The short-run effects of a large immigration wave: Spain 1998-2008

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Abstract

This paper investigates the effects of the large immigration wave experienced by Spanish regions in the period 1998-2008. We provide causal estimates of the effects of immigration on the main determinants of income and wages and simulate the response of Spanish regional economies to the immigration shocks in the data. We show that immigration is responsible for slower income per capita and labor productivity growth during this period. The main reason for the negative *short-run* effects that we find is that the short-run supply of capital is not perfectly elastic. Our findings also suggest that immigration may have induced a significant drop in unskilled wages but no effect on skilled wages in real terms. Intuitively, the previous capital-dilution effect is combined with an increase in the relative supply of unskilled labor.

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1 Introduction

Over the period 1998-2008 Spain has experienced a very large immigration wave. The foreign-born population has increased from 1.17 million to 5.22 million (Population Registry data). Over the same period, the foreign-born share among the working age population has increased from below 2% to almost 15%, as illustrated by Figure 1. Among OECD countries in the recent decades no other country has experienced larger inflows, in absolute level or relative to population.

As is often the case, the regional distribution of the recent immigrants has been highly unequal. Figure 2 reports each regions increase in the foreign-born population, relative to the 1998 population. The values range from 2 percent to 50 percent. More specifically, we can rank all regions by the size of immigration flows, relative to total initial population. The population growth at the 10, 50, and 90 percentiles is 3.95%, 13.78%, and 32.23%. The largest increases in the foreign-born share were in regions located along the Mediterranean coast and around Madrid. In contrast, the foreign-born share remained very low in most western provinces throughout the period.

It is no surprise that Spain displayed strong economic growth during the decade 1998-2008. However, the data reveal great disparity across regions. In particular, high immigration regions featured substantially lower growth in income per capita. Figure 4 plots annualized GDP per capita growth and the increase in the foreign-born population, relative to the total initial population in the region. Roughly speaking, the highest immigration regions grew 3 percentage points less annually than the regions with low immigrations. Figure 5 shows that labor productivity behaved likewise.

Additionally, average wages have been roughly constant in real terms over the period of interest. Figure 6 shows that, on average, nominal wages grew by approximately 3 percent, which was roughly the annual inflation rate over the decade. The Figure also shows that there appears to be no systematic relationship between immigration flows and average wage growth.

The goal of this paper is to investigate whether regional differences in the size of immigration flows can account for the regional differences in income, labor productivity, and wages in the data during the period 1998-2008. We are also interested in providing estimates of the different channels through which immigration may affect regional economic outcomes.

The analysis in this paper is close in spirit to the immigration accounting exercise in Peri (2008). We proceed in several steps. First, we present a simple model of the determinants of income and wages at the regional level. In our model, these outcomes are a function of i) the capital-labor ratio, ii) the size and skill composition of hours worked, and iii) skill-specific productivity levels. Second, we provide causal estimates of the effects of immigration on each of these variables. Our identification strategy is based on an instrumental-variables approach. Finally, we plug our estimates into the model and simulate the response of each region to its immigration shock during the period 1998-2008. In our simulation, regions are heterogeneous in their aggregate production functions, which captures the large differences in output composition across regional economies.

Our estimates imply the following causal effects of immigration. First, we find that following an immigration shock, the stock of capital in the region expands substantially in the very short run (one year). However, the elasticity is less than one. This implies that immigration leads to a reduction of the capital-labor ratio in the short run. Secondly, we find that immigration shocks have large effects on the total hours worked in the economy. However, they tend to have a larger effect on unskilled than on skilled hours. As a result, the relative quantity of skilled labor used in production decreases. Third, we do not find evidence of a causal effect of immigration on total factor productivity or on skill-specific productivity.

Our simulation predicts large disparities in the evolution of income and labor productivity across regions. Compared to the lowest-immigration regions, the regions with the highest immigration (top decile) have experienced an accumulated 30% larger growth in real GDP. In addition, these regions have suffered 4% and 6% lower growth, respectively, in per capita income and in labor productivity over the course of the decade. The simulated model also delivers predictions regarding the regional effects of immigration on the wages of skilled and unskilled workers. The model predicts that unskilled wages have grown by an accumulated 6% less in the highest-immigration regions. However, skilled wages are predicted to have grown practically equally in all regions. The intuition for this result is that an immigration shock leads to an increase in the relative supply of unskilled labor. This tends to increase the skilled-unskilled wage ratio. As argued earlier, immigration causes capital dilution in the short run. This reinforces the downward pressure on unskilled wages, whereas it turns out to offset the previous positive effect on skilled wages.

Our estimates differ substantially from those found by Peri (2008) for the US for the period 1960-2006. As is the case here, he finds that immigration increases the relative supply of unskilled labor. However, in contrast to our results, he finds that an immigration shock does not cause capital dilution and substantially increases total factor productivity (mainly due to an increase in the productivity of unskilled labor). There are a number of reasons that can account for the differences between our estimates and his. Obviously, we use data for different countries in different periods. In particular, the source immigration countries differ substantially in the two cases. But perhaps the main difference lies in the time horizon of the effects being analyzed. In his regression analysis, the time units are decades whereas we use years. Roughly speaking, regional economies in his analysis have a few years to adjust since the year of arrival of the typical inflow. In addition, high-immigration regions in the US have a long history of immigration. As a result, it is more likely that immigration shocks are to some extent predictable, allowing for an anticipated response in physical capital investments. In contrast, the immigration experience of the last decade was totally unprecedented in the recent history of Spain. Both arguments suggest a more negative short-run effect of immigration shocks on capital intensity in the Spanish case.

Our results make several contributions to the growing literature on how local and regional economies respond to immigration flows. First, we study an episode of very large immigration flows within a relatively short period of time, which provides a great setup to try to assess the short-run effects of an immigration shock. We note that these are the most relevant estimates to evaluate the recent experience of Spanish regions. The typical region has received a constant stream of large shocks to its population throughout the decade as a result of immigration. This is likely to have little effect on income per capita or average wages in the long run. However, the short-run effect crucially depends on the elasticity of the supply of physical capital in the short run.

Secondly, we estimate the effect of immigration shocks on the stock of capital using actual data on regional capital stocks, disaggregated by asset type. These type of data do not currently exist for the US and, thus, capital stocks, say, for US states need to be imputed from national data.

This paper contributes to the long literature on the labor market effects of immigration in the US. An incomplete list of important contributions to this literature is Card (1990), Borjas et al (1996), Card (2001), Borjas (2003), Lewis (2005), Ottaviano and Peri (2007), Peri and Sparber (2008). Clearly, our work is also related to the recent growing literature on the effects of the recent immigration wave in Spain on the wage structure. Some important contributions are Amuedo-Dorantes and De la Rica (2007, 2008), Carrasco et al (2007), and Gonzalez and Ortega (2008).

The structure of the paper is as follows. Section 2 presents the model, section 3 outlines our empirical strategy, section 4 briefly describes our main data sources, section 5 presents our estimation results, section 6 carries out our simulation exercise, and section 7 concludes. All figures and tables can be found at the end of the paper.

2 Model

We consider a setup that closely follows Peri (2008). Consider a static model with many regions, indexed by $r = 1, ..., R$. Each region produces one final good, using two types of labor and one type of capital. Let K_r, L_r and H_r denote, respectively, the stock of capital, the total hours of low-skill labor, and the total hours of high-skill labor employed in production in region r. We postulate a constant-return-to-scale production function of the CES type:

$$Y = F_r(K, H, L) = K^{\alpha_r} \left[(A_H H)^{\frac{\sigma-1}{\sigma}} + (A_L L)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}(1-\alpha_r)} \tag{1}$$

Observe that we allow for regional heterogeneity in technology by letting the labor-share vary by region. This small departure from Peri (2008) is an attempt to capture the large differences in output composition that are often encountered among regional economies.

For now we assume that the supply of capital and the two types of labor is fixed. Under this assumption, the equilibrium value for labor productivity is given by

$$y = k^{\alpha_r} \left[(A_H h)^{\frac{\sigma-1}{\sigma}} + (A_L l)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}(1-\alpha_r)}. \tag{2}$$

where $N = H + L$ is the total hours worked, $h = H/N$ is the fraction of skilled hours in total hours, $l = L/N$ is the fraction of unskilled hours in total hours, and $k = K/N$ is the capital-labor ratio. Clearly, labor productivity is determined by three factors: the capital-labor ratio, the share of skilled labor in total hours, and the skill-specific productivity parameters. Note also that a drop in k implies a drop in output per hour. Moreover, the drop is increasing in the value of α_r.

We can as easily derive the equilibrium skilled-unskilled wage ratio (skill premium):

$$\frac{w_H}{w_L} = \left(\frac{A_H}{A_L} \right)^{\frac{\sigma-1}{\sigma}} \left(\frac{h}{l} \right)^{\frac{-1}{\sigma}} \tag{3}$$

Under our production function, the elasticity of substitution between capital and the two labor inputs is the identical. As a result, the skill premium only depends on the ratio of skill-specific productivity parameters and on the ratio of skilled to unskilled hours.

