The Immigration Surplus and the Substitutability of Immigrant and Native Labor: Evidence from Spain

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INSIDE Paper No. 11
July 2009

INSIDE
(Insights on Immigration and Development)
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Abstract

How immigration affects the labor market of the host country is a topic of major concern for many immigrant-receiving nations. Spain is no exception following the rapid increase in immigrant flows experienced over the past decade. We assess the impact of immigration on national income in Spain by estimating the net immigration surplus under the assumptions of both perfect and imperfect substitutability of immigrant and native labor of similar educational attainment and work experience. In the latter case, we use information on the occupational distributions of immigrants and natives of different education-age groups to develop a mapping of immigrant-to-native skills that reveals the combination of natives of distinct education-age cells equivalent to an immigrant in a given education-age cell. We then use the information on the immigrant-to-native occupation or skill correspondence to account for the imperfect substitutability between immigrant and native labor within education-age cells. The results show that the magnitude of the immigration surplus significantly rises with the size of the immigrant population and, in particular, with the imperfect substitutability between immigrant and native labor.

JEL Classification: J61, F22
Keywords: Immigration surplus, imperfect substitutes, Spain.

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The authors appreciate comments from David Card and from participants at the ESPE conference at the University of Illinois, Chicago, and from participants in a seminar at the University of Paris. Financial support from the Ministry of Education and Science (SEJ2006-10827/ECON) is gratefully acknowledged.

I. Introduction

How immigration affects the labor market of the host country is a topic of major concern for many immigrant-receiving nations. Spain is no exception following the rapid increase in immigrant flows experienced over the past decade. In 1991, only 1.2 percent of the Spanish adult population (about 300,000 individuals) was foreign-born. Within a decade, this percentage quadrupled to 4.0 percent (1,370,000 individuals) and, by 2008, it had roughly reached 11 percent (5,200,000 individuals). In fact, since the year 2000, Spain has displayed one of the largest rates of immigration in the world – three to four times as large as the average immigration rate in the U.S. Hence, it is not surprising that the majority of Spanish citizens usually declare immigration as one of their main social concerns together with unemployment, housing and terrorism according to the Spanish Sociological Research Centre (CIS).

Do immigrants raise the incomes of Spanish natives? In this paper, we address this question. As in the Hecksher-Olin Model, where trade raises national income if the factor shares of the trading partner differ from those of the home country, immigration raises income inasmuch the skill shares of the inflow of immigrants differ from those of natives. The greater the difference between the skill shares of natives and immigrants, the greater the increase in income will be. If native and immigrant workers of similar educational attainment and experience posses productive skills that lead them to specialize in different occupations, immigrants and natives will not be competing for the same jobs. Instead, they will complement each other and immigration may then raise natives' incomes. Therefore, the increase in income depends on the degree of substitutability between natives and immigrants, with an underlying redistribution of income from groups of natives to those of incoming immigrants with similar skills and to groups of immigrants and natives with complementary skills. It is this income redistribution that often lies behind anti-immigration sentiments and substantiates the need to gain a better understanding of the consequences that the geographic distribution of immigrants may have on the well-being of natives.

To date, there is an extensive group of studies that have assessed the effects of immigration on natives on account of the differential skill share of immigrant and native groups (e.g. Altonji and Card 2001; Card 2001; Borjas 1995, 2003; Ottaviano and Peri 2005, 2006). With the exclusion of a few recent studies, such as Ottaviano and Peri (2006), Peri (2006) and Manacorda *et al.* (2006), most analyses assume perfect substitutability between immigrants and natives within an education-age cell –where age is used as a proxy for labor market experience. Yet, as noted more recently by Amuedo-Dorantes and De la Rica (2008) for Spain, foreign-born workers do not appear to be perfect substitutes of native workers of similar age and education. Instead, immigrants display a distinct task specialization and occupational distribution than natives of the same education and age. This is not surprising as immigrants often have limited language proficiency and, even when they speak the same language as the host country's natives, their human capital (both education and work experience) is not perfectly transferable. Instead, immigrants' educational attainment and experience are likely to be valued differently in the host country and, consequently, differently from those of natives. As a result, immigrants are likely to have skills that differ from those of natives with similar education and work experience and, thus, hold different occupations and earn different wages.

In this paper, we assess the impact of immigration on national income in Spain by estimating the net immigration surplus under two scenarios: (a) first, assuming that immigrants and natives are perfect substitutes, and (b) second, taking into account the imperfect substitutability of immigrant and native labor even within education-age cells.

To account for the imperfect substitutability of immigrant and native labor, we use information on the occupational distribution of immigrants and natives in different education-age cells and develop a mapping of immigrant-to-native skills that reveals the combination of natives in various education-age cells equivalent to an immigrant in a given education-age cell. In this manner, we distinguish between immigrant skill shares measured by the incidence of immigrants in a given education-age cell and immigrant skill shares resulting from the aforementioned immigrant-to-native occupation (as a proxy for skill) correspondence. The former skill shares allow us to measure the immigration surplus under the assumption of perfect substitutability between immigrant and native labor, whereas the former takes into account the imperfect substitutability between immigrant and native labor within education-age cells.

The rest of the paper is organized as follows. Section II provides a description of the data we will be using in our analysis and Section III discusses some descriptive evidence by skill level of the foreign-born relative to natives. Section IV explains how the analysis accounts for the imperfect substitutability of immigrant and native labor and Section V describes the production function used in our structural approach to estimate the immigration surplus. Results are discussed in Section VI and Section VII concludes the study.

II. Data

The main database for our analysis is the 2001 Census. The Census has the advantage of surveying immigrants regardless of their legal status. Nonetheless, we are aware that an important fraction of unauthorized immigrants may not fill in the questionnaire and, as such, this group is likely to be under-represented in the Census. The Census gathers information on personal and demographic characteristics (such as age, education and province of residence). This information is used to group individuals into education and experience (proxied by age) cells.

However, the Census is limited with respect to the list of variables for which data are compiled. For instance, it lacks information on respondents' language skills or on where they completed their schooling. Yet, for our group of recent migrants, this is likely to have taken place in their countries of origin.[1] As we shall show in what follows, this is important an important point as immigrants' educational attainment, as well as their work experience, may not be fully transferable. Additionally, the Census only asks respondents about their nationality and not about their place of birth or the nationality of their parents and grandparents. Therefore, we define immigrants as individuals reporting a foreign nationality. Perhaps most crucial for the analysis at hand is the Census' lack of information on labor earnings. To supplement this shortcoming, we make use of Spanish data from the 1994 through 2001 waves of the *European Community Household Panel* (ECHP) –a longitudinal survey that collects demographic and employment information on a random sample of Spanish individuals for up to eight waves. We use these data to compute labor-income shares for each of the skill groups in 2001. Additionally, we use these data to compute the elasticities of substitution across education groups and the elasticities of substitution between workers with different experience levels but within the same education group.

