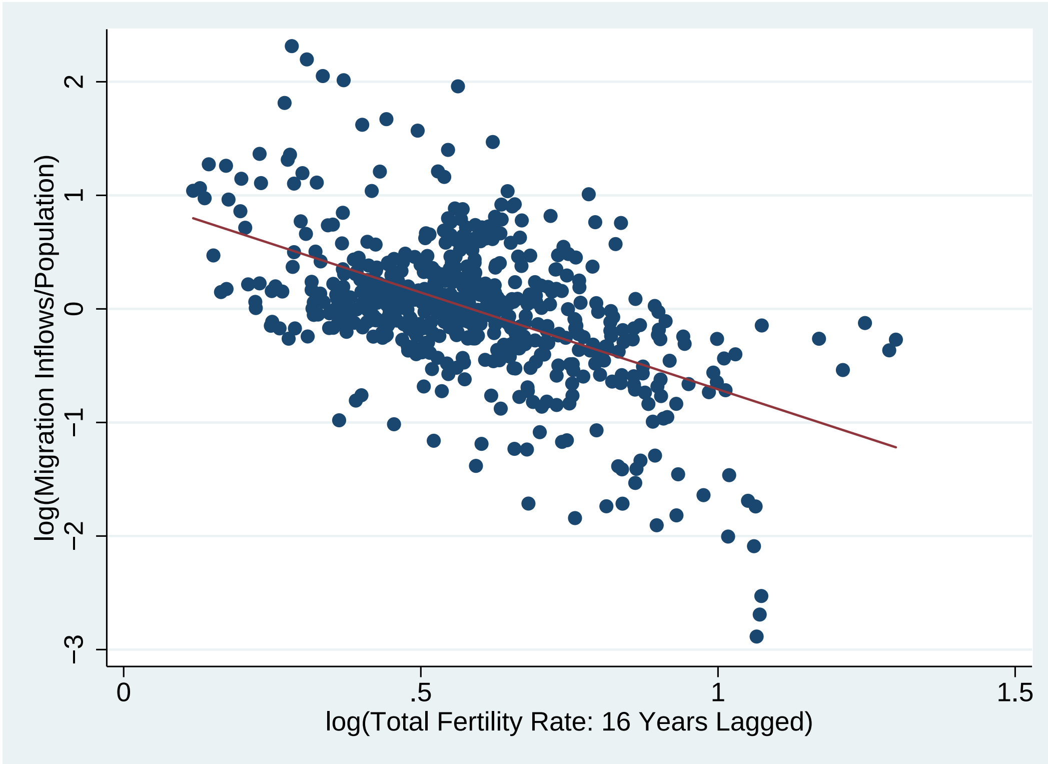

Figure 1: Lagged (16 years) Total Fertility Rates and Immigration Flows (Conditioned on Country Fixed Effects)