We note that given data on labor productivity, capital-labor ratio, shares of skilled and unskilled labor in total hours, and on the skill premium, these two equations can be used to back out values for the labor-specific productivity parameters A_H and A_L. [1]

In this setup, the analysis of the effects of immigration is straightforward. Consider an increase in the supply of unskilled labor, L. Clearly, the equilibrium skill premium will increase, as skilled labor becomes relatively more scarce. Consider now a proportional increase in H and L, and hence in N, keeping constant the capital stock. Clearly, equilibrium labor productivity, defined as output per hour, will fall due to a capital-dilution effect.

However, in reality several assumptions behind this simple model may be violated. Specifically, an exogenous inflow of workers into the region may induce i) changes in the total supply of labor, ii) changes in the total supply of capital, iii) changes in factor-specific productivities. For example, these effects would appear if immigrants displace native workers, if the supply of capital from the point of view of the region is not totally inelastic, or if immigration leads to a reorganization of workers in production, respectively.

3 Empirical strategy

The goal of this section is to explain our approach to obtaining causal estimates. Specifically, we are interested in the effects on the factors that determine income and wages: the total

[1] We also need to assign values to the labor shares and the elasticity of substitution between skilled and unskilled labor.

hours worked by skilled and unskilled workers, the stock of capital, and the labor-specific productivity parameters.

3.1 Identification Strategy

We use interregional variation in the change of the foreign-born population to identify the effect on the total supply of skilled labor, unskilled labor, capital, and on the labor-specific productivity parameters.

As usual, we should be concerned that immigration is not exogenous. Typically, the literature finds an upward bias in OLS estimates of, say, the effects of immigration on wages. The reason is that immigrants tend to locate in high-growth regions. To deal with the endogeneity of location decisions we shall adopt an instrumental variable approach. In particular, we shall build an instrument for population growth based on ethnic networks. I will define the instrument more precisely later on.

3.2 Econometric Specification

Consider panel data where each observation is indexed by a pair (r, t), respectively, a region and a year. For each region-year, the total population can be decomposed into native-born and foreign-born:

$$Pop_{r,t} = Nat_{r,t} + FB_{r,t}.$$

Using these data we estimate a series of regression models. The dependent variables that we shall consider are the total hours by skilled workers, the total hours by unskilled workers, the stock of capital, and so on. Across all these models, the right-hand side is always identical. It includes year dummies, region fixed effects, and the log of the population in (r, t), including both natives and immigrants. That is,

$$lny_{r,t} = \lambda_t + \mu_r + \beta lnPop_{r,t} + \epsilon_{r,t} \tag{4}$$

$$\Delta lny_{r,t} = \lambda_t + \beta \Delta lnPop_{r,t} + \Delta\epsilon_{r,t} \tag{5}$$

Coefficient β is the elasticity of dependent variable y to population. In words, it quantifies the percentage change of y in response to a one percent increase in total population. Needless to say, population growth may be endogenous to unobservable determinants of, say, income per capita growth. In order to address this problem, we shall instrument population growth with a predictor of the growth in the foreign-born population that is arguably uncorrelated with the disturbance in the regression. Below we describe the instrument in detail.

The thought experiment we are trying to capture with this specification is the following. Some regions are assigned an inflow of foreign-born workers (treatment) while others are not. As a result, population increases in the treated regions and this may trigger a number of effects on regional income and its determinants.

Our specification is relatively common in the immigration literature.[2]. However, it is not the only one that is used. Essentially, Peri (2008) adopts the following specification:[3]

$$\frac{y_{r,t} - y_{r,t-1}}{y_{r,t-1}} = \lambda_t + \beta \frac{FB_{r,t} - FB_{r,t-1}}{Pop_{r,t-1}} + \epsilon_{r,t}. \tag{6}$$

We will also experiment with a third specification, which replaces the log of the foreign-born population instead. That is,

$$\Delta ln y_{r,t} = \lambda_t + \gamma \Delta ln FB_{r,t} + \Delta \epsilon_{r,t}. \tag{7}$$

Coefficient γ measures the elasticity to a one percent increase in the foreign-born population. Obviously, we expect $\gamma < \beta$, given that a one percent increase in the foreign-born population only is a much smaller shock than a one percent increase in the total population.[4]

3.3 Instrument

The instrument we employ dates back to Card (2001) and has been widely used since.[5]. It is based on a well-documented feature of immigration: the existence of ethnic networks. That is to say, the tendency of recent immigrants to locate in cities or regions with communities of individuals from their same countries of origin, in order to enjoy a more smooth transition into the new culture. The existence of these networks has been widely documented (Bartel 1989) and has been recently analyzed by Munshi (2003).

More specifically, our prediction of the size of the foreign-born population in a given region-year is done as follows. We assign the current stock of immigrants from a given country of origin to the regions in a country by using the regional distribution of that type of immigrants at an earlier date. Then we add across all countries of origin. In other words,

$$Z_{r,t} = \sum_c \left(\frac{FB_{r,c,t_0}}{FB_{c,t_0}} \right) FB_{c,t} \tag{8}$$

for some $t_0 << t$, where FB_{c,t_0} denotes the total population of individuals born in country c residing in the country at an earlier date t_0, FB_{r,c,t_0} is the number of those individuals

[2]For example, see Card(2005), Lewis (2005), and Cortes(2008)

[3]Strictly speaking, the main explanatory variable in Peri (2008) is the increase in the total hours worked by the foreign-born population divided by the total hours worked by the total population, including natives and foreign-born workers.

[4]In our sample, the average foreign-born share across all regions and years is 7.7%. As a result, β should be approximately 13 times larger than γ.

[5]Lewis(2005), Cortes(2008), Ottaviano and Peri(2007), Peri(2008), Saiz(2007) and so on

residing in region r at that time, and $FB_{c,t}$ is the current period-t stock of individuals born in foreign-country c. By construction, the instrument only uses region-level information from an earlier period t_0. Thus it is arguably exogenous to current shocks that may affect the location decisions of current immigrants.

The first-stage regression that we estimate is

$$\Delta lnPop_{r,t} = \lambda_t + \alpha \Delta lnZ_{r,t} + \epsilon_{r,t} \tag{9}$$

Thanks to the region fixed effects and the time dummies, the identification assumption is that unobserved factors that determined that more immigrants decided to locate in a given region in t_0 are not correlated with current region-specific shocks.

4 Data sources

We combine data from different sources covering the period 1998-2008. Unfortunately, as of today, not all series cover the whole period. We next explain the coverage for each of the sources. Our regional unit is a province. Spain is divided into 50 provinces plus Ceuta and Melilla, two Spanish cities on the African continent. Due to lack of data, these two cities are occasionally dropped in our regressions.

1. Hours of work, employment, and skill composition. We obtain these variables from the Spanish Labor Force Survey 1998-2008, second quarter. We classify individuals as skilled if they hold a college degree and as unskilled otherwise. We do not feel comfortable in disaggregating the population in more education levels because the number of observations in each province-year-skill becomes too low. In studies for the US, the Census is often used, allowing for samples that are much larger than those provided by labor force surveys such as the Current Population Survey. In addition, recently arrived foreign-born workers are often forced to take on jobs for which they are overqualified. This is because they do not speak the language of the host country correctly or because they have not had time to wait for the job that perfectly matches their skills. We restrict our sample to individuals age 16-64.

2. Instrument. To build our instrument we make use of the 1991 Population Census to obtain the regional distribution of immigrants across provinces by country of origin. The 1991 Census reports country of birth classified in 17 world regions. We use the 1998-2008 Population Registry to measure the size of the Spain-wide foreign-born population classified by country of origin, and build the 17 regions defined in the 1991 Census. We then combine the data as explained earlier.

3. Regional Income, Value added by industry-region, regional Wage bills. We obtain these variables from the Regional Accounts published by the Spanish statistical institute (INE). The data is available at www.ine.es. As of today, the coverage for these data only reaches 2005.

4. Regional price index. We combine several province-level CPI series to cover the period 1998-2008. These data are produced by the Spanish Statistical Institute and are available in their website (www.ine.es). GDP price deflators at the province level are not yet available for the period of interest. The year dummies in the specification amount to using a common price deflator for all provinces.

5. Regional capital stocks. We use the data produced by the BBVA foundation and the IVIE. [6] Specifically, we use the Real gross capital stock (in 2000 euros) that covers the period 1964-2004.[7] These stocks include both private and public capital, disaggregated in four types of assets: (1) Housing, (2) Non-housing construction (mainly infrastructures), (3) Equipment, and (4) Transportation equipment.

6. Province-level wages by skill level. We obtain estimates of the annual changes in the wages of skilled and unskilled workers over the period 1998-2006 using the 2006 Continuous Sample of Working Lives. This is a large sample of the universe of individuals that had Social Security records in year 2006. For these individuals, regardless of their employment status at the time, full working histories are provided. That is, the data contains information on all their employment relationships and on the earnings corresponding to each of those relationships. The dataset also contains characteristics of the job and some demographic information obtained from other sources, mainly the Population Registry. We restrict our sample to full-time, year-round employed workers in each year who were not self-employed.