III. The Skill and Occupational Distribution of Immigrant and Native Labor

In order to compute the net immigration surplus, we focus on working individuals. Additionally, given the young age at which most individuals migrate and the fact that most natives do not enter the job market until age 20, we center our attention on working individuals between 20 and 50 years of age.

[1] The Census question regarding the educational attainment of individuals 10 years of age and older is phrased as follows: "What is the highest grade you have completed?"

Before proceeding any further, we first look at the education-age distribution of immigrants and natives. We consider 12 education-age levels resulting from 3 educational categories (i.e. primary or less, secondary and university) and 4 age intervals (i.e. 20-30 years, 31-35, 36-40 and 41-50 years). One of the interesting features that emerge from Figure 1 is the concentration of most immigrants and natives within the education-age groups no. 5 through no. 8 (secondary education at each age interval). Despite some differences between immigrants and natives (such as the greater relative concentration of natives in higher ranked education-age groups and of immigrants in education-age groups 1, 2, 3, 5 and 6), the fact that most immigrants and natives are found within a limited number of education-age cells suggests that both groups display similar educational and age distributions.

Yet, are their education and work experience (as proxied by their age) similarly valued in the Spanish labor market? In particular, are immigrants' educational attainment and work experience fully transferable? And, if not, does the imperfect transferability of immigrants' education and work experience result in an occupational distribution that significantly differs from that of natives of similar education and age? As noted earlier, if immigrants and natives were perfect substitutes within a given education-age cell, the occupational distributions of both groups within that cell should look alike. Figures 2 through 5 display the occupational distribution (at the two-digit ISCO level) of immigrants and natives in education-age groups no. 5 through no. 8 (that is, those with a secondary education) – where more than 50 percent of natives and immigrants are concentrated. One of the key findings from those figures is the unequal occupational distribution of immigrants and natives within each of the education-age groups being examined. Overall, immigrants display a significantly greater concentration in occupation no. 50 (i.e. restaurants and food services), occupation no.

71 (i.e. extraction and building trades), occupation no. 91 (i.e. domestic service), occupation no. 94 (i.e. non-skilled agriculture workers), and occupation no. 96 (i.e. non-skilled construction workers) than their native counterparts. Natives appear to display a higher concentration in occupations placed to the left of the graphs (i.e. more qualified non-manual jobs), whereas the opposite is true for immigrants. The distinct occupational distribution of immigrants and natives with similar education and age suggests that the education and work experience of immigrants may not be fully transferable. In that event, immigrant and native labor within an education-age cell can no longer be considered perfect substitutes as it has been traditionally done by the literature. Instead, we need to account for the imperfect substitutability between immigrant and native labor within education-age cells.

IV. Addressing the Imperfect Substitutability of Immigrant and Native Labor

One way to address the imperfect substitutability of immigrant and native labor within an education-age cell is to assume that an immigrant in the education-age group *i* is not equivalent to a native in the same education-age cell but, rather, to a weighted linear combination of natives in different education-age cells.[2] More specifically, we assume that an immigrant in a given education-age cell is equivalent to: w_1 natives in education-age group no.1, plus w_2 natives in education-age group no. 2,…, plus w_N natives in education-age group no. N. These weights are based on the occupational distribution of immigrants and natives in each education-age cell and are obtained in two steps.

In the first step, for each education-age group *i*, we look for a set of weights, i.e. w_{i1}, …, w_{iN} (where N=12 and it stands for the number of education-age groups) that

[2] We are very grateful to David Card for suggesting this approach as an alternative way of computing the substitutability between immigrant and native labor in the absence of wage data by worker nationality.

give the linear combination of natives that is closest to one immigrant. These are estimated separately for each education-age group according to the occupational distribution of immigrants and natives across occupations: 1,…*j*. Denote by $p_{i1},..., p_{ij}$ the occupational distribution of natives in the education-age group *i* across occupations: 1,…*j* –where: $p_{i1} + ... + p_{ij} = 1$ for each education-age group *i*. Likewise, denote by $q_{i1},..., q_{ij}$ the occupational distribution of immigrants in education-age group *i* across occupations: 1,…*j* –where: $q_{i1} + ... + q_{ij} = 1$ for each education-age group *i*. We can obtain the estimated weighted linear combination of natives that is closest to one immigrant by estimating, for each education-age group *i*, a linear regression of the occupational distribution of immigrants across the *j* occupations (q_i) on the occupational distribution of natives across those *j* occupations (p_i) as follows: $q_i = w_{i1}\, p_1 + \ldots + w_{i12}\, p_{12} + \varepsilon_i$, where: $w_{i1} + \ldots + w_{i12} = 1$.

Once we have estimated the set of weights: $w_{i1}, \ldots, w_{iN}$, we construct what we refer to as the corrected immigrant skill shares, which is the linear combination of natives that is equivalent to one immigrant in the education-age group *i*, i.e. $\beta_i^{'} = w_{i1}b_1 + ... + w_{i12}b_{12}$ (where b_i denotes the share of natives in the education-age cell *i*).

Figure 6 displays the differences between immigrant and native skill shares that result when we use immigrant skill shares computed using information on the distribution of immigrants across education-age cells (i.e. β), and the differences between immigrant and native skill shares that result when we use the immigrant skill shares described above (i.e. β'). The two series are particularly different in the case of younger workers with a secondary education (i.e. education-age group no. 5) and in the case of 36-40 years old workers with secondary education (i.e. education-age group no.

7). As noted in Figure 1, these are two of the education-age groups most frequented by both immigrant and native labor. Such differences are suggestive of the imperfect substitutability of immigrant and native labor within a given education-age cell and, consequently, of the importance of using the corrected immigrant skill shares in the computation of the immigration surplus.

V. Computing the Immigration Surplus

To calculate the immigration surplus, we expand the framework used in Borjas (1995) to compute the immigrant surplus under the assumption of homogeneous labor to a case of heterogeneous labor where workers can belong to *n* different education-age groups. We assume a production technology that can be described by the following concave and linear homogeneous production function:

$$Q = f\left(K, L_1, \ldots, L_n\right) \quad (1)$$

Each education-age group (or cell) *i* is defined in terms of educational attainment $\left(k\right)$ and experience $\left(j\right)$. Educational attainment is measured in three categories: primary, secondary and university, while experience is proxied with the following four age categories: 20-30, 31-35, 36-40 and 41-50.

