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Complements or Substitutes? Immigrant and Native Task Specialization in Spain

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Non-Technical Abstract

Learning about the impact that immigration has on the labor market of the receiving nation is a topic of major concern, particularly in Spain, where immigration has more than doubled from 4 percent to roughly 10 percent of the population within a decade. Yet, very little is known about the impact that large immigrant inflows have had on the labor market outcomes of Spanish natives. Furthermore, most studies assume that natives and immigrants are perfect substitutes within skill groups –a questionable assumption given recent findings in the literature. In this paper, we first document that foreign-born workers are not perfect substitutes of similarly skilled native Spanish workers, which may help explain why immigration has not significantly lowered natives' wages. Instead, immigration has affected the occupational distribution of natives. Specifically, owing to the comparative advantage of foreign-born workers in manual as opposed to interactive tasks, natives relocated to occupations with a lower content of manual tasks –such as technical and alike professional occupations, clerical support jobs, and sales and service occupations. Yet, possibly owing to the significant and simultaneous reduction in the manual to interactive task supply resulting from the increase in the share of native female workers, the increase in the relative supply of manual to interactive tasks from foreign-born workers does not appear to have significantly changed the overall manual to interactive task supply in the Spanish economy.

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Abstract

Learning about the impact that immigration has on the labor market of the receiving nation is a topic of major concern, particularly in Spain, where immigration has more than doubled from 4 percent to roughly 10 percent of the population within a decade. Yet, very little is known about the impact that large immigrant inflows have had on the labor market outcomes of Spanish natives. Furthermore, most studies assume that natives and immigrants are perfect substitutes within skill groups –a questionable assumption given recent findings in the literature. In this paper, we first document that foreign-born workers are not perfect substitutes of similarly skilled native Spanish workers, which may help explain why immigration has not significantly lowered natives' wages. Instead, immigration has affected the occupational distribution of natives. Specifically, owing to the comparative advantage of foreign-born workers in manual as opposed to interactive tasks, natives relocated to occupations with a lower content of manual tasks –such as technical and alike professional occupations, clerical support jobs, and sales and service occupations. Yet, possibly owing to the significant and simultaneous reduction in the manual to interactive task supply resulting from the increase in the share of native female workers, the increase in the relative supply of manual to interactive tasks from foreign-born workers does not appear to have significantly changed the overall manual to interactive task supply in the Spanish economy.

1. Introduction

The impact of immigration on 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 2007, it has roughly reached 10 percent (4,500,000 individuals).

While there is a large and growing literature on the consequences of migration on the wages of native workers in the U.S. (see Borjas (1994, 1995, 1999, 2003, 2005), Borjas and Katz (2007), Card (1990, 2001, 2005), Card and Di Nardo (2000), Card and Lewis (2007), Lewis (2003), Ottaviano and Peri (2005, 2006), among others), with a few exceptions, very little is known about the impact of migration on the employment patterns and wages of Spanish natives. Take, for instance, the well-accepted fact that, if workers' skills are differentiated mainly by their level of educational attainment and workers of different education levels are imperfect substitutes, a large flow of immigrants with limited schooling should (i) increase wages paid to highly-educated natives and (ii) reduce wages paid to less-educated ones. Yet, in general, the effect of immigration on the wages of less-educated natives has been, if any, of very small magnitude in the U.S. as well as in Spain (e.g. Amuedo-Dorantes and De la Rica (2008), González and Ortega (2007), Carrasco et al (2008)). However, as recently noted by Ottaviano and Peri (2006), this is not surprising given that the effect of immigration depends on the degree of substitution between native and immigrant workers *within* each education group. If native and immigrant workers of similar educational attainment posses productive skills that lead them to specialize in different occupations, it is reasonable to find a small or null impact of immigration on natives' wages as immigrants and natives are not competing for the same jobs.

Therefore, in order to learn about the impact of immigration on the host country economy, it is first crucial to empirically assess the degree of substitution between native and immigrant workers of comparable educational attainment. First, we provide evidence of immigrants and natives being imperfect substitutes *within* skill categories. Subsequently, we proceed to examining some of the reasons as for why that may be the case. In particular, we explore whether immigration encourages native specialization in occupations that differ from those held by immigrants, thus explaining recent native and immigrant employment patterns, as well as the lack of a negative wage impact of immigration on natives' wages. We find that natives seem to relocate to jobs with a lower content of manual, as opposed to interactive or non-manual tasks.[1] In particular, once we look more closely at the impact that immigration inflows may have had on the occupational distribution of natives in Spain, we find that low-educated natives are leaving jobs with a higher content of manual tasks –such as crafts and related trades, machine operations and assembly, or other low skilled jobs, as domestic help– for jobs with a lower content of manual tasks –such as technical, professional, clerical support, and sales and service jobs. Yet, possibly owing to the significant and simultaneous reduction in the manual to interactive task provision in the overall economy resulting from the increase in the share of native female workers, the increase in the relative supply of manual to interactive tasks from foreign-born workers does not appear to have significantly changed the overall manual to interactive task supply in the Spanish economy.

The rest of the paper is organized as follows. Section 2 presents the theoretical model upon which we base our empirical analysis. A detailed data description and some motivating descriptive statistics are provided in Section 3 of the manuscript. In Section 4, we discuss our empirical methodology and preliminary findings and Section 5 concludes the paper.

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[1] Throughout the paper, we will be using the terms "interactive" and "non-manual" interchangeably.

2.   Theoretical Model

We develop an extension of Peri and Sparber's (2008) general equilibrium model. In their model, immigrants, compared to natives, have a comparative advantage in performing manual relative to interactive tasks owing to their limited language proficiency and their often missing Spanish-specific human capital skills. We extend their model to allow for gender differences in the native comparative advantage in manual as opposed to interactive tasks. Specifically, we assume that women have a comparative advantage in performing interactive, as opposed to manual, tasks relative to their male counterparts. This extension is relevant in the Spanish case given the significant increase in female labour force participation in the recent years. Figure 1 shows the evolution of male and female employment rates in Spain between 1976 and the year 2008. Starting in the mid 1980's, female employment rates started to rise from approximately 25 percent to about 65 percent by the year 2008. In fact, during the period under examination in this study, that is: between 1999 and the year 2007, female employment rates have risen by approximately 20 percentage points, from 45 percent to about 65 percent. In contrast, over the same time period, male employment rates have stayed fairly stable at around 85 percent.