As noted in Gonzalez and Ortega (2007), there are three important caveats in using this dataset for our purposes. First, as we move away from 2006 into the past, the sample may become less representative. Secondly, earnings are severely top and bottom coded. Finally, the information on education levels is out of date.[8].

We address these problems in the following ways. To reduce the effects of top and bottom coding, we compute median wages rather than means. We do not use the information on education levels to classify workers by skill levels. Instead, we use the information on job characteristics. We use a variable that classifies workers in several categories that are used to determine the payment that the employer has to make to the Social Security for each worker ("grupo de cotizacin"). Fortunately, these categories are closely related to education levels and must be kept up to date. Specifically, we classify a worker as *skilled* if his/her category is 1 or 2 (engineers, college graduates, firm managers, and holders of a 3-year university degree). Individuals in all lower categories are classified as unskilled.

[6] For more details, see http://w3.grupobbva.com/TLFU/tlfu/ing/areas/econosoc/bbdd/stock.jsp1.

[7] In January 2009 the data for years 2005-2006 will be released.

[8] According to these data the share of college graduates in Spain in year 2006 is less than 10 % but the Labor Force Survey and other reliable sources reveal the figure is over 20 %

5 Estimation

5.1 The effect of Immigration on Income

As we saw in Figures 3-5, regions that received large immigration flows, relative to initial population, seem to have experienced relatively larger GDP growth but relatively lower growth in GDP per capita and in labor productivity, defined as GDP per hour.[9]

Our first task is to examine whether these effects are causal and to provide estimates. To address this question, we estimate

$$\Delta lnGDP_{r,t} = \lambda_t + \beta \Delta lnPop_{r,t} + \epsilon_{r,t},$$

as well as analogous regressions substituting GDP by GDP per capita and GDP per hour.

Table 2 reports our estimates of these models on an annual panel for Spanish provinces covering the period 1998-2005. Each column corresponds to a different dependent variable: log GDP, log per capita GDP, and log GDP per hour worked. The first row reports the OLS estimate of γ, the elasticities to a one percent increase in the foreign-born population. We find no significant effect on GDP but negative, and significant, effects on GDP per capita and per hour worked. The second row presents the estimated elasticities to a one percent increase in the total population. In this case, a *ten* percent increase in population is associated to a 3.8 % increase in GDP but to a 6.2 % and 6.7 % *reductions* in GDP per capita and per hour, respectively.

The third row reports our instrumental variable estimates of immigration-induced popolation growth. Specifically, a ten percent growth in total population leads to a 6.7 % increase in GDP but to reductions of 3.3 % and 4.0 % in GDP per capita, and GDP per hour, respectively. To the extent that our instrument is valid, these effects can be given a causal interpretation.

Table 3 reports the results of our first-stage regressions. These results show that growth rates of our instrument are a stronger predictor of growth rates of total population than of growth in the foreign-born population. Consequently, in the remainder of the paper we focus on IV estimates for this specification.[10]

Our next goal is to determine what have been the main channels through which immigration has led to slower growth in income per capita and in labor productivity. We focus on the three determinants of income and wages in our framework: the size and skill composition of hours worked, the capital-labor ratio, and skill-specific productivity.

[9] Recall that regions have been sorted from higher to lower increases in the foreign-born population, relative to population, between 1998 and 2008. Hence, a negative slope means that high-immigration regions experienced lower growth than low-immigration regions.

[10] In preliminary regressions, with slightly different specifications or samples, the coefficient of lnFB in the first-stage regression also turns up significant, although it is always much less precisely estimated than the coefficient of lnPop.

5.2 The effect of immigration on hours worked

Next we turn to the estimation of the effects of immigration on the total hours worked for skilled and unskilled workers. For each skill type, we also carry out an extensive-intensive margin decomposition. Namely, we estimate the effect of immigration on employment and on average hours worked.

Table 4 presents our results. Let us comment first on the OLS estimates. In response to an immigration-induced population growth of one percent, total unskilled hours increase by 1.1 percent. The effect is mainly due to the extensive margin. Total unskilled employment increases by 0.9 percent and average hours increase by $1.1 - 0.9 = 0.2$ percent. Turning to the elasticity of total skilled hours, the OLS point estimate is 0.8, and it is mainly driven by an extensive margin effect. Overall, the OLS estimates suggest that immigration has induced a roughly proportional increase in total hours worked, with a slightly larger increase in unskilled hours than in skilled hours.

The IV estimates are very similar. The elasticity for unskilled hours becomes 1.15 and for skilled labor it is 0.68. In both cases, the effect mainly reflects the expansion of employment, for both skill types. We note that the IV estimate on total skilled hours is estimated quite imprecisely. As the decomposition shows, this is the combination of a fairly precisely estimated large positive effect on employment and a very imprecise, negative estimate of the effect on average hours. For this reason we view the point estimate as being economically meaningful and will take this into account in the simulations.

5.3 The effect of immigration on the stock of capital

A key question to understand the effects of immigration on average wages, income and labor productivity is what happens to the stock of capital. In particular, it is crucial to determine whether the capital-labor ratio is reduced in the short run following an immigration shock.

Surprisingly, this question has not received much attention in the literature. The reason for neglecting this question has been that data on capital stocks are only available at the national level for the US and for other countries. The usual response to this shortcoming has been to use impute regional capital stocks using national data (Garofalo and Yamarik, 2000). This is the route followed by Peri (2008). The general idea is to assign each region a portion of the national stock of capital employed in each industry according to the region's share in total industry output. The region's capital stock is then defined as the aggregation across all industries. This procedure imposes the assumption that capital intensity in each industry is identical across all regions. Unfortunately, recent evidence shows that immigration itself affects capital intensity (Lewis, 2006). This potentially undermines the validity of these data to estimate the effects of immigration on the capital stock is not known.

A contribution of this paper is to use actual data on regional capital stocks. Data on regional capital stocks, disaggregated by several asset categories, are available for Spain dating back to 1964.

It is also worth noting that we are studying very short run effects. Specifically, we are estimating the effect of an immigration-induced growth in population relative to the previous year on the stock of capital in that same period.

Table 5 presents our findings. OLS estimates of the effects of immigration-induced population growth on the total stock of capital are positive and significant for the four asset types. Respectively, OLS estimates for equipment, transportation equipment, housing and non-housing construction are 0.32, 0.36, 0.46, and 0.49. When we aggregate all capital types, the OLS estimate is 0.45. These results suggest that immigration generates capital dilution.

We now turn to our IV estimates. Estimated coefficients increase substantially for all asset types except non-housing construction. For the total stock of capital, the point estimate for the elasticity is 0.74. For equipment, transportation equipment, housing and non-construction housing the elasticities are now 0.93, 0.70, 0.93, and 0.43, respectively. These elasticities suggest that immigration causes some capital dilution in the short run, but the magnitude is relatively small. In particular, equipment capital practically expands 1-for-1 *in the year of arrival* of immigration.

We interpret our results as saying that the supply of capital at the regional level is very elastic. This will play a major role in our simulation.

5.4 The effect of immigration on TFP and skill-specific productivity

Cutting-edge research has uncovered a series of new channels by which immigration affects the important choices of employers and native workers. Peri and Sparber (2008) argue that immigration flows into a local labor market induce specialization of native workers in occupations characterized by tasks that are relatively intensive in communication skills. Lewis (2006) shows that firms optimally respond to an increase in the relative supply of low-skill labor by adopting production technologies that use this factor more intensively. Cortes and Tessada (2008) find that highly skilled US-born women are able to work longer and in demanding occupations (for which they already hold the education credentials) thanks to the use of home help, which becomes relatively cheaper in cities with large inflows of unskilled foreign-born women. Finally, Mas and Moretti (2007) show the existence of positive motivational spillovers within firms. Under the assumption that immigrants are more highly motivated than natives, say in unskilled jobs, the increase in employment in a region driven by immigration flows would lead to an increase in productivity, particularly in unskilled jobs.

Of course, our aggregate framework is ill-suited to explicitly capture these effects. However, we expect these changes to surface in our estimates of total factor productivity and of skill-specific productivity.

5.4.1 Construction of skill-specific productivity series

As noted in Section 2, we can use our production function framework to obtain measures of the skill-specific productivity parameters A_H and A_L. We do this in the fashion of growth accounting exercises. That is to say, we postulate an aggregate production function in each region, and we use data on output, hours work, capital, and wages to back out region-specific time series for the productivity of each type of labor as residuals.

Methodologically, we make a small but important departure from Peri (2008). We allow for regional heterogeneity in aggregate production functions. In particular, we calibrate each region's production function to match the labor share in income in each region. These shares vary widely in the data, reflecting the large differences in industry composition across regional economies.