We make several assumptions about the production function. First, we assume that all capital is owned by natives. Immigrants do not contribute any capital. If they did, the immigration surplus accruing to natives would only be smaller as we shall discuss later on. Second, the supply of labor is perfectly inelastic. As noted by Borjas (1995), this assumption only makes the calculation of the immigration surplus simpler. Third, we assume that capital is infinitely elastically supplied at a constant rate *r*. This assumption is more realistic than assuming a fixed-capital stock and, as noted by Borjas (1995, p. 6), it makes no significant difference in the calculation of the gains from immigration. Capital owners do not obtain any gain as there is no change in the interest rate, *r*. Fourth, we assume that the production function exhibits constant returns to scale; therefore, the entire output is distributed among workers. Under these conditions, the immigration surplus is positive as long as the skill composition of immigrants differs from that of native workers, i.e., inasmuch as immigrants' skill shares (β'_i) differ from those of natives (b_i). Otherwise, wages would be unaffected by immigration and the immigration surplus would equal zero. Finally, we allow for the imperfect substitutability of immigrant and native labor within a given education-age cell by using the immigrant skill shares (β'_i) described in the previous section.[3]

At equilibrium, the price of each of the factors of production has to equal the value of its marginal product and, consequently, the increase in income accruing to natives following the entry of *M* immigrants (i.e. the increase in national income per unit of output accruing to natives) is given by:

$$IS = \frac{\Delta Q_N}{Q} = (K\frac{\partial r}{\partial M} + b_1 N\frac{\partial w_1}{\partial M} + b_2 N\frac{\partial w_2}{\partial M} + ... + b_n N\frac{\partial w_n}{\partial M})\frac{M}{Q} \qquad (2)$$

where b_i denotes the share of natives in a given education-age cell $i = 1...n$. Under the assumption that capital is infinitely elastically supplied at a constant rate *r*, that only immigrants with skills that differ from those of natives create a positive surplus, and evaluating the derivatives of wages at the average rate (i.e., at: (1/2)*M*), which implies obtaining half the gain obtained when the derivatives are evaluated at $L=N+M$, we can rewrite equation (2) as :

[3] Other authors, like Ottaviano and Peri (2005, 2006) and Manacorda *et al.* (2006), assume a production function where immigrants and natives within a given education-age cell are imperfect substitutes and estimate the elasticity of substitution between immigrants and natives using a (log) wage regressions. Unfortunately, we lack representative data on wages earned by native and immigrant workers in Spain for the time periods under consideration. Therefore, our approach must be seen as an alternative way to address the imperfect substitutability between immigrants and natives within a given education-age cell. In particular, instead of estimating the native-immigrant relative efficiency parameter (as Manacorda *et al*. 2006 refer to it) using wage data, we do so using information on the occupations held by immigrants and natives –a proxy of their skills in the Spanish labor market.

$$IS = \frac{\Delta Q_N}{Q} = \frac{1}{2}\left[b_1 N \left(\beta'_1 - b_1\right) M \frac{\partial w_1}{\partial M} + b_2 N \left(\beta'_2 - b_2\right) M \frac{\partial w_2}{\partial M} + ... + b_n N \left(\beta'_N - b_N\right) M \frac{\partial w_n}{\partial M} \right] \quad (3)$$

where β_i' denotes the share of immigrants within education-age cell *i* as described in section IV. As in free trade, immigrants create a surplus as long as their skills differ from those of natives, i.e. the immigration surplus is positive only when $\left(\beta'_i - b_i\right) \neq 0$. Otherwise, owing to the CES assumption, the prices of the various factors of production would remain unchanged (as their relative supplies would remain unaltered) and natives would not gain anything from immigration.

Given that: $\frac{\partial w_i}{\partial M} = \sum_{j=1}^{n} \frac{\partial w_i}{\partial L_j} \frac{\partial L_j}{\partial M}$, we can convert equation (3) into percentage terms and measure the surplus at the average value of M, which yields the following expression for the immigration surplus:[4]

$$IS = \frac{1}{2}(1-m)m\left[\left\{\sum_{i=1}^{n}\left[(\beta'_i - b_i)^2 \frac{s_i}{p_i}\left[\sum_{j=1}^{n} e_{ji}\right]\right]\right\}\right] \qquad (4)$$

where $m = \frac{M}{L}, s_i = \frac{w_i L_i}{Q}, p_i = \frac{L_i}{L}$, and e_{ij} stands for the (absolute value of the) inverse of factor price elasticity within and across education-age cells. According to equation (4), the immigration surplus increases with: (i) the difference in the skill composition of the native and immigrant workforce, (ii) the shares of national income accruing to each education-age level, and (iii) the total factor price elasticity (in absolute value), which will be larger when labor demand is inelastic.

<u>Computing Factor Price Elasticities:</u>

In order to compute the immigration surplus accruing to the main immigrant-receiving regions and to the nation as a whole, we need information on $b_i, \beta'_i, m, p_i, s_i$

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[4] A detailed description of all steps involved in deriving equation (4) can be found in the appendix.

and e_{ij}. The first four parameters can be easily computed using information from the 2001 Census. However, in order to compute the factor price elasticities $\left(e_{ij}\right)$, we need to make some specific assumptions regarding the technology at hand. Following Borjas (2003), we assume a three-level CES technology. Under the three-level CES production function, we assume that workers with similar educational attainment are aggregated to form the labor supply of a particular education group. Workers of different educational levels but with the same work experience, as captured by age, are, in turn, aggregated to form the national labor supply. As such, the aggregate production function for the whole economy at time *t* is given by:

$$Q_t = \left[\lambda_{K_t} K_t^{\nu} + \lambda_{L_t} L_t^{\nu}\right]^{\frac{1}{\nu}} \tag{6}$$

where $\nu = 1 - 1/\sigma_{KL}$, with σ_{KL} being the elasticity of substitution between capital and labor. As suggested by Hamermesh (1993, p.92) and assumed in Borjas (2003), we allow for σ_{KL} to take the value of 1. The lambdas represent time-variant technology shifters, which satisfy that: $\left(\lambda_{K_t} + \lambda_{Lt}\right) = 1$. The labor aggregate L_t includes workers that differ in their educational attainment and experience and is defined as:

$$L_t = \left[\sum_{k=1}^{4} \theta_{kt} L_{kt}^{\rho}\right]^{\frac{1}{\rho}} \tag{7}$$

where *k* stands each of the educational categories. The parameter ρ is given by: $\rho = 1 - 1/\sigma_E$, where σ_E is the elasticity of substitution across education groups. Within each educational group *k*, we allow for workers with different experience levels to be imperfect substitutes. As such, the labor supply of workers within a particular educational group at a point in time is given by:

$$L_{kt} = \left[\sum_{j=1}^{4} \alpha_{kj} L_{kjt}^{\eta} \right]^{\frac{1}{\eta}} \quad (8)$$

where j are age intervals. The parameter η is given by: $\eta = 1 - 1/\sigma_j$, where σ_j measures the elasticity of substitution between workers with different experience levels but within the same educational group.