2.1.   Aggregate Demand Function

We start with an economy that produces one tradable final consumption good we call Y, which only requires a low skilled intermediate input: Y_L.[2] The production of Y_L is carried out by less educated workers and requires a technology that combines two different types of tasks: manual (M) and interactive or interactive (I) tasks. Manual tasks can be routine or non-routine in nature. Examples of manual tasks include body coordination and physical strength, whereas interactive tasks require interactive skills, such as being able to easily communicate

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[2] For simplicity, we focus on low skilled goods given that competition among natives and immigrants is more likely to occur in low-skilled jobs. Regarding high-skilled goods, we are implicitly assuming that they are produced by high skilled workers.

with other people, being capable of performing team work or supervising the work of others. Both tasks are combined to produce Y_L according to the following CES production function:

$$Y_L = [\beta_L M^{\frac{\lambda-1}{\lambda}} + (1-\beta_L)I^{\frac{\lambda-1}{\lambda}}]^{\frac{\lambda}{\lambda-1}} \qquad (1)$$

where β_L measures the productivity of manual versus interactive tasks in the production of Y_L and λ captures the elasticity of substitution between manual (*M*) and interactive (*I*) tasks. Profit maximization in a competitive market then yields the following relative demand function for manual versus interactive tasks:

$$\frac{M}{I} = m = \left(\frac{\beta_L}{1-\beta_L}\right)^{\lambda} (w_m)^{-\lambda} \qquad (2)$$

where w_m is the relative compensation for manual versus interactive tasks, i.e., $w_m = \dfrac{w_M}{w_I}$.

2.2. Immigrant and Native Task Supplies

In order to focus on native specialization in occupations that differ from those held by immigrants as a potential explanation for the imperfect substitutability of natives and immigrants within skill cell, we assume that less educated natives and immigrants differ in their comparative advantage in manual versus interactive tasks Specifically, we assume that immigrants have, relative to their native counterparts, a comparative advantage in performing manual as opposed to interactive tasks. This is a reasonable assumption given that, unlike manual tasks, interactive tasks require the usage of communication skills that most immigrants may still lack upon arrival owing to their limited language proficiency, lack of Spanish-specific human capital, and overall imperfect transferability of skills. If we denote by e_{mi} and e_{mn} as the efficiency in manual relative to interactive tasks of native and immigrant workers, respectively, the stated assumption implies that: $\bar{e}_{mi} > \bar{e}_{mn}$, where the subscripts *i* and *n* refer to immigrants and natives, respectively.

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Now consider a representative worker j, who dedicates his/her work time (e.g. one unit) to perform manual and interactive tasks. If we denote by s_M the share of time each worker dedicates to work on manual tasks, then each worker j will choose how to allocate his time among manual and interactive tasks so as to maximize his/her labor income (w_{Lj}):

$$w_{Lj} = \left(s_M\right)^{\alpha} t_{mj} w_M + \left(1 - s_M\right)^{\alpha} t_{ij} w_I \qquad (3)$$

where t_{mj} and t_{ij} refer to the work time each worker j dedicates to manual and interactive tasks, respectively. The superscript α (where: $\alpha<1$) reflects decreasing returns in performing either manual or interactive tasks –which guarantees that workers do not completely specialize in performing one particular type of tasks. Maximization of equation (3) with respect to s_M yields the optimal relative supply of manual versus interactive tasks, η_{mj}, which is directly related to the relative task compensation in manual versus interactive tasks, (w_m), and to the worker relative efficiency in performing manual versus interactive tasks (e_{mj}) :

$$\eta_m = w_m^{\frac{\alpha}{1-\alpha}} \left(e_{mj}\right)^{\frac{1}{1-\alpha}} \qquad (4)$$

2.3. The Equilibrium Relative Provision of Manual versus Interactive Tasks

In order to find the equilibrium relative provision of manual to interactive tasks, we need to aggregate equation (4) across all workers to obtain the market relative supply of manual relative to interactive or interactive tasks, denoted by m:

$$m^* = \left(w_m\right)^{\frac{\alpha}{1-\alpha}} \left(\overline{e}_m\right)^{\frac{1}{1-\alpha}} \qquad (5)$$

Using equations (5) and (2), we can solve for the aggregate equilibrium provision of manual versus interactive tasks as well as for the equilibrium relative compensation:

$$m^* = \left(\frac{\beta_L}{1-\beta_L}\right)^{\frac{\alpha\lambda}{(1-\alpha)\lambda+\alpha}} \left(\overline{e_m}\right)^{\frac{\lambda}{(1-\alpha)\lambda+\alpha}} \qquad (6)$$

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$$w_m^* = \left(\frac{\beta_L}{1-\beta_L}\right)^{\frac{(1-\alpha)\lambda}{(1-\alpha)\lambda+\alpha}} (e_m)^{\frac{-1}{(1-\alpha)\lambda+\alpha}} \qquad (7)$$

2.4. Task Supplies of Natives and Immigrants

We have solved for the equilibrium relative task provision of manual versus interactive tasks of a representative worker assuming that all workers are homogeneous with regards to their efficiency in performing manual and interactive tasks. However, one of the key assumptions of the model is the existence of heterogeneity in the comparative advantage of manual versus interactive tasks across workers. In particular, we assume that (i) immigrants are more efficient in providing manual relative to interactive tasks than natives, and (ii) among natives, women are more efficient in providing interactive relative to manual tasks than their male counterparts. Therefore, we now expand the model to take into account these two assumptions.

We first rewrite the aggregate supply of manual versus interactive tasks in this economy as a weighted average of the relative supply by natives and immigrants of both tasks, where the weight is the share of interactive tasks provided by immigrants (which is a monotonic transformation of the foreign-born share of low-educated workers, $L_i/(L_N+L_i)$) :

$$m = \left(\frac{M}{I}\right) = \left(\frac{M_i + M_n}{I_i + I_n}\right) = f\left(\frac{M}{I}\right)_i + (1-f)\left(\frac{M}{I}\right)_n = fm_i + (1-f)m_n \qquad (8)$$

If we further disaggregate the native provision of relative tasks, i.e. m_n by gender, equation (8) can be rewritten as follows:

$$m = fm_i + (1-f)\big(gm_{nw} + (1-g)m_{nm}\big) \qquad (9)$$

where g is the share of interactive tasks provided by native women among all native workers, which is a monotonic transformation of the native female share of our sample of native workers. The subscript nm stands for native men and nw for native women.