Specifically, we use the two equations that determine output per hour worked and the skill premium, namely,

$$y = k^{\alpha_r} \left[(A_H h)^{\frac{\sigma-1}{\sigma}} + (A_L l)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}(1-\alpha_r)} \tag{10}$$

$$\frac{w_H}{w_L} = \left(\frac{A_H}{A_L} \right)^{\frac{\sigma-1}{\sigma}} \left(\frac{h}{l} \right)^{\frac{-1}{\sigma}} . \tag{11}$$

Observe that given an estimate for the elasticity of substitution between the two types of labor (σ), the labor share (α), and data on output per hour (y_t), capital per hour, (k_t), the share of skilled hours (h_t), and the skill premium ($w_{H,t}/w_{L,t}$), for each region and period, these two equations determine the time series ($A_{H,t}, A_{L,t}$) for each region.

First, we impose a common elasticity of substitution between the two types of labor for all regions and periods: $\sigma = 2$. This is in the range of values commonly used in the literature.

Second, we set each parameter α_r to match each region's labor share in income. The cross-sectional average labor share is 0.46 and it ranges from 0.41 to 0.51.[11]

Next, we use data on real labor productivity (output per hour), the share of skilled labor in total hours worked, capital per hour, and the skill premium, for each region and year. Given these data, the two equations above produce values of the two skill-specific productivities for all periods and regions.[12]

[11] Unfortunately, we do not have wage bills by province. Our approach is to impute labor shares at the province level by using assuming that labor shares by industry are identical across all provinces. Then we build the province-level aggregate labor share by computing a weighted sum of industry-level labor shares, where the weights are given by each province's share in Spain's value added for each industry. This procedure is meaningful because the cross-sectional dispersion of labor shares within industries is quite low, whereas between-industry differences in labor shares are quite large. In our data, Agriculture and Energy production have relatively low labor shares whereas Construction has the highest labor share.

[12] Rearranging the terms in the production function it is easy to show that we can obtain a measure of total factor productivity given by $TFP = (A_H + A_L)^(1 - \alpha)$.

5.4.2 Estimation results

Table 6 reports the results of our estimates of the effects of immigration-induced population growth on TFP and our skill-specific productivity parameters, A_L and A_H. Our OLS estimates are large, negative, and significantly different from zero for the three productivity measures. The estimated elasticities are -0.07, -2.02, and -0.38, for unskilled, skilled, and total productivity.

Interestingly, the IV estimates are much higher, that is, closer to zero. The point estimates are now -0.31, -0.73, and -0.15. Moreover, none of them is significantly different from zero.

In short, we do not find evidence of a causal effect of immigration on any of the three productivity measures. However, our OLS results suggest that immigration has been larger in low-productivity-growth regions. It is hard to interpret these results in the context of our one-sector model. However, this negative association might be explained if immigrants flocked to industries such as agriculture. Regions specialized in agriculture are likely to display low TFP growth and also to experience native rural-urban migration. Immigrants might be moving to those regions to fill up those vacancies. This would show up as a negative OLS coefficient. But note that immigration would not be causing a slowdown in productivity, that is, the IV estimate should be zero.

6 Simulation

We are now ready to address the main question of the paper. Have regional differences in the size of immigration flows been responsible for the differences in income per capita and labor productivity across regions?

Specifically, we carry out the following exercise. First, we take from the data the increase in the foreign-born population in each region between 1998 and 2008, relative to the total 1998 population in the region. Secondly, we calibrate the region-specific production functions to match the labor shares in the data. Finally, we use the estimated IV elasticities for the effects of immigration on each of the determinants of income and wages to predict growth in real income (total, per capita and per hour worked) and in wages by skill for each region.

6.1 Region-specific immigration flows and parameter values

In the context of our model we can carry out the following thought experiment. We assign to each region an exogenous inflow of foreign-born population that we take from the data. In particular, our measure of inflows is given by

$$\left[\frac{FB_{r,2008} - FB_{r,1998}}{Pop_{r,1998}}\right]_{r=1}^{r=R}$$

where $Pop_{r,1998}$ is the sum of the native-born and foreign-born population each region in year 1998.

Figure 7 summarizes the data. We have sorted regions from highest to lowest inflows, relative to initial population, and report annualized inflows. The highest-immigration regions have experienced a 40-50 % increase in population due to increases in the foreign-born population. In annualized terms, this is a 3.3-4.3 % annual population increase for each of the years in the decade. In contrast, the regions less affected by immigration have received an annualized inflow equal to 0.2 of their population, which amounts to a 2.4 % increase over the whole decade.

We consider several parameter configurations. In addition to calibrating the model using our IV estimates, we also include two simple benchmarks. The first benchmark is a model where total skilled and unskilled hours respond one-for-one to immigration flows and, in addition, the supply of capital is totally inelastic. The second benchmark maintains unit elasticities on hours but assumes a perfectly elastic capital supply. That is to say, the stock of capital expands proportionally to the increase in population and in hours worked.

Table 7 summarizes the parameters values for each case, where in addition to the IV estimates and the two benchmarks, we have also included a column with the OLS values.[13] In short, our IV estimates imply elasticities for skilled hours, unskilled hours, total capital stock, and skill-specific productivities of 0.7, 1.1, 0.7, and zero. That is to say, an immigration shock leads to a slight reduction in the capital-labor ratio in the next year. In addition, total unskilled hours increase roughly 40 % more than skilled hours. Partly, this is due to the lower average schooling level of immigrants, relative to natives. But it is also due to the fact that, in the short-run, recently arrived immigrants are forced to take on jobs for which they are overqualified.

Mechanically, we follow three steps. First, we calibrate regional production functions to match the labor share in each region. Secondly, we obtain data on the initial (1998) values for skilled hours, unskilled hours, capital stocks, and the skill-specific labor parameters, for each region. Third, we compute the annual geometric average of the population growth experienced by each region as a result of changes in its foreign-born population between 1998 and 2008. Namely, we use data on the initial and final stocks of foreign-born individuals in each region, as well as the 1998 total population in the region, to find g_r such that

$$1 + \frac{FB(r,2008) - FB(r,1998)}{Pop(r,1998)} = (1+g_r)^{10}.$$

Fourth, we compute the endogenous response of capital, hours, and productivity, to each regions immigration shock using our estimates for each parameter configuration. More specifically,

[13]Recall that we estimated the responses to annual shocks. Consequently, we apply them to the annualized increase in the foreign-born population.

$$
\begin{aligned}
H_{r,2008} &= H_{r,1998}(1+\epsilon_H g_r)^{10} \\
L_{r,2008} &= L_{r,1998}(1+\epsilon_L g_r)^{10} \\
K_{r,2008} &= K_{r,1998}(1+\epsilon_K g_r)^{10} \\
A^H_{r,2008} &= A^H_{r,1998}(1+\epsilon_{AH} g_r)^{10} \\
A^L_{r,2008} &= A^L_{r,1998}(1+\epsilon_{AL} g_r)^{10},
\end{aligned}
$$

where ϵ_X denotes the one-year ahead percentage change in X in response to a one percent increase in population driven by inflows of foreign-born individuals. Finally, we compute the percentage change in output, output per capita, output per hour, skilled and unskilled wages between 1998 and 2008.

6.2 The effect of immigration on Income and labor productivity

Let us start by examining the impact of immigration on real GDP in the two benchmark cases. Figure 7 reports the results. Under a totally inelastic capital supply, high-immigration regions expand their real output by 20 %, while output is practically unchanged in low immigration regions. The effect on GDP is magnified when the supply of capital is perfectly elastic, with high-immigration regions displaying a 50 % increase in real output. The intuition is straightforward: hours worked of the two types of skills expand one-for-one with immigration and so does the capital stock. As a result, the capital-labor ratio remains constant. By constant-returns-to-scale this implies that the level of production also expands one-for-one with population. Observe that the model parameterized with our IV estimates behaves similarly to the model with a perfectly elastic capital supply. According to the model, real output would have grown by roughly 40 % in high-immigration regions. Essentially, the elasticities of the supply of capital, skilled hours and unskilled hours are close to unity, while skill-specific productivities are exogenous to immigration shocks (zero elasticity).

Let us now turn to the effects of immigration shocks on per capita and per hour real output, respectively, Figures 8 and 9. Clearly, immigration has a very negative short-run effect when the supply of capital is inelastic. In this case, output per capita and per hour worked would both have fallen by 20 % in the highest immigration regions over the course of the decade. In contrast, under a perfectly elastic supply of capital, output per capita and per hour would have remained constant in all regions. Following an immigration shock of a given size, capital would have expanded to maintain a constant capital-labor ratio.[14] The effect of immigration shocks in the model estimated by instrumental variables is again

[14] Recall that in the two benchmark cases skilled and unskilled hours expand at the same pace, which in turn, is one-for-one with the size of the shock.

between the two benchmark cases, but leaning toward the model with a highly elastic supply of capital. Specifically, the estimated model implies a reduction of 5 % in output per capita and of 6-8 % in output per hour for the regions receiving the largest immigration flows over the course of the decade.