One advantage of the three-level CES production function is that the technology can be summarized in terms of three elasticities of substitution: $\sigma_{KL}, \sigma_E, \sigma_j$. As noted by Card and Lemieux (2001), the marginal productivity condition describing the wage for workers in the education-age group (k, j, t) for this type of production function allows us to get an estimate of σ_j as follows:

$$\log\left(w_{kjt}\right) = \delta_t + \delta_{kt} + \delta_{kj} - \left(1/\sigma_j \right) \log L_{kjt} \quad (9)$$

whereas the marginal condition determining the wage of workers in a particular educational group k allows us to derive an estimate of σ_E from:

$$\log\left(w_{kt}\right) = \delta_t + \delta_{kt} - \left(1/\sigma_E \right) \log L_{kt} \quad (10)$$

In order to estimate equations (9) and (10), we need aggregate data on wages and total employment for each education-age category over several time periods. As noted in the Data section, one important drawback of the Census is that it lacks information on wages. Therefore, we get wage and employment data from the *European Community Household Panel* (ECHP) –a longitudinal survey that collects demographic and employment information on a random sample of Spanish individuals for up to eight waves (i.e. from 1994 through 2001).[5] In the estimation of equation (9), we include

[5] We have 96 observations (i.e. three educational categories, four age groups and eight time periods) for the estimation of equation (9) and 24 observations (i.e. three educational categories and eight time periods) for the estimation of equation (10).

time, education and age fixed-effects, as well as interactions between education and age,[6] whereas equation (10) is estimated with time and education fixed-effects. All estimations are weighted using the cell size.

We first estimate equations (9) and (10) using OLS.[7] Subsequently, we account for the endogeneity of the workforce size with respect to the average wage in a particular cell using the number of immigrants in that cell as an instrument for the cell's workforce size.[8] Table 1 displays the results from the estimation of equations (9) and (10) using OLS and instrumental techniques. The implied elasticity of substitution across experience (age) groups is approximately 4.5 —a figure very close to Card-Lemieux (2001) estimates, which range between 3.8 to 4.9 using U.S. data. Likewise, the point estimate of the elasticity of substitution across education groups is 1.44 –very similar to the one found by Borjas (2003) and Katz-Murphy (1992) for the U.S. (between 1.1 and 3.1).

With estimates for the three elasticities summarizing our production function, we can proceed to compute the factor price elasticities describing the wage impacts of immigration on natives in the same education-experience group, as well as in other education and experience categories. Following Hamermesh (1993), the three-level CES technology leads to an equation of the wage effect of an increase in the supply of workers with education k and experience j as follows:

$$e_{kj,kj} = -\frac{1}{\sigma_j} + \left(\frac{1}{\sigma_j} - \frac{1}{\sigma_E}\right)\frac{s_{kj}}{s_k} + \left(\frac{1}{\sigma_E} - \frac{1}{\sigma_{KL}}\right)\frac{s_{kj}}{s_L} + \frac{1}{\sigma_{KL}} s_{kj} \qquad (11)$$

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[6] Given the limited number of observations, we are unable to include interaction terms between education and time fixed-effects.
[7] We use the logarithm of gross hourly wages as the dependent variable and weight the regressions by the cell size. Standard-errors are corrected for clustering at the cell level.
[8] This instrument is valid insofar the number of immigrants in a particular cell is independent of the relative wages of the various cell categories. Even if this unlikely, cells with higher relative wages should have a larger number of workers in them and, therefore, we would still have underestimates of the negative impact of a labor supply increase on the average cell wage.

where $e_{kj,kj}$ are the own factor price elasticities, and s stands for the share of income accruing to each input. Likewise, the cross-factor price elasticities are given by:

$$e_{kj,kj'} = \left(\frac{1}{\sigma_j} - \frac{1}{\sigma_E}\right)\frac{s_{kj'}}{s_k} + \left(\frac{1}{\sigma_E} - \frac{1}{\sigma_{KL}}\right)\frac{s_{kj'}}{s_L} + \frac{1}{\sigma_{KL}} s_{kj'} \tag{12}$$

and:

$$e_{kj,k'j'} = \left(\frac{1}{\sigma_E} - \frac{1}{\sigma_{KL}}\right)\frac{s_{k'j'}}{s_L} + \frac{1}{\sigma_{KL}} s_{k'j'} \tag{13}$$

To compute the factor price elasticities summarized in equations (11) through (13), we use a value of 0.7 for the labor share of income.[9]

To compute the income shares for each education-age group, we make use of the wage information contained in the *European Community Household Panel* (ECHP) for 2001 as well as the employment information contained in the Census. Table 2 displays the income shares of each of the 12 education-age groups, whereas Table 3 displays the estimated own elasticitiy, the elasticity across age groups within educational categories and the elasticity across educational categories. The own elasticities range between -0.25 and -0.38, cross elasticities within an education branch fluctuate between -0.01 and -0.16, and cross elasticities between workers with different educational attainments are closer to zero. These factor price elasticities are, overall, of similar magnitude to the ones reported by Borjas (2003) for the U.S.