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The average relative efficiency of all low educated workers in performing manual versus interactive tasks, $\overline{e_m}$, can also be rewritten as a weighted average of natives and immigrants' relative efficiency in manual and interactive tasks as follows:

$$\overline{e_m} = \left[f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} (1-f)\overline{(e_m)}_n^{\frac{1}{1-\alpha}} \right]^{(1-\alpha)} \quad (10)$$

If we further assume that the relative efficiency in manual versus interactive tasks of native men and women also differs, we have that:

$$\overline{e_m} = \left[f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} (1-f)\left[g\overline{(e_m)}_{nw}^{\frac{1}{1-\alpha}} + (1-g)\overline{(e_m)}_{nm}^{\frac{1}{1-\alpha}} \right]^{\frac{1}{1-\alpha}} \right]^{(1-\alpha)} \quad (11)$$

We need to obtain an expression for the optimal supply of manual to interactive tasks by natives, $(m)_n^*$, and for the equilibrium provision of relative tasks in the economy, $(m)^*$, as a function of the relative efficiency in performing tasks by each group. With that purpose, we make use of equation (5) and obtain the optimal supply of tasks provided by native workers:

$$m_n^* = \left(w_m^*\right)^{\frac{\alpha}{1-\alpha}} \overline{(e_m)}_n^{\frac{1}{1-\alpha}} \quad (12)$$

In addition, the equilibrium compensation of relative tasks can be written as:

$$w_m^* = \left(\frac{\beta_L}{1-\beta_L}\right)^{\frac{1-\alpha)\lambda}{(1-\alpha)\lambda+\alpha}} \left(f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} (1-f)\overline{(e_m)}_n^{\frac{1}{1-\alpha}} \right)^{\frac{-(1-\alpha)}{(1-\alpha)\lambda+\alpha}} \quad (13)$$

By substituting equation (13) into equation (12), we can solve for the optimal supply of relative tasks of natives as a function of the relative efficiency of natives and immigrants in performing manual versus interactive tasks, which is given by:

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$$m_n^* = \left(\frac{\beta_L}{1-\beta_L}\right)^{\frac{\alpha\lambda}{(1-\alpha)\lambda+\alpha}} \left[f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} (1-f)\overline{(e_m)}_n^{\frac{1}{1-\alpha}} \right]^{\frac{-\alpha}{(1-\alpha)\lambda+\alpha}} \overline{(e_m)}_n^{\frac{1}{1-\alpha}} \qquad (14)$$

In order to obtain the expression of the equilibrium provision of relative tasks in the economy, we can substitute equation (10) into equation (6) and rewrite the equilibrium provision of manual to interactive tasks as a function of the relative efficiency of each of the three groups under consideration, i.e., native men, native women and immigrants, in manual relative to interactive tasks:

$$m^* = \left(\frac{\beta_L}{1-\beta_L}\right)^{\frac{\alpha\lambda}{(1-\alpha)\lambda+\alpha}} \left[f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} + (1-f)\left[g\overline{(e_m)}_{nw}^{\frac{1}{1-\alpha}} + (1-g)\overline{(e_m)}_{nm}^{\frac{1}{1-\alpha}} \right]^{\frac{1}{1-\alpha}} \right]^{\frac{\lambda(1-\alpha)}{(1-\alpha)\lambda+\alpha}} \qquad (15)$$

Figures A and B in the appendix illustrate the impact of an increase in *f* and in *g* on the provision of relative manual tasks in the economy. To start with, Figure A depicts the effect of an immigration shock in the overall provision of relative tasks in the economy. Given that the supply of relative tasks of immigrants is clearly to the right of that of natives, the entrance of immigrants in the Spanish labour market shifts the economy's supply of manual to interactive tasks to the right from equilibrium point A to equilibrium point B. At point B, relative wages decrease and, at the lower wage, natives supply fewer manual to interactive tasks. Yet, the supply of relative manual tasks in the economy increases.

What would be the impact of an increase in foreign-born workers if, simultaneously, the economy's is shocked with an increase in native female workers? Figure B in the appendix addresses this question. Given our assumptions regarding the comparative advantages of foreign-born and native female workers in manual as opposed to interactive tasks, an increase in foreign-born workers would raise the supply of manual to interactive tasks in the economy, whereas an increase in native female workers would reduce it. As a

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result, the relative supply of manual to interactive tasks in the economy may shift to the right, to the left, of simply remain unchanged (e.g. example illustrated in Figure B).

2.5. Key Assumptions and Testable Hypotheses

As pointed out in the theoretical model, there are two critical assumptions made in the model. The first one is that, relative to natives, immigrants have a comparative advantage in providing manual as opposed to interactive tasks, i.e. $\overline{(e_m)}_i > \overline{(e_m)}_n$. This assumption implies that the average supply of manual to interactive tasks by immigrants will be greater than that of natives or: $\overline{(m)}^*_i > \overline{(m)}^*_n$. The second assumption is that, among natives, women have a comparative advantage in interactive as opposed to manual tasks, i.e., $\overline{(e_m)}_{nw} < \overline{(e_m)}_{nm}$ which implies that: $\overline{(m)}^*_{nw} < \overline{(m)}^*_{nm}$. Using these assumptions, we derive two testable hypotheses:[3]

i) Hypothesis no.1: Impact of Immigration on the Provision of Manual to Interactive Tasks by Less Educated Natives: According to equation (14), as the share of immigrant workers increases, the supply of manual to interactive tasks of low-educated natives will decrease (see appendix for the proof). That is:

$$Hypothesis \ no.1: \ \frac{\partial (m)^*_n}{\partial f} < 0$$

ii) Hypothesis no. 2: Impact of Immigration on the Economy's Provision of Manual to Interactive Tasks: In order to assess the impact of immigration on the overall economy, we must evaluate the change in the equilibrium provision of manual to interactive tasks as the share of foreign-born rises, *ceteris paribus*, that is, for a given share of native women in the workforce. To do so, we must first make some assumptions regarding the relationship between the share of foreign-born and native female workers.

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[3] Peri and Sparber (2008) examine the impact of immigration on the relative compensation of manual versus interactive tasks as well. However, owing to the lack of adequate data on wages, we do not test the model predictions regarding the relative manual to interactive compensation.