6.3 Wages by skill level

Let us start with the simulated effects on unskilled wages. Qualitatively, the effects of an immigration shock on unskilled wages depend on its effect on the capital-labor ratio and on the relative supply of unskilled labor. In the benchmark case with a totally inelastic supply of capital and symmetric elasticities on skilled and unskilled labor, unskilled wages are severely depressed in response to a large immigration shock. Figure 10 presents our results. Our simulation predicts as much as a 20 % drop for the highest-immigration regions. In contrast, when the supply of capital is perfectly elastic (and the elasticities on hours are symmetric), real unskilled wages would remain unaffected. According to our estimated model, the accumulated effect of immigration shocks over the whole decade would have reduced real unskilled wages by roughly 5 % in high-immigration regions.

We now turn to the effects of immigration on skilled wages, reported in Figure 11. The assumption of symmetric effects of an immigration shock on hours of skilled and unskilled workers implies an effect on skilled wages that is identical to the effect on unskilled wages described above. More interestingly, the estimated model predicts virtually no effect of immigration on real skilled wages. The reason is that two offsetting effects are at play. On the one hand, the reduction in the capital-labor ratio tends to reduce skilled wages. At the same time, the immigration shock reduces the relative supply of skilled labor. Quantitatively, these two effects cancel out. As the Figure reveals, the accumulated effect of immigration on skilled wages is virtually zero even for high-immigration regions.

7 Conclusion

In the period 1998-2008, Spain has experienced a very large immigration wave. One important feature of this episode has been the high regional variation in the size of the inflows, relative to population. Some regions have received inflows throughout the period that amount to 50 % of their 1998 population, while for others the increase in population due to increases in the foreign-born population has been a meager 2 %.

In this paper we have attempted to estimate the impact of these inflows on income, wages, and labor productivity at the regional level. In particular, we were interested in finding out if immigration is responsible for the higher GDP growth, and the lower growth in GDP per capita and per hour of high-immigration regions over our period of interest.

Our estimates suggest that immigration shocks lead to a small reduction in the capital-labor ratio due to a less than perfectly elastic one-year ahead stock of capital. Secondly, immigration shocks induce a large increase in total hours worked, with a larger effect on unskilled hours. As a result, the relative quantity of skilled labor used in production falls. Finally, we do not find a causal effect of immigration on skill-specific productivity.

Quantitatively, our estimates imply that an increase in the foreign-born population equal to 10 % of the initial population in the region triggers a 7 % increase in the capital stock and in skilled hours, and an 11 % increase in unskilled hours.

Imposing these estimated elasticities on a simple aggregate model for our regional economies, we predict higher real GDP growth, lower real growth in GDP per capita and in labor productivity. Compared to no-immigration regions, the top decile of regions in terms of inflows would have experienced 30 % higher growth in real GDP, 4 % lower growth in real per capita GDP, and 6 % lower growth in real labor productivity, defined as real GDP per hour.

Our simulation also produces predictions regarding the differential impact of immigration on wages by skill. According to the model, the regions in the top immigration decile have experienced an accumulated 6 % lower growth in unskilled wages compared to no-immigration regions. In contrast, the model predicts a virtually identical evolution of skilled wages in all regions, regardless of the size of immigration flows. The intuition for this result is that immigration slightly reduces the capital-labor ratio and simultaneously decreases the relative supply of skilled labor. These two opposing effects on equilibrium skilled wages cancel out.

Over time, as the immigration wave ends and the share of foreign-born workers in the Spanish economies stabilizes, we expect high-immigration regions to recover within a few years. The recovery would be driven by the relatively higher investment rates in physical capital in high-immigration regions as well as by the relative increase in the supply of skilled labor, once immigrants find jobs that allow them to make full use of their human capital.

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Tables

Table 1: Descriptive statistics

1998 Variable	Obs	Mean	Std. Dev.	Min	Max
pop_all	**52**	**509876**	**646354**	**39939**	**3539880**
pop_edu1	52	477135	583719	37265	3108105
pop_edu2	52	32741	66567	2674	431776
emp_all	**52**	**263847**	**355290**	**18190**	**1903255**
emp_edu1	52	238859	306027	16128	1650666
emp_edu2	52	24988	51854	1917	326909
fbsh_all	**52**	**0.03**	**0.03**	**0.00**	**0.16**
fbsh_edu1	52	0.03	0.03	0.00	0.16
fbsh_edu2	52	0.05	0.05	0.00	0.22

2008 Variable	Obs	Mean	Std. Dev.	Min	Max
pop_all	**52**	**586365**	**757317**	**42990**	**4258243**
pop_edu1	52	525835	641545	39825	3437494
pop_edu2	52	60530	123604	3165	820748
emp_all	**52**	**388573**	**537535**	**22683**	**3020896**
emp_edu1	52	336640	435498	20223	2309924
emp_edu2	52	51934	108044	2460	710972
fbsh_all	**52**	**0.14**	**0.08**	**0.03**	**0.38**
fbsh_edu1	52	0.14	0.08	0.03	0.38
fbsh_edu2	52	0.12	0.09	0.00	0.48

Note: Data from LFS 1998 and 2008, second quarter. Population ages 16-64 only. ALL refers to the two skill groups combined. POP refers to population, EMP is employment, FBSH is the share of foreign-born.

1998-2008 Variable	changes	Mean
pop_all	**pch**	**0.1500**
pop_edu1	pch	0.1021
pop_edu2	pch	0.8488
emp_all	**pch**	**0.4727**
emp_edu1	pch	0.4094
emp_edu2	pch	1.0783
fbsh_all	**ch**	**0.1112**
fbsh_edu1	ch	0.1141
fbsh_edu2	ch	0.0741

Note: PCH refers to percentage change. CH refers to changes.

Table 2: Income and labor productivity
Period: 1998-2005

Dep. Var:	lngdp	lngdp_pop	lngdp_h
OLS - lnFB stdev.	-0.002 [0.004]	-0.026 [0.004]***	-0.036 [0.006]***
OLS - lnPop stdev.	0.376 [0.037]***	-0.624 [0.037]***	-0.667 [0.055]***
IV - lnPop stdev.	0.673 [0.099]***	-0.327 [0.099]***	-0.398 [0.141]***
year dummies region dummies Number of prov	yes yes 52	yes yes 52	yes yes 52

Table 3: First-stage Regressions
Period: 1998-2008

Dep. Var:	lnPop	lnFB
lnZ stdev.	0.19 [0.02]***	0.15 [0.19]
year dummies region dummies R2 t-stat	yes yes 0.66 8.28	yes yes 0.42 0.79

Table 4: Labor input, by education
Period: 1998-2008

Dep. Var:	lnhours	lnemp	lnavhours
Low educated			
OLS - lnFB	0.047	0.04	0.006
stdev.	[0.008]***	[0.007]***	[0.004]
OLS - lnPop	1.102	0.911	0.191
stdev.	[0.040]***	[0.033]***	[0.029]***
IV - lnPop	1.157	1.116	0.04
stdev.	[0.116]***	[0.100]***	[0.085]
Highly educated			
OLS - lnFB	0.077	0.071	0.006
stdev.	[0.019]***	[0.018]***	[0.007]
OLS	0.823	0.777	0.046
stdev.	[0.145]***	[0.135]***	[0.055]
IV	0.681	0.946	-0.265
stdev.	[0.420]	[0.393]**	[0.165]
year dummies	yes	yes	yes
region dummies	yes	yes	yes
Number of prov	52	52	52

Table 5: Capital stock by type of asset
Period: 1998-2004

Dep. Var:	lntotalK	lnEquipment	lnTrans	lnHousing	lnOtherCons
OLS - lnFB stdev.	0.018 [0.004]***	0.019 [0.006]***	0.042 [0.007]***	0.008 [0.006]	0.023 [0.005]***
OLS - lnPop stdev.	0.448 [0.045]***	0.32 [0.079]***	0.364 [0.096]***	0.458 [0.070]***	0.493 [0.057]***
IV - lnPop stdev.	0.738 [0.116]***	0.931 [0.207]***	0.696 [0.235]***	0.927 [0.181]***	0.434 [0.137]***
year dummies region dummies Number of prov	yes yes 52	yes yes 52	yes yes 52	yes yes 52	yes yes 52

Table 6: TFP and skill-specific productivity
Period: 1998-2004

Dep. Var:	TFP	A-Low	A-High
OLS - lnFB stdev.	-0.023 [0.004]***	-0.068 [0.010]***	0.056 [0.039]
OLS - lnPop stdev.	-0.384 [0.051]***	-0.627 [0.123]***	-2.018 [0.471]***
IV - lnPop stdev.	-0.15 [0.126]	-0.307 [0.301]	-0.733 [1.150]
year dummies	yes	yes	yes
region dummies	yes	yes	yes
Number of prov	52	52	52

Table 7: Parameter configurations, simulation.

configuration elasticity	1 el_K=0	2 el_K=1	3 OLS	4 IV
H: skilled hours	1	1	0.8	0.7
L: unskilled hours	1	1	1.1	1.1
K: total capital stock	0	1	0.7	0.7
AH: skilled productivity	0	0	-2.0	0
AL: unskilled productivity	0	0	-0.6	0