VI. Findings

To finally estimate the immigration surplus, we combine the estimated factor price elasticities and labor income shares with information on the parameters $b, \beta', p,$ and m using equations (4) and (5). Table 4 shows the estimated immigration surplus under the assumption of perfect and of imperfect substitutability between immigrant and

[9] See Conesa (2004) for the calibration of the labor share of income in Spain.

native labor of the same age-education group in columns (1) and (2), respectively. It is worth noting that, as predicted by the Hecksher-Olin Model for trade, immigration raises income inasmuch the skill shares of the inflow of immigrants differ from those of natives. As a result, the computed immigration surplus under the assumption of imperfect substitutability between natives and immigrants is approximately three and a half times larger than the one computed assuming the perfect substitutability between both types of labor. In particular, the immigration surplus under the assumption of perfect substitutability of immigrant and native labor amounts to approximately 0.0065 percent of GDP, whereas the immigration surplus under the assumption of imperfect substitutability of immigrant and native labor is estimated to be 0.023 percent of GDP. Using 2001 GDP figures, the immigration surplus when immigrant and native labor are perfect substitutes amounts to roughly 3.88 million euros/year, while it reaches 13.8 million euros/year if immigrants and natives are considered imperfect substitutes. While this figure is smaller than previous U.S. estimates (about 0.1 percent of GDP, see Borjas (1995)), it is still quite significant in magnitude considering the recent character of Spanish immigration.[10]

To learn more about how the magnitude of the immigration surplus may change when we incorporate information on recent and also significantly larger immigration rates, columns (3) and (4) of Table 4 use immigrant penetration rates from 2007 (as opposed to 2001) in the computation of the immigration surplus. As documented in Table 5, this is an important exercise as immigrant penetration rates grew from 5 to 10 percent over the six year period. Given the large increase in the immigration population, it is not surprising to find that the new immigration surpluses approximately double the estimates reported in columns (1) and (2). As a result, the immigration

[10] Here, it is worth noting that, while immigrants account for as much as 40 percent of the workforce in some U.S. regions, in Spain this figure never exceeds 15 percent.

surplus under the assumption that immigrant and native workers are perfect substitutes within an education-age cell is 0.017 percent of GDP (about 10.2 million euros/year using 2001 GDP figures), whereas it rises to 0.04 percent of GDP (approximately 24 million euros/year) when immigrants and natives are considered imperfect substitutes.

Overall, the figures in Table 4 indicate that immigration benefits Spanish natives. Furthermore, the benefit to natives rises with: (a) the size of the immigrant stock, and (b) the imperfect substitutability between immigrant and native labor within an education-age cell.

VII. Summary and Conclusions

Spain has experienced growing immigration inflows during the past decade. In 1991, only 1.2 percent of the Spanish adult population (about 300,000 individuals) was foreign-born. Within a decade, this percentage quadrupled to 4.0 percent (1,370,000 individuals) and, by 2008, it had roughly reached 11 percent (5,200,000 individuals). In fact, since the year 2000, Spain has displayed one of the largest rates of immigration in the world –three to four times as large as the average immigration rate in the U.S. As such, it is only logical to question how these new immigrants are impacting the economic well-being of Spanish natives.

In this paper, we address this question using data from the 2001 Census, along with Spanish data from the *European Community Household Panel* (ECHP) for 1994 through 2001. Assuming a three-level CES production function, along with minimal interregional labor mobility and changes in the industries that intensively employ migrants (Lewis 2003), we compute the immigration surplus accruing to Spanish natives via changes in relative factor prices. In addition to examining the impact of immigration on the Spanish economy –an interesting and almost unprecedented case study given the impressive growth of its immigrant population over the past 15 years, a major contribution of our analysis is the computation of the immigration surplus under the assumption of both perfect and imperfect substitutability between immigrant and native labor within an education-age cell. This proves to be crucial because, as noted by Amuedo-Dorantes and De la Rica (2008), foreign-born workers do not appear to be perfect substitutes of Spanish native workers of similar age and education. Instead, immigrants are more highly concentrated in non-skilled occupations relative to natives of similar educational attainment and age.

We find that the immigrant surplus amounts to approximately 0.04 percent of GDP when we take into account the imperfect substitutability of immigrant and native labor and make use of the 2007 figures on immigration. This estimate more than doubles the immigration surplus under the traditional assumption of perfect substitutability of immigrant and native labor using the 2007 figures on immigration. This increase in the immigration surplus is not surprising. Theoretically, as noted by the Hecksher-Olin Model for trade, the immigration surplus is expected to increase inasmuch immigrants differ from natives.

What is the main policy implication stemming from these findings? To the extent that the magnitude of the immigration surplus depends on the degree of substitutability between natives and immigrants, if attempting to maximize the contribution of immigrants to national income, immigration policy should favour immigrant inflows with skills complementary to those of natives.

Finally, it is worth noting that the computed immigration surplus does not take into account the fact that immigrants create valuable consumption externalities, such as a growing demand for various goods and services. The latter shifts the labor demand curve to the right, creates employment, and can raise the immigration surplus beyond the figure computed herein. Likewise, the computed immigration surplus does not include other benefits stemming from the increased immigration. In particular, immigrants shape the population pyramid –a contribution that may be crucial in financing the retirement of a progressively older population owing to declining fertility rates and increasing longevity. Therefore, the computed immigration surplus may understate the significant bearing of immigration on the Spanish economy.

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Table 1: Elasticities of Substitution

(Dependent Variable: Log Gross Hourly Wages)

Elasticity of Substitution across Experience Groups ($1/\sigma_j$)		**Elasticity of Substitution across Educational Groups ($1/\sigma_E$)**	
OLS	**IV**	**OLS**	**IV**
-0.34	-0.22	-0.65	-0.69
(0.04)	(0.15)	(0.16)	(0.25)

Notes: Standard errors in brackets**.** The regressions estimating ($1/\sigma_j$) include 3 education fixed-effects, 3 fixed-age effects and 7 year fixed-effect. We do not include interaction terms between education and experience (age) groups due to the small sample sizes. We instrument the log of the number employed in each cell with the number of working immigrants in that cell. The regressions estimating ($1/\sigma_E$) include 7 year fixed-effect and 3 education fixed-effects.

Source: European Community Household Panel (ECHP), 1994-2001.

Table 2: Income Shares by Education-Age Group

Education	Age	Cell Income Shares	Income Shares (within education branch)
Primary or less	20-30	0.008	0.095
Primary or less	31-35	0.019	0.095
Primary or less	36-40	0.025	0.095
Primary or less	41-50	0.035	0.095
Secondary	20-30	0.033	0.366
Secondary	31-35	0.132	0.366
Secondary	36-40	0.114	0.366
Secondary	41-50	0.098	0.366
University	20-30	0.009	0.239
University	31-35	0.078	0.239
University	36-40	0.071	0.239
University	41-50	0.072	0.239

Source: European Community Household Panel (ECHP), 1994-2001.

Table 3: Estimated Factor Price Elasticities by Education-Age Group

Education	Age	Own Elasticity	Cross Elasticity (within education branch)	Cross Elasticity (across education branches)
Primary or less	20-30	-0.256	-0.036	0.004
Primary or less	31-35	-0.308	-0.088	0.011
Primary or less	36-39	-0.331	-0.111	0.014
Primary or less	41-50	-0.376	-0.156	0.019
Secondary	20-30	-0.245	-0.024	0.018
Secondary	31-35	-0.317	-0.097	0.074
Secondary	36-39	-0.304	-0.084	0.064
Secondary	41-50	-0.293	-0.072	0.055
University	20-30	-0.233	-0.013	0.005
University	31-35	-0.332	-0.112	0.044
University	36-39	-0.322	-0.102	0.040
University	41-50	-0.323	-0.102	0.040

Source: European Community Household Panel (ECHP), 1994-2001.