To start, let's suppose that the increase in native female workers is unrelated to the growth in the share of foreign-born workers. In that instance, we can use equation (15) and compute the partial derivative with respect to f for a given share of native female workers. Given our assumption regarding the comparative advantage of foreign-born, native female, and native male workers in manual as opposed to interactive tasks, i.e. $\overline{(e_m)}_i > \overline{(e_m)}_{nm} > \overline{(e_m)}_{nf}$, it is straight forward to show (see appendix) that:

$$Hypothesis \ no.2a: \ \frac{\partial (m)^*}{\partial f} > 0$$

In other words, as the share of foreign-born workers increases, the provision of manual to interactive tasks in the economy rises.

However, many people would argue that the entry of foreign-born workers has favored the increase in native female workers over the past decades and, as such, would question the above assumption regarding the independence of the increases in foreign-born and native female workers (e.g. Furtado and Hock 2008 for the U.S). While we are unaware of any study regarding Spain, descriptive evidence of the evolution of the share of native women and the share of foreign born displayed in Figure 2 suggests that both shares are positively correlated. If $\frac{\partial g}{\partial f} > 0$, the partial derivative of equation (15) with respect to f indicates that an increase in foreign-born workers has an ambiguous impact on the overall provision of manual to interactive tasks in the economy (see appendix for the proof). Therefore, hypothesis no.2 would instead be given by:

$$Hypothesis \ no.2b: \ \frac{\partial (m)^*}{\partial f} \leq or \geq 0$$

In other words, even though the increase in foreign-born workers raises the supply of manual to interactive tasks in the economy, immigrants favour an increase in native female workers. Since native women have a comparative advantage in interactive tasks, they lower the native

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supply of manual to interactive tasks and, consequently, the relative supply of manual to interactive tasks in the economy may decrease, increase or stay the same.

3.   Data and Some Descriptive Evidence

We use the 1999-2007 Spanish Current Population Survey (Encuesta de Población Activa, EPA), which provides the most representative sample of the Spanish workforce. For the descriptive analysis, we also use the wage information contained for Spain in the European Union Standard Living Conditions (EU-SILK) – a micro data panel that currently spans from 2004 to 2006. Because of the limited variables contained in this dataset, as well as the reduced number of years for which these data are available, we are unable to use it in the empirical analysis. We restrict our analysis to recent immigration inflows as recent immigrants (i.e. those with five or fewer years in Spain) are less likely to have yet acquired the language proficiency and Spanish-specific human capital skills than longer-term migrants may enjoy. As a result, they are less likely to display a comparative advantage in interactive tasks relative to long-term migrants who may have already acquired the needed skills to perform well in such tasks. Additionally, since our intent is to explore the implications of low-skilled immigrants' comparative advantage in performing manual as opposed to interactive tasks relative to similarly skilled natives, we focus on immigrants and natives with less than a university degree.[4]

Table 1 presents some descriptive statistics of the sample of natives and immigrants taken from the pooled EPA 1999-2007. We define immigrants as holding a foreign nationality (those with a double nationality are excluded – less than 4 percent), and distinguish recent immigrants, i.e. those with 5 or fewer years in Spain, from all immigrants in the sample. About 3 percent of the sample is foreign-born and a total of 2 percent entered the country recently. Immigrants differ from natives in various regards. First, immigrants, in

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[4] Nonetheless, it is worth noting that our results are robust to the inclusion of all immigrants since the vast majority of them are concentrated in occupations with greater manual task content.

particular recent immigrants, are younger than their native counterparts. For instance, among recent immigrants, sixty-four percent of immigrants are 35 years old or younger relative to 40 percent of natives. In contrast, thirty-two percent of natives are older than forty-five as compared to 12 percent of recent immigrants. Secondly, a higher fraction of immigrant women work relative to native women (i.e. forty-three of all immigrant workers and 46 percent of all recent immigrant workers are women relative to 38 percent for of all native workers). Third, there are also some differences in the educational attainment of immigrants and natives. While the percentage of low educated workers in both groups is rather similar (i.e. 3 to 5 percentage points difference –see Amuedo-Dorantes and De la Rica (2008) for a lengthier discussion), the fraction of workers with secondary schooling is 4 to 7 percentage points higher for immigrants, whereas that of workers with a university degree is 7 percentage points higher among natives. Furthermore, although we cannot distinguish recent from non-recent migrants in the EU-SILK data, natives earn, on average, significantly higher wages than foreign-born workers, which would possibly be indicative of the fact that natives perform different tasks than immigrants. Therefore, the small differences in educational attainment or other observable skills, such as age (or experience), do not necessarily mean that immigrants and natives are substitutes in the labor market.

3.1. Are Immigrants and Natives Close Substitutes?

The first empirical evidence on the lack of substitutability between immigrants and natives emerges from Figure 3, which displays the relative position of low-educated immigrants in the wage distribution of low-educated natives (pooled 2004-2006 from EU-SILK). We have divided the native wage distribution in deciles and, for each decile, we have calculated the percentage of immigrants within each native wage decile. The horizontal line shows that 10 percent of natives fall within each wage decile. However, immigrants are concentrated to a greater extent in the lowest wage deciles of natives, whereas the opposite is

true in higher wage deciles. As such, Figure 3 suggests that immigrants may only compete with low-wage natives.

Additional evidence on the lack of substitutability between natives and immigrants emerges from differences in their occupational distribution in Table 2. For the purposes of our analysis, we focus on working-age individuals (i.e. between 16 and 65 years of age) without a university education. The concentration of immigrant workers in a few occupations is quite remarkable. In particular, about 71 percent of immigrants and an astonishing 78 percent of recent immigrants (relative to 40 percent of natives) work in three broad occupational categories: 1) Low skill jobs that only require an elementary education, 2) service and sales occupations, and 3) craft and related trade jobs. Furthermore, two of those three occupations are among the worse paid.

Is the occupational concentration of immigrants, as compared to natives, due to their distinct educational attainment? Table 3 displays the occupational distribution of immigrants and natives according to their educational attainment, i.e. primary or less and secondary. It is worth noting that 80 to 85 percent of immigrants with secondary education and 75 to 90 percent of immigrants with a primary or lower education are concentrated in three occupations (i.e. low skill jobs that only require an elementary education, service and sale related occupations, and craft and related trade jobs) relative to 55 percent and 61 percent of similarly educated natives, respectively. Therefore, immigrants, particularly more recent immigrants, are concentrated in poorly paid occupations to a greater extent than natives regardless of their educational attainment.