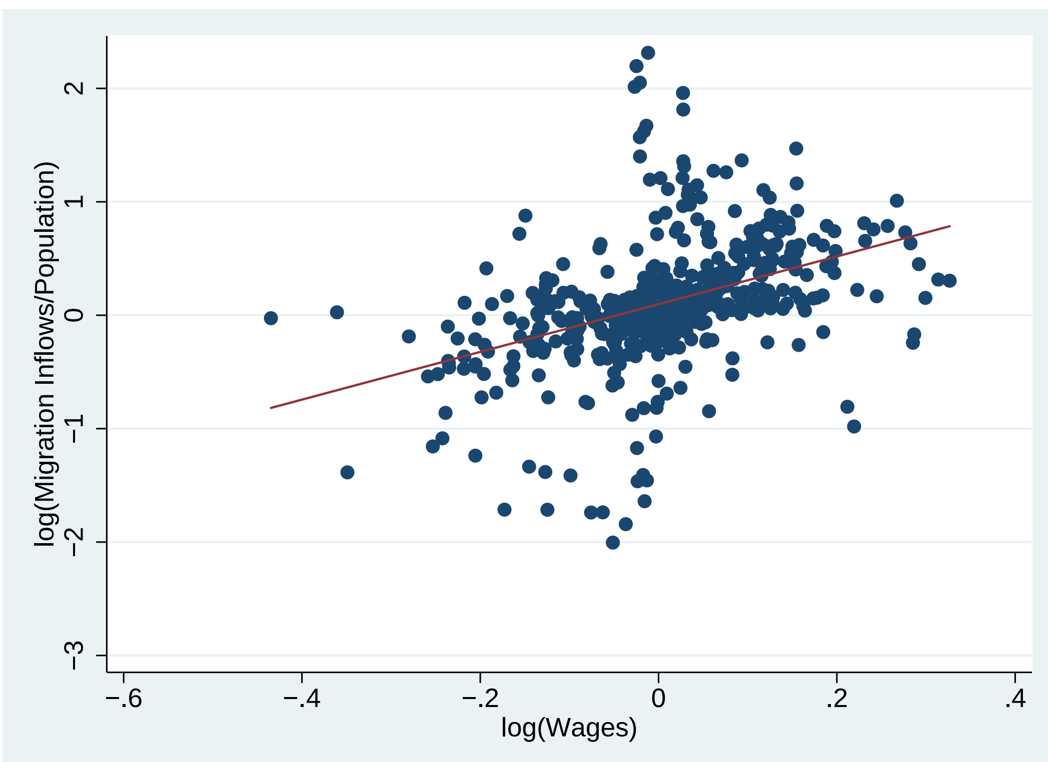

Figure 2: Wages and Immigration Flows (Conditioned on Country Fixed Effects)

through which past fertility changes affect migration inflows. When there is a decline in the current local labour supply, immigrants fill the empty vacancies. Hence, when fertility rate declines, we expect an increase in future replacement migration; we label this as the direct effect. The indirect effects of fertility changes works through changes in wages that are caused by changes in the stock of capital per unit of labor or the growth of productivity. In this case we expect the fertility decreases to affect wages positively, which in turn should affect immigration inflows positively. Figure 1 plots the relationship between the immigration inflows to population ratio, conditioned on country fixed effects (country dummies) only, and the 16 year lagged fertility rate. The relationship is clearly negative suggesting a potential effects of fertility on immigration. Similarly, in Figure 2 we display the positive association between one-year lagged wages and immigration inflows conditioned on country fixed effects.

In our immigration inflows specification we take the fertility decisions a generation ago (for instance as in Becker, Murphy, and Tamura (1990)) as given and allow an indirect fertility effect on the level immigration that follows. Thus our identifying assumption is that the value of the local total fertility rate associated with roughly a generation ago is exogenous to future economic conditions and most importantly to future migration inflows into the country.[5] In all specifications we condition on 16 years lagged local fertility rates as suggested by the Akaike Information Criteria. Yearly time dummies are included to account for business cycle effects. In alternative specifications we control for the log of gross capital formation to real GDP ($I/RGDP$) with a year lag, a measure of productivity proxied by the log real GDP per hour worked ($RGDPH$) with a year lag, a proxy for one year lagged long term nominal interest rates i and consumer price inflation CPI. In our final specification we include log real wages ($wages$) as an additional control. This version of the model allows us to evaluate the indirect effect of lagged fertility changes on net migration inflows transmitting through their impact on lagged relative real wages next to their direct effect through replacement migration. Formally, the benchmark fixed effects specification is given by:

$$log(IIR_{i,t}) = \alpha_i + \beta_t + \gamma log(TFR_{i,t-16}) + \delta X_{i,t-1} + \epsilon_{i,t} \quad (6)$$

with X vector including the specified controls.

Table 1 shows the results for annual data (we suppress time dummies as controls for ease of exposition). Column (1) displays results for the estimation where lagged log fertility appears together with time dummies on the right-hand side, Column (2) shows results when we control for the log of the ratio of gross capital formation and GDP, in Column (3) we add the log of

[5] See for instance Aksoy, Basso, Smith, and Grasl (2019) for formal weak exogeneity tests of the impact of economic variables on demographic structures in a sample of OECD countries.

Table 1: Estimation (annual)

	(1)		(2)		(3)		(4)		(5)	
$log(TFR_{t-16})$	-1.964*	(0.030)	-1.972*	(0.013)	-1.932**	(0.008)	-1.572*	(0.028)	-1.710*	(0.031)
$log(I/Y)_{t-1}$			1.439*	(0.019)	1.444*	(0.011)	1.349*	(0.010)		
$log(RGDPH)_{t-1}$					-0.00758	(0.676)	-0.0288	(0.214)		
i_{t-1}							-0.126**	(0.008)		
CPI_{t-1}							-0.00566	(0.652)		
$log(wages)_{t-1}$									2.518*	(0.045)
$log(wages)_{t-2}$									-1.841	(0.113)
Observations	580		576		573		516		444	
Adjusted R^2	0.504		0.561		0.567		0.608		0.441	
AIC	713.5		640.2		628.8		438.2		459.1	
BIC	809.5		736.1		724.5		527.4		549.2	

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

the hourly productivity level control and in Column (4) we add the interest rate and the rate of inflation. The coefficient of log fertility lagged 16 years is around -2, which implies that an increase in the total fertility rate of 1% would reduce migration inflows to total population ratio by 2% 16 years later. The coefficient of the investment rate is also statistically significant. The numerical estimate shows that a 1% increase in the investment ratio is associated with an increase of the immigration rate by 1.4. As predicted in our model with capital mobility, a lower rate of interest attracts immigration, the coefficient estimate implies that a one percent fall in interest rates, increases the immigration inflow rate by 0.12%. Finally, and somewhat to our surprise, the log of hourly productivity has a statistically insignificant coefficient. Given substantial immigration policy heterogeneity within the OECD (e.g. Japan implementing with very strict immigration regime), our estimates should be regarded as fairly conservative.