Table 4: Immigration Surplus (as a Percent of GDP)

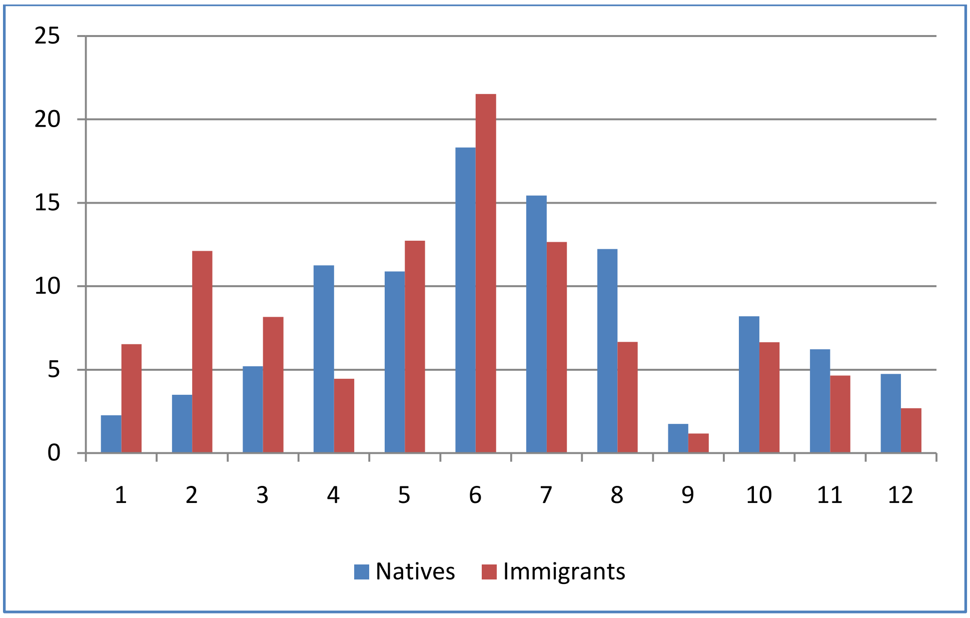
Specifications	Using the 2001 Immigration Penetration Index		Using the 2007 Immigration Penetration Index	
	Perfect Substitutability	Imperfect Substitutability	Perfect Substitutability	Imperfect Substitutability
	(1)	(2)	(3)	(4)
Immigration Surplus	6.47×10^{-3}	0.023	0.017	0.040

Table 5: Immigrant Penetration (*m*)

Year	**2001**	**2007**
Immigrant Penetration Index	0.05	0.10

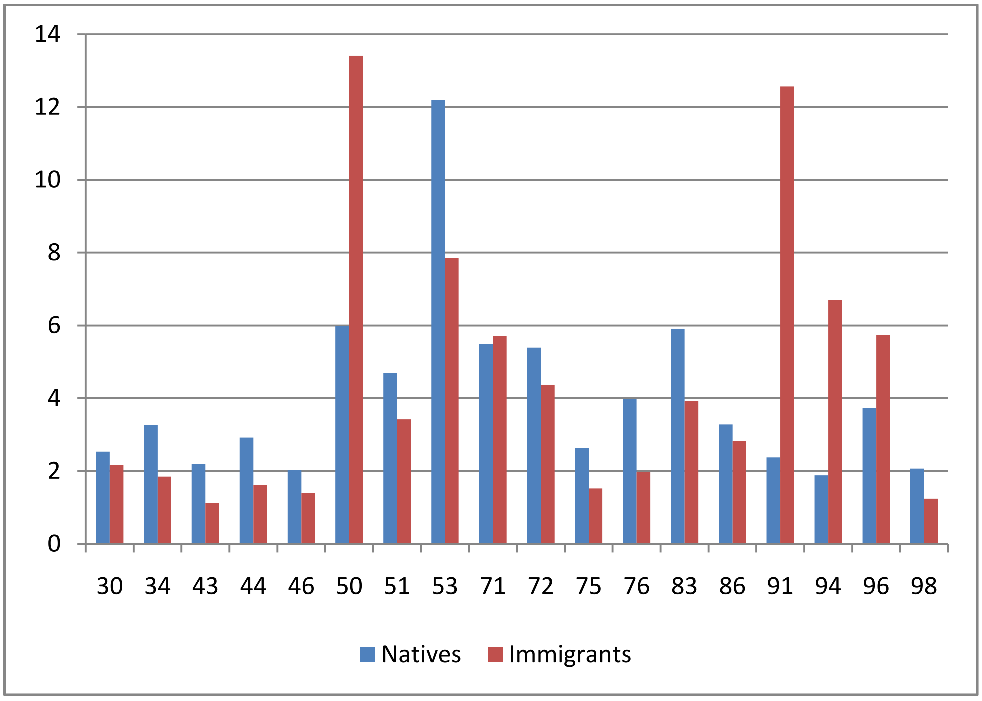
Source: Official population registers (Padrón Municipal), Instituto Nacional de Estadística.