In most studies, the skill level is not measured only in terms of the educational attainment, but rather in terms of education and experience (usually proxied by age), which better reflect the acquired human capital. Most of the literature has traditionally assumed that immigrants and natives within skill groups are close substitutes. This implies that immigrants

and natives within a skill group would compete for similar jobs and, therefore, display similar occupational and wage distributions. However, one would expect immigrants' acquired human capital to differ to a great extent from that of natives with similar observable skills (as measured by age and education). First, most immigrants acquire their education elsewhere and, consequently, their human capital is not fully transferable. Additionally, most immigrants face language barriers and lack country-specific human capital, such as useful work contacts or awareness of social norms innate to natives. Therefore, immigrants are unlikely to be close substitutes to natives even within observed skill levels. We, nonetheless, check whether that is the case in Table 4, which shows the distribution of immigrants and natives across ten skill groups (five age categories and 2 educational groups), along with their average wages and their corresponding wage gaps. With the exception of immigrants and natives in the lowest skill category (i.e. younger than 30 and with a primary education or less), natives earn consistently more than immigrants within any given skill group. The wage gap rises from 0.05 for workers below age 30 and with secondary schooling to 2.68 for workers older than 45 years of age with a secondary education (about 57 percent of the average hourly wage of foreign-born workers in that category). These large wage gaps indicate that immigrants and natives cannot be considered close substitutes within the traditional skill categories. Therefore, observed skills, measured in terms of age and education, cannot be used as a good measure of acquired human capital when we try to compare immigrants and natives.

The observed imperfect substitutability of immigrants and natives of comparable age and educational attainment may be the result of the distinct sorting of immigrants and natives across occupations. More specifically, as Peri and Sparber (2008) suggest, most immigrants, due to their lack of language proficiency and other necessary production skills (interactive skills), may feel that they have a comparative advantage in occupations that do not require

such abilities and that, instead, require more manual than interactive tasks. In this context, immigrants would sort into occupations requiring more manual tasks, whereas natives would specialize in jobs demanding other interactive or tasks.

3.2. Measuring Task Specialization

To examine whether, indeed, immigration leads natives to relocate in jobs demanding greater interactive skills, thus allowing for immigrants to occupy more manual intensive jobs, we rely on information on the job task requirements assembled by Autor, Levy and Murnane (2003).[5] In their paper, Autor et al. (2003) merged data on job task requirements based on the U.S. Department of Labor's *Dictionary of Occupational Titles* (DOT) with Census occupation classifications to examine how computerization altered job skill demands.[6] We merge the job task requirement information gathered by Autor et al. (2003) to the Current Population Survey data from Spain, i.e. the Encuesta de Población Activa (EPA).[7]

We focus our attention on two of the job task requirements recorded by Autor et al. (2003), i.e. the "eye-hand-foot coordination" or EHF and the "direction-control-planning" or DCP measures. The first measure refers to manual tasks. In particular, EHF describes the "ability to move the hand and foot coordinately with each other in accordance with visual stimuli". The second measure, DCP, is defined as the "adaptability to accepting responsibility for the direction, control or planning of people and activities" and captures the interactive content of job tasks.[8] Both variables take values that range from zero to ten.

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[5] The authors are grateful to David Autor for kindly providing the data.
[6] The *Dictionary of Occupational Titles* (DOT) is a dataset elaborated by the U.S. Department of Labor to measure the intensity of skill use in occupations in 1977 and in 1991. As we note in what follows, the dataset contains information only on two measures of manual skills (*Eye, Hand, and Foot Coordination* and *Finger Dexterity*) and on one measure (*Direction, Control and Planning activities*) that comes closer to measuring communication skills. The other two variables pertain to analytical or cognitive skills.
[7] Census Occupation Codes (COC) from 1980 are matched to the International Standard Classification of Occupations (ISCO88) –from which the Clasificación Nacional de Ocupaciones (CNO94) used in the Spanish-SILK data are derived– using a crosswalk from the U.S. COC-1980 to the ISCO88 based on the translation provided by Harry Ganzeboom at: http://home.scw.vu.nl/~ganzeboom/occisco/index.htm
[8] We also experimented with other measures of the manual content of job tasks, such as the finger dexterity (FINGER). However, because finger dexterity can take relatively high values in jobs typically considered as having a high interactive content, as is the case of administrative personnel, we chose to exclude it from the

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Table 5 displays information on the manual and interactive tasks involved in various occupations. As it would be expected, high skill occupations with lower CNO-94 classification codes in the top panel of Table 5 have a greater content of interactive tasks and a smaller content of manual tasks than low skill occupations with higher CNO-94 codes. In contrast, low skill occupations in the bottom panel of Table 5 on average display a greater content of manual, as compared to interactive, tasks than the high skill occupations in the top panel of Table 5. These results are evident from the values of the DCP and EHF measures. They are generally higher for the first measure and lower for the second measure in the high skill occupations in the top panel of Table 5, and vice versa for the occupations in the bottom panel of Table 5. In any event, to keep things simpler, we use the EHF and DCP measures to create a summary measure of the relative manual to interactive task content of each occupation, i.e. [EHF/(EHF+DCP)]. This measure takes values between 0 and 1, which facilitates the interpretation of our results.

Additionally, since these job task requirement measures are based on specific U.S. Department of Labor's *DOT* definitions and we are using Spanish data, we also make use of a more traditional and possibly better understood categorization of jobs in Spain, e.g. the blue-collar versus white-collar classification. The rationale behind this measure is that blue-collar jobs have, by definition, a greater content of manual tasks compared to white collar jobs, which are intrinsically interactive jobs. Specifically, for the purpose of the analysis, we classify as blue collar jobs the occupations with the following 2-digit ISCO88 codes: 51 (personal and protective service workers), 61 (Skilled agricultural and fishery workers), 71-

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analysis discussed herein. Yet, as we note in what follows, results using finger dexterity along with the EHF and DCP measures follow closely those using the EHF and DCP measures and are available from the authors upon request. Additionally, we do not use two other task measures from the *DOT*, i.e. GED Math and STS, because they are both more closely related to the educational attainment of the worker than to her/his comparative advantage in manual versus interactive tasks owing to country-specific or language skills. In particular, GED Math is defined as "General educational development, mathematics" and is considered a measure of analytical tasks, whereas STS is defined as "the adaptability to situations requiring the precise attainment of set limits, tolerances or standards" and is primarily a measure of cognitive skills.