Figures

Figure 1

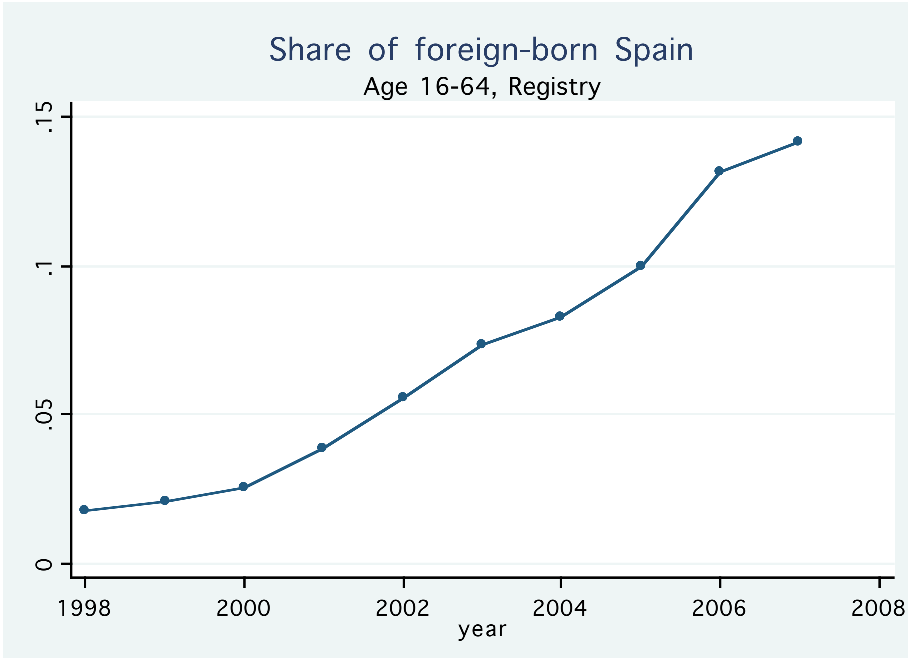
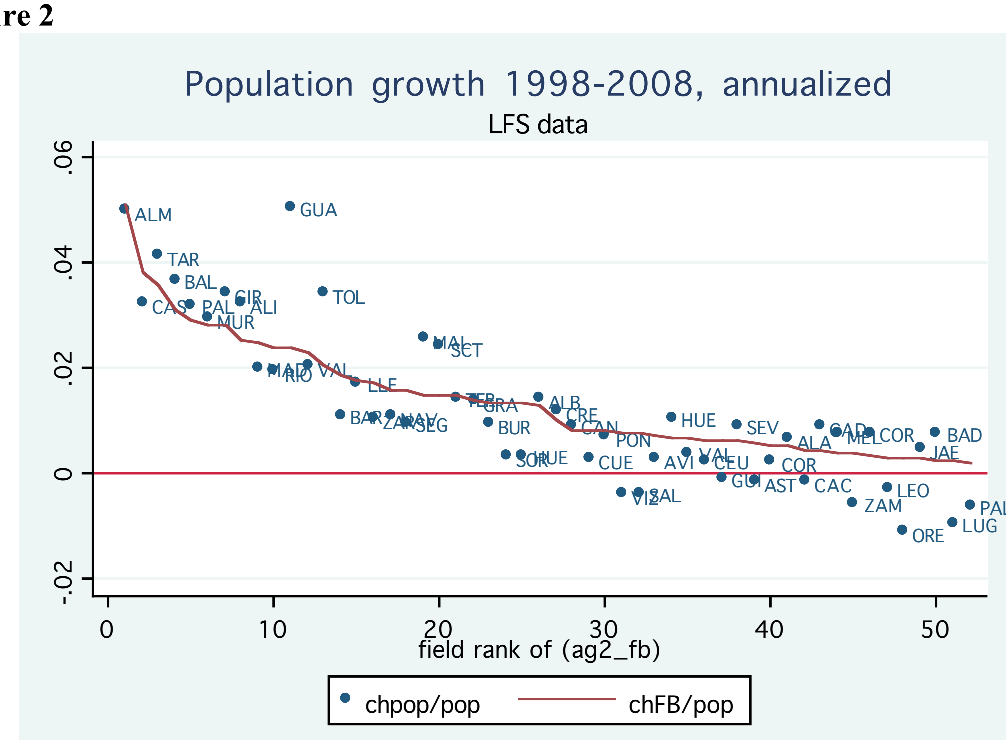
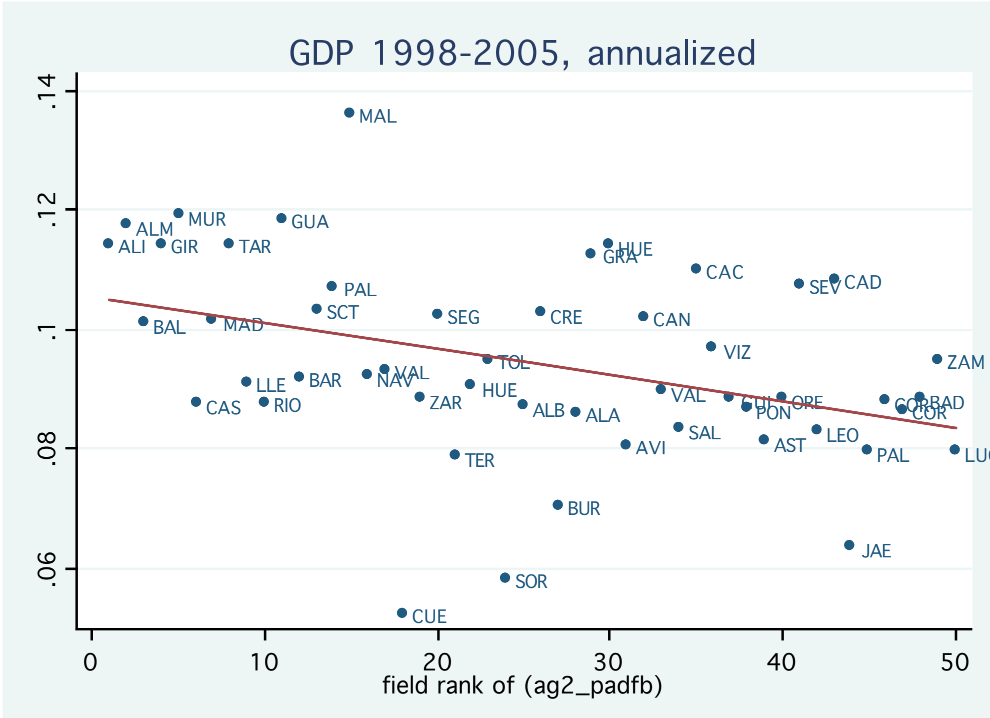


Figure 2



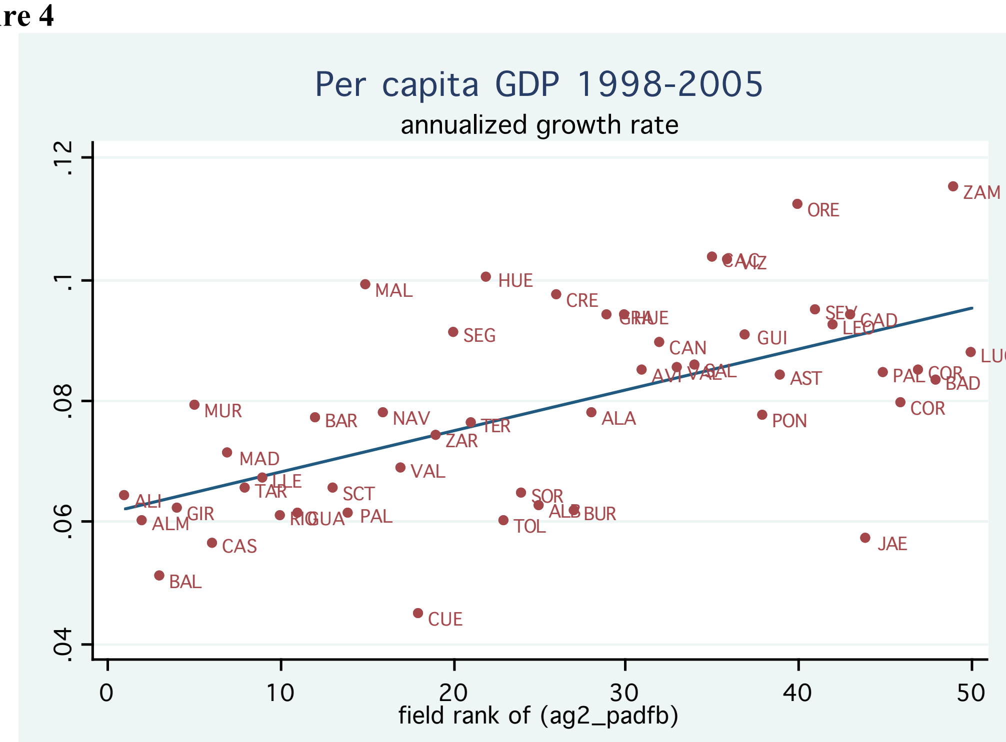
Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 3