Figure 1
Distribution of Immigrants and Natives across Education-Age Groups



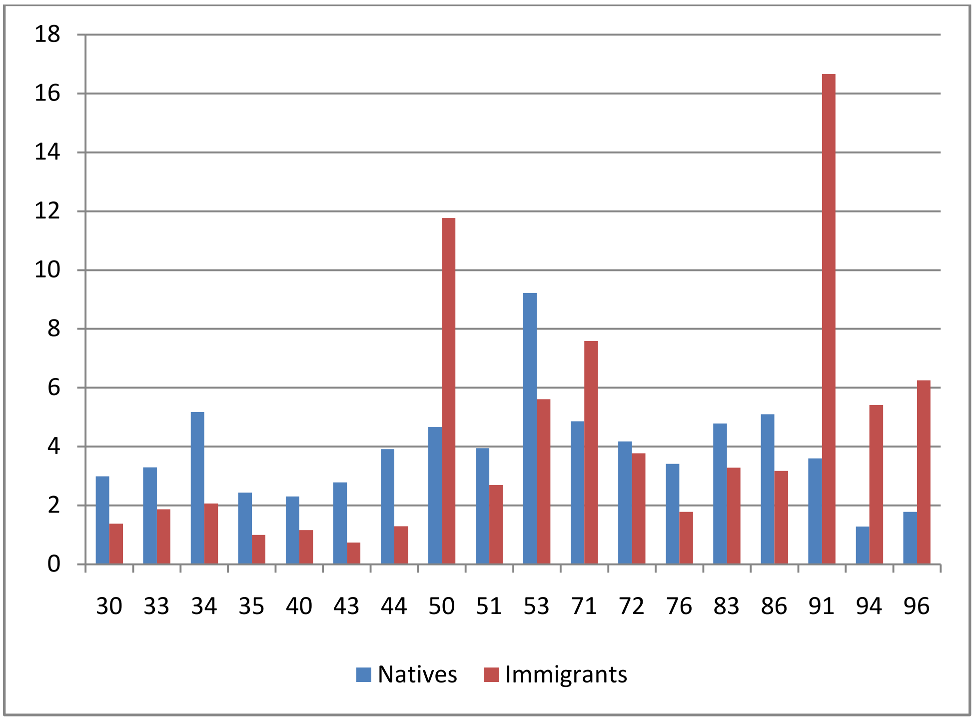
Notes: Education-age groups are defined as follows: 1=Primary or less and less than 30 years; 2=Primary or less and 31-35 years; 3= Primary or less and 36-40 years; 4=Primary or less and 41-50 years; 5= Secondary and less than 30 years ; 6=Secondary and 31-35 years; 7= Secondary and 36-40 years; 8=Secondary and 41-50 years; 9=University and less than 30 years; 10=University and 31-35 years; 11=University and 36_40 years: 12=University and 41-50 years.
Source: 2001 Census.

Figure 2
Occupational Distribution of Natives and Immigrants with a Secondary Education and Less than 30 Years Old



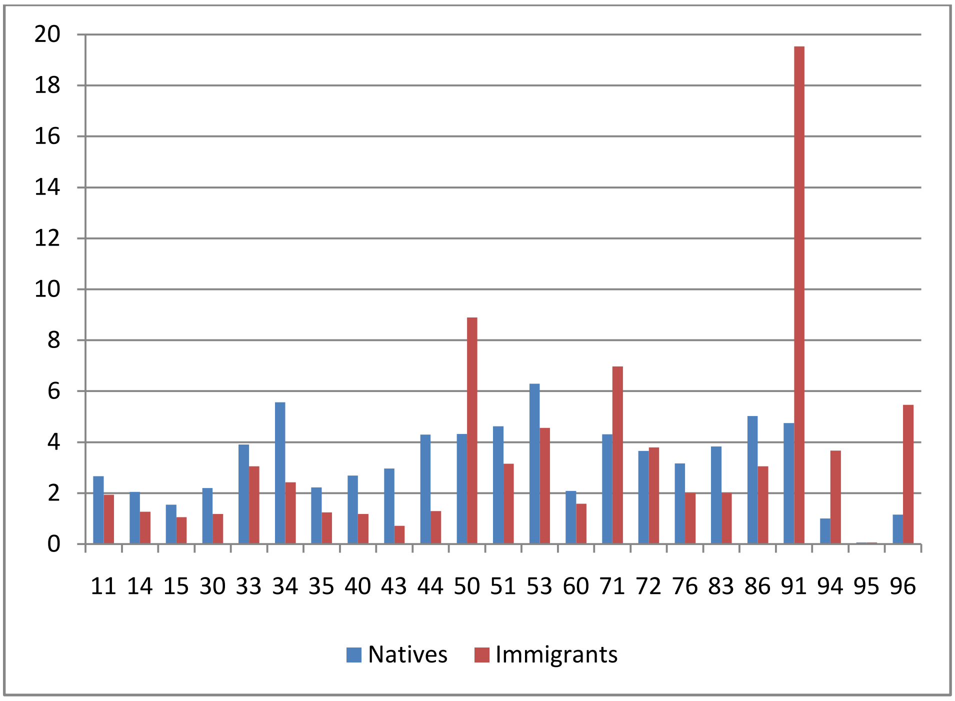
Source: 2001 Census.

Figure 3
Occupational Distribution of Natives and Immigrants with a Secondary Education and 31-35 Years Old



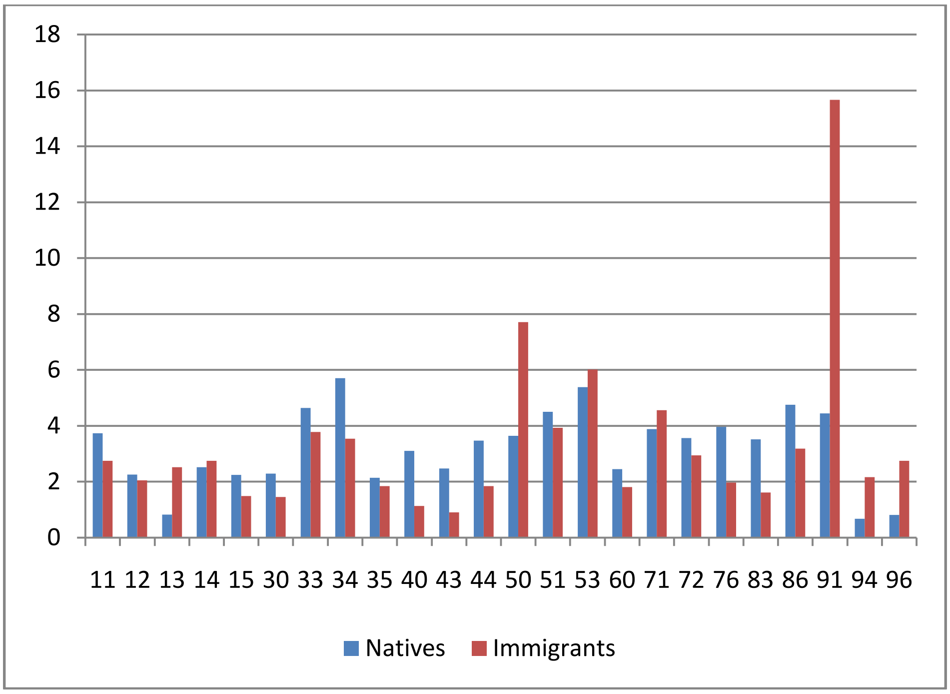
Source: 2001 Census.