74 (Craft and related trade workers), 81-84 (Plant/machine operators and assemblers) and 91-94 (Elementary Occupations). The remaining occupations are grouped into the so-called white collar job group. When carrying out the regression analysis, as we group the data into (province, year) cells, we re-define this measure as the *relative intensity of blue collar jobs in each cell*, i.e. [BC/(BC+WC)] –a variable that, as with: [EHF/(EHF+DCP)], takes values between 0 and 1.

3.3. Comparative Advantage in the Relative Task Provision According to Nativity

Evidence of our assumption of a greater comparative advantage in the provision of manual as opposed to interactive tasks by immigrants is provided by Figures 4a and 4b. These figures plot the relative manual content of the jobs performed by less educated immigrants and natives using the two measures discussed in Section 3.2. It is worth noting that immigrants with a secondary education or less take jobs with a greater manual, relative to interactive, component as compared to similarly educated natives. Furthermore, the gap in the manual to interactive component of the tasks performed by immigrants and natives has widened in the midst of heightened immigration. In fact, just during the time period under consideration, this gap rose by an additional 5 percent. It is also important to mention that much of the widening gap is explained by the increased concentration of immigrants in jobs that require relatively more manual tasks. Indeed, native concentration in jobs with a greater manual relative to interactive component has remained practically unchanged over the course of the entire period. This suggests that technological change is not likely to be the factor driving the higher concentration of immigrants, relative to natives, in jobs with a greater manual, as compared to interactive, component.

Further support for the higher manual to interactive intensity of job tasks performed by immigrants as compared to natives with a similar educational attainment is provided in Figures 5a and 5b. Each dot is a (province, year) cell, i.e. our unit of observation in the

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empirical analysis. Specifically, each dot provides a measure of the relative manual to interactive intensity of tasks carried out by immigrants as compared to natives in those Spanish provinces with more than the average share of less educated immigrant workers in each of the years being plotted, i.e. over 2.5 percent for the entire 1999-2007 period. Overall, regardless of the measure used for the relative manual content of job tasks, most points lie above the 45-degree line, thus indicating that, for high immigrant-receiving regions, the ratio of manual to interactive tasks in jobs performed by the foreign-born exceeds that of jobs performed by similarly educated natives as assumed by the model.

3.4. Comparative Advantage in the Relative Task Provision According to Gender

As noted earlier, the immigration shock in Spain has coincided with a notable growth in native women's employment rates between 1999 and 2007, even among less educated women. Figure 6 shows the evolution of male and female employment rates among less educated workers in our sample. Over the time period under consideration, employment rates for less educated women rose by an average of 10 percentage points while those of similarly educated men remained constant. More importantly, women have primarily occupied jobs with lower relative manual task content. Indeed, regardless of the task measure being used, Figures 7a and 7b indicate that, during the time period under consideration, native women with a secondary education or less have been taking jobs with a significantly lower manual, relative to interactive component as compared to similarly educated men. Further support for the higher manual to interactive intensity of job tasks performed by native men as compared to native women with a similar educational attainment is provided in Figures 8a and 8b. As in Figures 5a and 5b, each dot provides a measure of the relative manual to interactive intensity of tasks carried out by native men as compared to native women in each province with more than the average share of less educated native female workers in each of the years being plotted. Regardless of the measure used for the relative manual content of job tasks,

most points lie above the 45-degree line. Hence, for regions with above average shares of native female workers, the ratio of manual to interactive tasks in jobs performed by native men exceeds that of jobs performed by similarly educated native women. Overall, Figures 7a through 8b suggest that, along with the increase in the relative manual task supply provided by foreign-born workers, Spain may have also witnessed a significant reduction in the relative manual task supply provided by native female workers.

4.   Methodology and Results

Figures 4a-5b and 7a-8b provide evidence of the greater relative supply of manual tasks by immigrants compared to natives, as well as of the greater relative supply of interactive tasks by native females compared to native males –both central assumptions to the model. We now proceed to testing the hypotheses derived from the model.

4.1.   Immigration and the Relative Task Provision by Natives

Hypotheses no. 1 predicts that the equilibrium relative supply of manual tasks by less educated natives decreases as the share of foreign-born rises. To test hypothesis no.1, we collapse our data into region-time cells using data from 52 Spanish provinces from 9 years, i.e. from 1999-2007, and transform equation (14) into the following regression equation:

$$\ln\left(\frac{M}{M+I}\right)_{n,pt} = \alpha_p + \delta_t + \eta_n (Share\_foreign)_{pt} + \varepsilon_{pt} \qquad (16)$$

Equation (16) examines whether the relative supply of manual tasks by less educated natives decreases with the share of foreign-born as natives specialize in occupations requiring fewer manual, as opposed to interactive, tasks. In that event, the coefficient η_n should be negative and statistically different from zero as predicted by hypothesis no.1.

To address any potential endogeneity between the share of foreign-born workers and the relative supply of manual tasks by less educated natives, we re-estimate equation (16) using the share of long-term immigrants –those with more than five years of residence in

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Spain, which have been excluded from the analysis– as an instrument for the current share of recent immigrants. We base our instrument choice on previous studies in the literature that show that settlement patterns of previous immigrants are a main determinant of immigrants' location choices (e.g. Card 2001, Cortes 2006, Lewis 2003, Ottaviano and Peri 2006, Peri 2006, Saiz 2003, and Peri and Sparber 2008, among other ones, for similar strategies). Our instrument is strongly correlated to the share of foreign-born workers. Regardless of the task measure being used as the dependent variable, the first stage regressions from the two-stage instrumental variable estimation procedures yield coefficients that are statistically significant at the 1 percent level with an F-statistic that is also significant at the 1 percent level (i.e. $F(1,51)=192.43$, Prob>F=0.0000). Because the model is just identified, we do not perform over-identification tests.

Table 6 displays the results from estimating equation (16) using the two measures of the relative manual content of tasks performed by workers. The figures in the first row of Table 6 help confirm our first hypothesis, that is, the fact that the relative supply of manual versus interactive tasks among natives decreases with the share of foreign-born. In fact, it is reassuring to find that, regardless of the task measure being used, as well as independently of whether we instrument the share of foreign-born or not, the estimated coefficients turn out to be always negative. A 10 percentage point increase in the share of foreign-born workers – similar to the one experienced by the Spanish economy over the course of the past two decades– lowers the native supply of manual to interactive tasks by approximately 5 to 6 percent.[9]

4.2. Immigration and the Economy's Relative Task Provision

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[9] As a reference, it is worth noting that Peri and Sparber find that a10 percentage-point increase in the share of less-educated foreign-born workers is associated with a 2 percent decline in the relative supply of manual versus interactive tasks among natives. As such, the rapid immigration growth experienced by the Spanish economy within a period of two decades appears to have had a much stronger impact than in the U.S.