Column (5) in Table 1 shows the direct effect of wages on migration flows next to lagged fertility rates. As our model suggests, we find that one-year lagged wages affect inflows positively without removing the significant positive impact of the decline in fertility rates on immigration. We interpret our findings as supportive for both the direct and the indirect influence of fertility changes on migration outcomes.

Table 2: Estimation (5 yearly)

	(1)		(2)		(3)	
	Model_1		Model_2		Model_3	
$log(TFR_{t-10})$	-3.257	(0.001)	-2.441	(0.002)	-2.578	(0.001)
$log(ED_t)$			2.197	(0.020)	2.693	(0.011)
Δy_t					1.119	(0.121)
Observations	115		115		112	
Adjusted R^2	0.484		0.564		0.626	
AIC	142.6		124.2		106.5	
BIC	145.3		129.7		114.7	

p-values in parentheses

4. Concluding Remarks

We study dynamic relationships between local fertility changes and replacement migration in the OECD. We find that lagged fertility can partly explain differences in the current level of immigration across OECD countries in spite of these countries' diverse immigration policies. It follows that immigration compensates for falling fertility while changing the composition of the population.

A Appendix

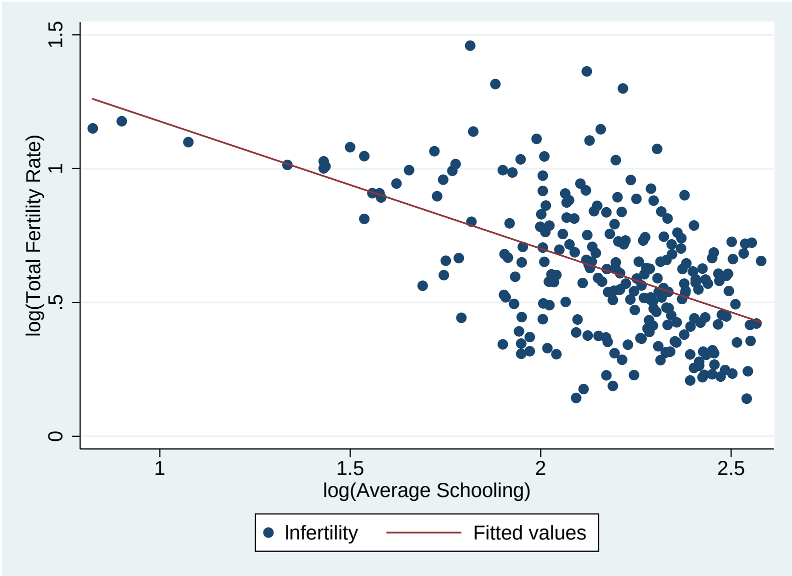

Figure 3: Contemporaneous Relationship between Average Years of Schooling and Total Fertility Rates (in logs)

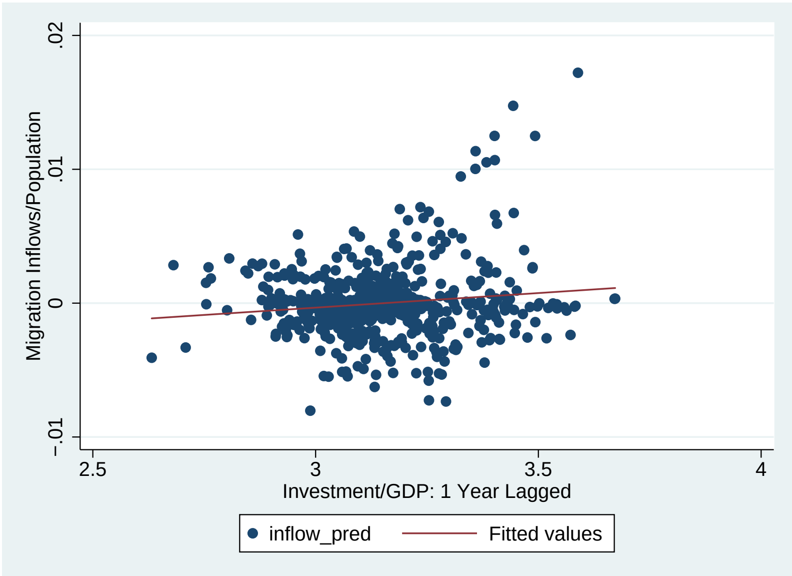

Figure 4: Lagged (1 year) Investment/GDP Ratio and Immigration Flows

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