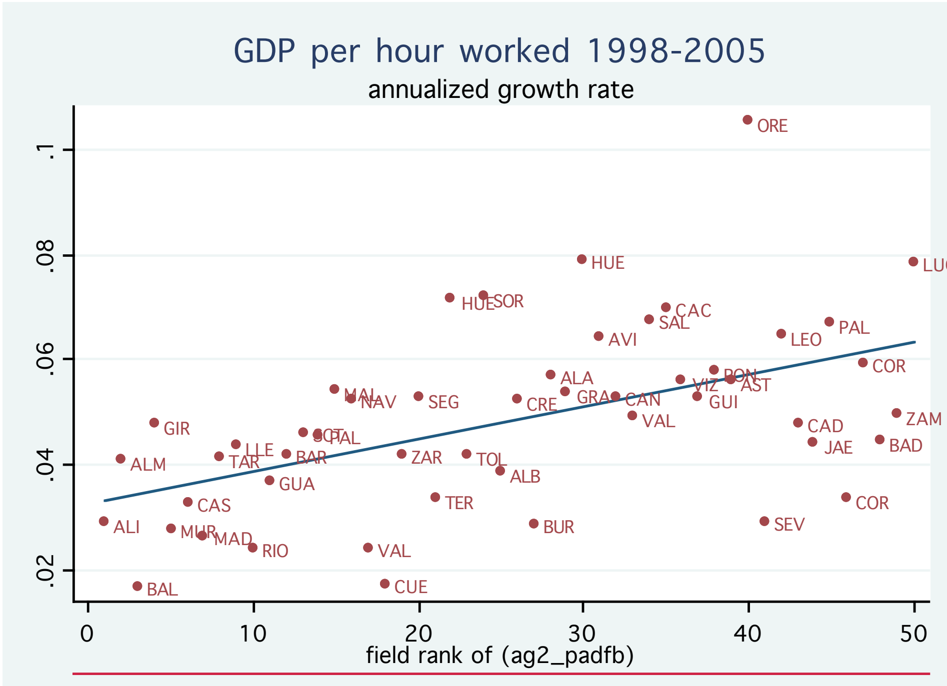
Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 4



Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 5



Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 6: Wage bill over total employment.

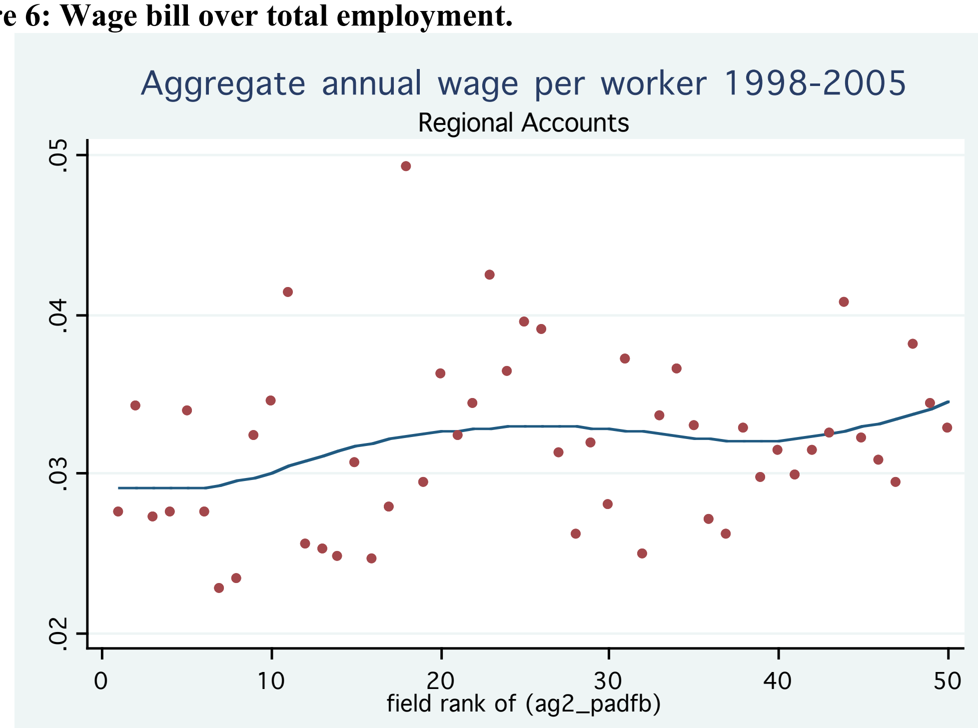


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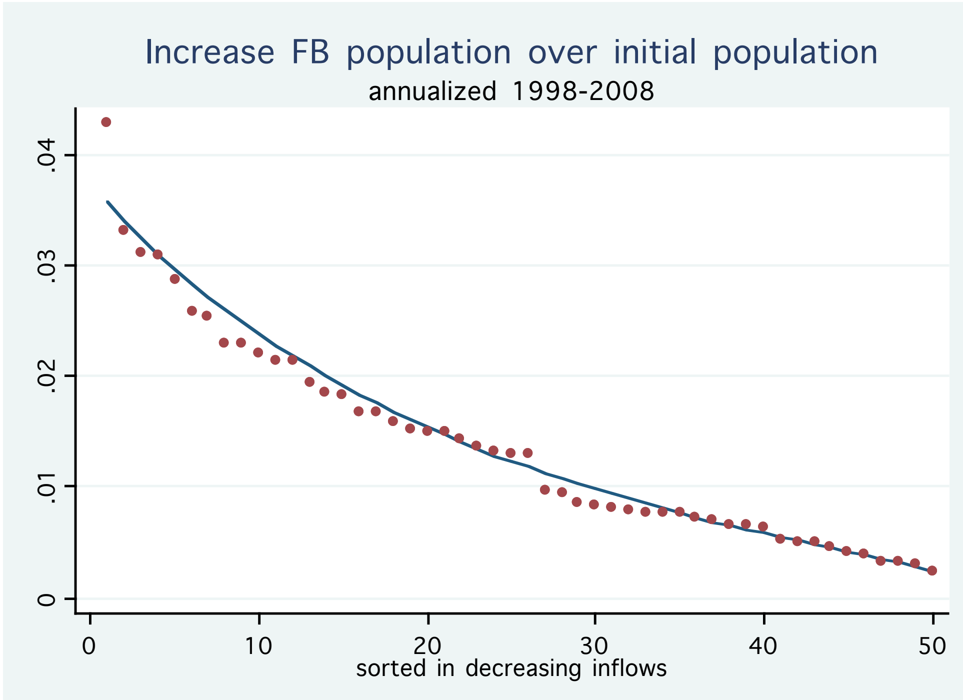
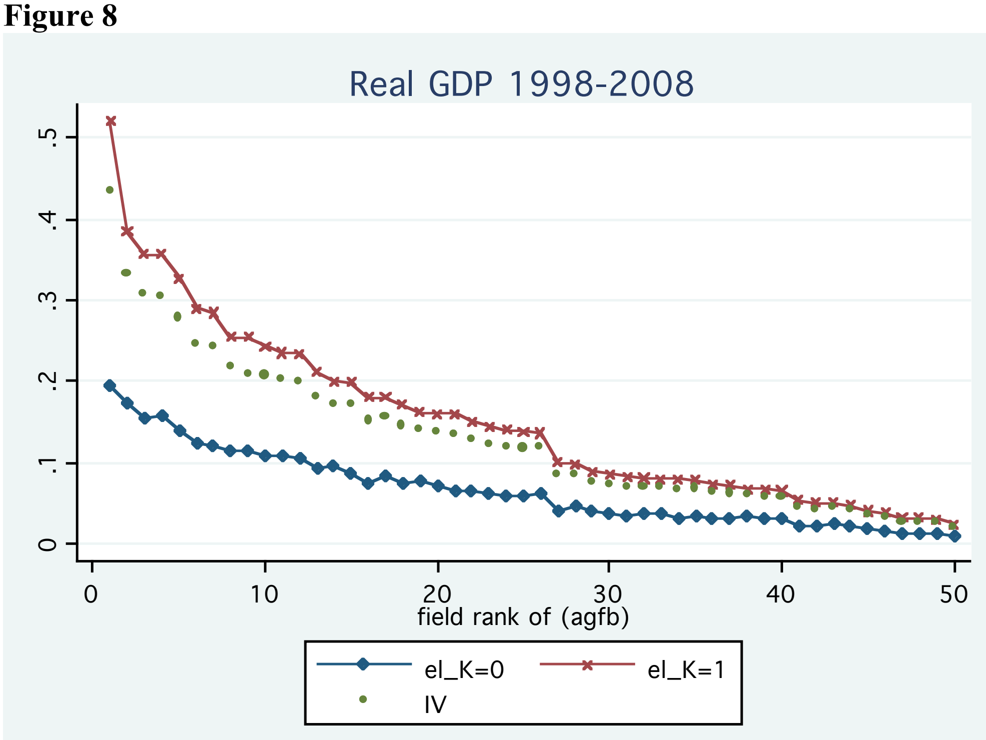
Figure 7