Has the relative provision of manual tasks in the economy risen following the increase in foreign-born workers? According to hypothesis no.2a, if the increases in the share of foreign-born and native female workers are unrelated to each other, the relative provision of manual tasks in the economy would increase following an increase in the share of foreign-born workers. Alternatively, the relative provision of manual tasks in the economy could remain unchanged, increase or decrease if we assume that the share of native female workers increased with immigration, i.e. hypothesis no.2b. To test hypothesis 2a, we transform equation (15) to derive the following regression equation:

$$\ln\left(\frac{M}{M+I}\right)_{pt} = \alpha_p + \delta_t + \eta(Share\_foreign)_{pt} + \gamma\left(Share\_women\right)_{pt} + \varepsilon_{pt} \quad (17)$$

Equation (17) examines whether the relative provision of manual tasks in the overall economy increases with the share of foreign-born (i.e. $\eta>0$) and decreases with the share of native women entering the workforce (i.e. $\gamma<0$).

However, if we allow the share of native women to increase with the share of foreign-born workers as assumed by hypothesis no.2b, i.e. if: $g = g(f)$, we may first write the relationship between g and f as follows:

$$Share\_women_{pt} = \alpha'_p + \delta'_t + \theta(Share\_foreign)_{pt} + \varepsilon'_{pt} \quad (18)$$

Substituting equation (18) into equation (17), we obtain the following regression equation:

$$\ln\left(\frac{M}{M+I}\right)_{n,pt} = \chi_p + \phi_t + \beta(Share\_foreign)_{pt} + \xi_{pt} \quad (19)$$

where: $\chi = (\alpha + \gamma\alpha')$, $\phi = (\delta + \gamma\delta')$, $\beta = (\eta + \gamma\theta)$ and $\xi = (\varepsilon + \gamma\varepsilon')$. Note that, under the assumption that $\frac{\partial g}{\partial f} > 0$ (i.e. $\theta>0$), β can take either a positive, negative or zero value as $\eta>0$ and $\gamma<0$.

As when testing hypothesis no.1, in addition to estimating equations (17) and (19) by OLS, we address any potential endogeneity between the share of foreign-born workers and the overall relative provision of manual to interactive tasks in the economy using the share of long-term immigrants as an instrument for the current share of recent immigrants. As noted in the previous section, this instrument is strongly correlated to the share of foreign-born workers. However, owing to the limited inter-regional mobility of Spanish natives (Bentolila 2001), we do not envision a problem of endogenous allocation of native female workers into particular regional labor markets as we do with immigrants. Therefore, we do not instrument for the share of native female workers.

What are our key findings? The second row of results in Table 6 displays the results from estimating equation (17). As with hypothesis no.1, our results seem robust to both the task measure being used as dependent variable, as well as to the regression methodology employed. Indeed, the estimates are never statistically different from zero regardless of the task measure being used and regardless of whether we instrument for the share of foreign-born workers. Consequently, an increase in the share of foreign-born workers does not appear to increase the overall share of manual versus interactive tasks in the economy but, rather, leaves it unchanged.

What could be the reason for this finding? A potential explanation may reside in the fact that, as in the U.S. and as suggested by Figure 2, the share of native female workers and the share of foreign-born workers in Spain are positively correlated, i.e. $\frac{\partial g}{\partial f} > 0$. In that event, as predicted by hypothesis no. 2b, it is possible for an increase in the share of native foreign-born workers to increase, decrease, or leave the economy's relative task provision unchanged. According to the figures in the third row of Table 6 resulting from estimating equation (19), an increase in foreign-born workers has no significant impact on the provision of manual to interactive tasks in the economy regardless of the task measure being used or the

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methodology employed. As such, our findings are suggestive of: (a) the share of native female workers and the share of foreign-born workers being positively correlated, and (b) the provision of manual to interactive tasks in the economy not fluctuating following a simultaneous increase in the share of native female and foreign-born workers.[10]

5.   Native Occupational Mobility Following an Immigrant Shock

According to the confirmed hypothesis no.1, natives relocate to less manual jobs as the share of foreign-born workers in the economy rises. In this last section of the paper, we examine in greater detail the occupational mobility of natives following an immigrant shock. Which are the specific occupations natives leave and which are the ones they go to as the share of foreign-born workers increases?

To answer this question, we make use of the one-digit level occupational disaggregation publicly available in the data being used herein, i.e. the EPA, and estimate a system of equations where the dependent variables reflect changes in the distribution of natives across the various occupations by province and year. The regressors are the same in all the equations. All of them include the share of foreign-born workers as well as region and time dummies. Of particular interest to us is the share of foreign-born workers in each cell, i.e. each province and year. While these equations appear independent from each other on the surface, they have the same regressors, use the same data and, as such, have correlated error terms. Thus, we estimate our system of regressions using a seemingly unrelated regression (SUR) model first developed by Zellner (1962). The SUR model is an extension of the linear regression model that allows for correlated errors between equations. The OLS

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[10] While it is not our primary focus, it is worth noting that the coefficient estimates for the share of native female workers included in the estimation of equation (17) and displayed in the second row of Table 6 using the blue-collar versus white-collar task measure more specific to our set of Spanish occupations suggests that, indeed, the entry of native women into the workforce did help reduce the relative provision of manual to interactive tasks in the economy. In particular, a 10 percent increase in the share of native female workers reduces the manual to interactive task provision in the economy by approximately 6 percent, regardless of whether or not we instrument for the share of foreign-born workers. Yet, while negative, the coefficient for the share of native women using the second task measure is not statistically different from zero.

estimates are still BLUE (i.e. will yield the Best Linear Unbiased Estimator) and, by estimating the equations jointly, the efficiency is improved upon. The results from this exercise are displayed in the first column of Table 7, whereas the second column displays the results as we instrument for the share of foreign-born workers using the share of long-term foreign-born workers.