Figure 4
Occupational Distribution of Natives and Immigrants with a Secondary Education and 36-40 Years Old



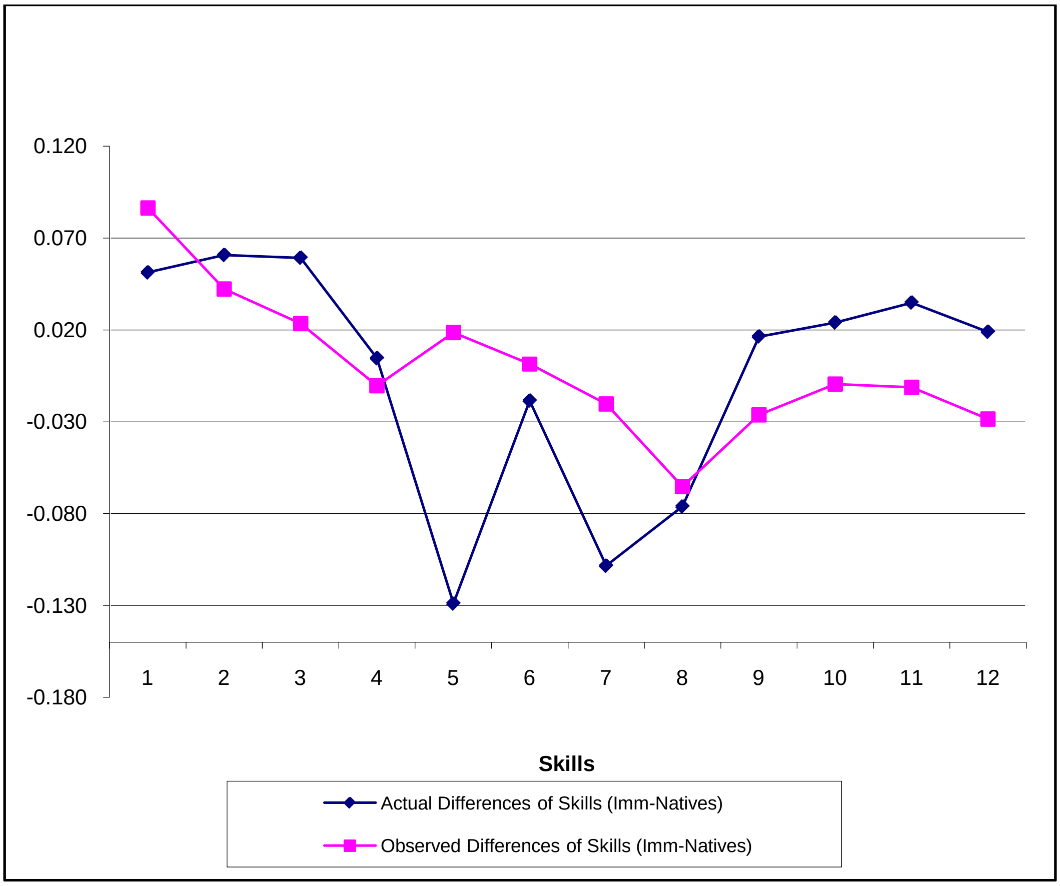
Source: 2001 Census.

Figure 5
Occupational Distribution of Natives and Immigrants with a Secondary Education and 41-50 Years Old



Source: 2001 Census.

Figure 6
Differences in Education-Age Shares of Immigrants and Natives



Notes: Education-age groups are defined as follows: 1=Primary or less and less than 30 years; 2=Primary or less and 31-35 years; 3= Primary or less and 36-40 years; 4=Primary or less and 41-50 years; 5= Secondary and less than 30 years ; 6=Secondary and 31-35 years; 7= Secondary and 36-40 years; 8=Secondary and 41-50 years; 9=University and less than 30 years; 10=University and 31-35 years; 11=University and 36_40 years: 12=University and 41-50 years.
Source: 2001 Census.

Appendix

Derivation of the Immigration Surplus in Equation (4)

The increase in income accruing to natives following the entry of *M* immigrants (i.e. the increase in national income per unit of output accruing to natives) is given by:

$$IS = \frac{\Delta Q_N}{Q} = (K\frac{\partial r}{\partial M} + b_1 N\frac{\partial w_1}{\partial M} + b_2 N\frac{\partial w_2}{\partial M} + ... + b_n N\frac{\partial w_n}{\partial M})\frac{M}{Q} \qquad (2)$$

where b_i denotes the share of natives with a particular education-age level $i = 1...n$. Under the assumptions that: (a) capital is infinitely elastically supplied at a constant rate *r*, and that (b) immigrants create a surplus as long as their skills differ from those of natives and, therefore, the immigration surplus is positive only when: $\left(\beta'_i - b_i\right) \neq 0$,[11] we can evaluate the derivatives of wages at the average rate (i.e., at: (1/2)*M*, which implies obtaining half the gain obtained when the derivatives are evaluated at *L*=*N*+*M*) and rewrite equation (2) as :

$$IS = \frac{\Delta Q_N}{Q} = \frac{1}{2}\left[b_1 N\left(\beta'_1 - b_1\right)M\frac{\partial w_1}{\partial M} + b_2 N\left(\beta'_2 - b_2\right)M\frac{\partial w_2}{\partial M} + ... + b_n N\left(\beta'_N - b_N\right)M\frac{\partial w_n}{\partial M}\right] \qquad (3)$$

where β_i' denotes the computed share of immigrants within education-age cell *i*.

Given that: $\frac{\partial w_i}{\partial M} = \sum_{j=1}^{n}\frac{\partial w_i}{\partial L_j}\frac{\partial L_j}{\partial M}$ and $\frac{\partial L_j}{\partial M} = (\beta_j' - b_j)$, after some manipulation to get the elasticities and income shares for each education-age level *i*, we can rewrite equation (3) as:

$$IS = \frac{\Delta Qn}{Q} = -\frac{1}{2}\frac{N}{L}\frac{M}{L}\left\{\sum_{i=1}^{n}\left[(\beta'_i - b_i)^2\frac{s_i}{p_i}\left[\sum_{j=1}^{n} e_{ji}\right]\right]\right\}$$

where $s_i = \frac{w_i * L_i}{Q}$, $p_i = L_i / L$, and e_{ji} stands for the (absolute value of the) inverse of factor price elasticity within and across skills. Substituting those terms in the equation above, we obtain the final expression for the immigration surplus:

$$IS = \frac{\Delta Q_N}{Q} = -\frac{1}{2}(1-m)m\sum_{i=1}^{n}\left(\frac{(\beta'_i - b_i)^2 s_i}{p_i}\left(\sum_{j=1}^{n} e_{ij}\right)\right) \qquad (4)$$

where $m = M / L$ and $(1-m) = N / L$.

[11] The supply shock that contributes to the Immigration Surplus is therefore not *M*, but: $\sum_{i=1}^{n}(\beta'_i - b_i)M$.