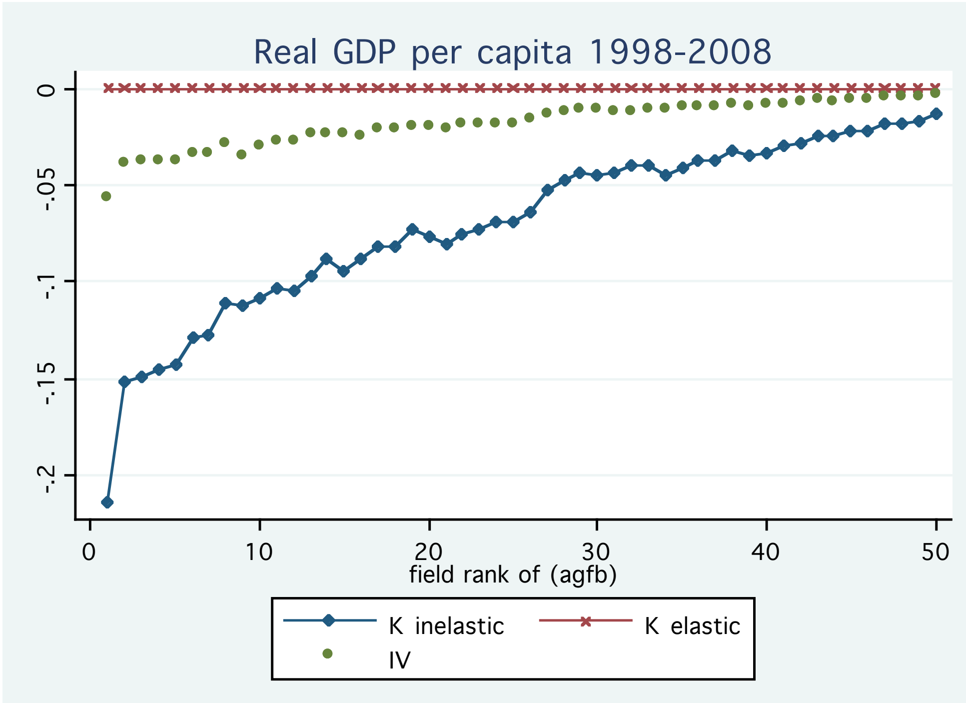
Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 8



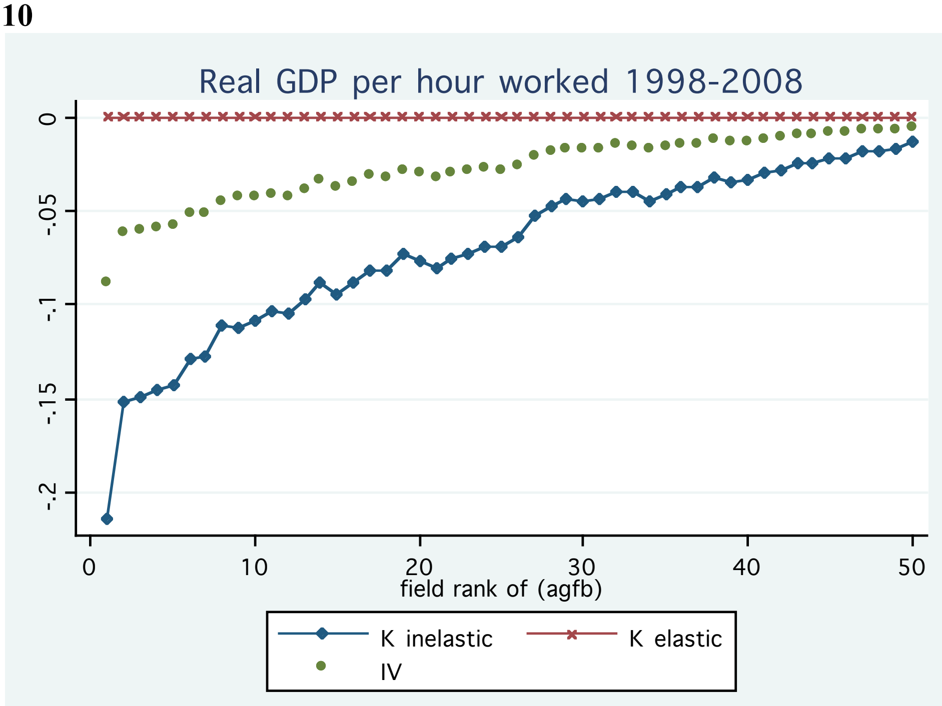
Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 9



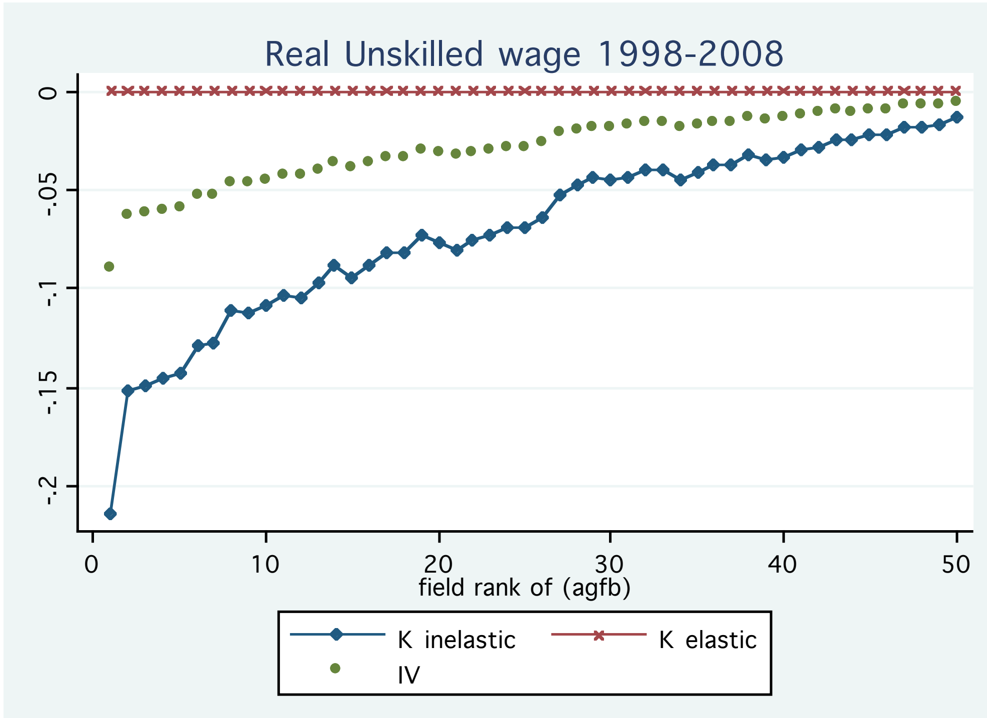
Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 10



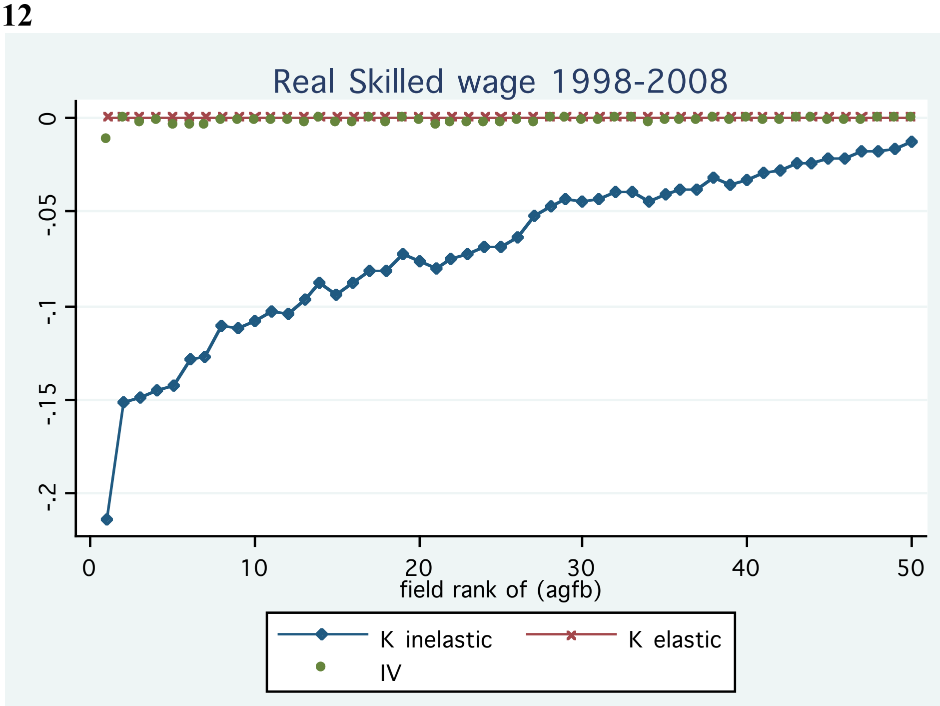
Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 11



Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.

Figure 12



Note: Regions are sorted in decreasing order of the change in foreign-born population, relative to total 1998 population.