A couple of findings are worth discussing from Table 7. First, the estimated coefficients are generally quite robust to the instrumentation of the share of foreign-born workers, with the exception of highly skilled occupations with lower relative manual to interactive tasks, such as managers and professionals. Therefore, we focus our attention on the IV estimates. Secondly, according to the IV estimates, a 10 percent increase in the share of foreign-born workers raises the growth rate of native workers in occupations characterized by a lower intensity of manual tasks (i.e. among technicians and professionals, clerical support workers, and service and sales workers) anywhere between 8 percent to 17 percent. The largest growth rate in the fraction of natives employed takes place in technical jobs, followed by jobs in services/sales and clerical jobs. In contrast, a 10 percent increase in the share of foreign-born workers lowers the growth rate of native workers in occupations with a higher intensity of manual tasks (i.e. crafts and related trade workers, machine operators and assemblers, or workers in other low skilled occupations) between 9 percent and 14 percent. Specifically, the largest reduction in the fraction of native workers occupied in those jobs takes place for both low skilled occupations, such as domestic help, as well as in crafts and related trades. The next largest decline is in machine operators and assemblers.

6.   Conclusions

Learning about the impact that immigration has on the labor market of the receiving nation is a topic of major concern to economists given the ever growing percentage of the world population living in a country other than her own. Spain is no exception following the

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rapid increase in immigrant flows experienced over the past decade. While there is a large and growing literature on the consequences of migration on the wages of native workers in the U.S., very little is known about the impact of migration on the employment patterns and wages of Spanish natives. Furthermore, the literature has generally failed to document a significant effect of immigration on the wages of less-educated natives, both in the U.S. as well as in Spain. As recently noted by Ottaviano and Peri (2006), this is not surprising given that the effect of immigration depends on the degree of substitution between native and immigrant workers *within* each education group. If native and immigrant workers of similar educational attainment posses productive skills that lead them to specialize in different occupations, it is reasonable to find a small or null impact of immigration on natives' wages as immigrants and natives are not competing for the same jobs. As such, the assumption of perfect substitutability between native and immigrant labor may not be a reasonable one to make. In this vein, some studies (e.g. Dustmann, Frattini and Preston (2008)) have shown that natives and immigrants in the U.K. of comparable skills do not compete for the same jobs, which can help explain the lack of a significant impact of immigration on native wages.

With the purpose of gaining a better understanding of the impact of recent immigration inflows on the Spanish economy, we first empirically assess the degree of substitution between native and immigrant workers of comparable educational attainment. Subsequently, we proceed to examining some of the implications of the increase in the share of foreign-born in the Spanish market. In particular, we explore whether immigration has encouraged native specialization in occupations that differ from those held by immigrants, thus explaining recent native and immigrant employment patterns.

Using data from the 1999 through 2007 *Encuesta de Población Activa* (EPA), we find evidence of immigrant and native workers of similar skill levels being employed in different occupations, hinting on the fact that native and foreign-born workers may not compete for the

same jobs. Therefore, using a variant of the model proposed by Peri and Sparber (2008) in their analysis of the impact of immigration on the U.S. labor market, we look for an explanation of the impact that recent immigration inflows have had on the Spanish labor market. We are able to confirm Peri and Sparber's first hypothesis, i.e. the fact that an increase in the share of foreign-born workers provokes a relocation of natives towards jobs with a lower intensity of manual (as opposed to interactive) tasks. However, possibly due to the impact that immigration itself may have had on the share of native female workers, we find that the relative supply of manual to interactive tasks in the economy did not significantly change during the time period under analysis. Finally, we look more closely at the impact that immigration inflows may have had on the occupational distribution of natives in Spain. We find that natives fled occupations with a higher content of manual as opposed to interactive tasks, such as crafts and related trades, machine operations and assembly, or other low skilled jobs, as domestic help. Where did they go? They moved to jobs with a lower content of manual tasks, such as technical and alike professional occupations, clerical support jobs, and sales and service occupations.

In sum, foreign-born workers do not seem to be substitutes of similarly skilled native workers in the Spanish case. This may help understand the lack of a significant wage impact of recent immigration inflows on native wages. What impact did immigration then have on the Spanish labor market? We find evidence that immigration affected the occupational distribution of natives. Specifically, owing to the comparative advantage of foreign-born workers in manual as opposed to interactive tasks, natives relocated to occupations with a lower content of manual tasks. However, possibly owing to the significant and simultaneous reduction in the manual to interactive task supply resulting from the increase in the share of native female workers, the increase in the relative supply of manual to interactive tasks from

foreign-born workers did not significantly changed the overall manual to interactive task supply in the Spanish economy.

Appendix – Proofs of Hypotheses 1, 2a and 2b

1.   **Hypothesis no.1:** $\dfrac{\partial (m)_n^*}{\partial f} < 0$:

Consider the equilibrium provision of relative tasks supplies offered by natives – eq. (14):

$$m_n^* = \left(\frac{\beta_L}{1-\beta_L} \right)^{\frac{\alpha\lambda}{(1-\alpha)\lambda+\alpha}} \left[f \overline{(e_m)}_i^{\frac{1}{1-\alpha}} + (1-f) \overline{(e_m)}_n^{\frac{1}{1-\alpha}} \right]^{\frac{-\alpha}{(1-\alpha)\lambda+\alpha}} \overline{(e_m)}_n^{\frac{1}{1-\alpha}}$$

If we take the partial derivative with respect to f:

$$\frac{\partial (m)_n^*}{\partial f} = \left(\frac{\beta_L}{1-\beta_L} \right)^{\frac{\alpha\lambda}{(1-\alpha)\lambda+\alpha}} \overline{(e_m)}_n^{\frac{1}{1-\alpha}} \, A \text{ , where:}$$

$$A = \left[\frac{-\alpha}{(1-\alpha)\lambda+\alpha} \right] \left[\left[f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} + (1-f)\overline{(e_m)}_n^{\frac{1}{1-\alpha}} \right]^{\frac{-\alpha}{(1-\alpha)\lambda+\alpha}-1} \right] \frac{\partial (f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} + (1-f)\overline{(e_m)}_n^{\frac{1}{1-\alpha}})}{\partial f}$$

The assumption that $\overline{(e_m)}_i > \overline{(e_m)}_n$ implies that $\left[f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} + (1-f)\overline{(e_m)}_n^{\frac{1}{1-\alpha}} \right]$ is increasing with f, so the last term of A is positive. The second term of A is also positive, but the first one is clearly negative.

2.   **Hypothesis no. 2a:** $\dfrac{\partial (m)^*}{\partial f} > 0$ (if g is assumed to be independent of f):

Consider the equilibrium provision of relative tasks of the overall economy – eq.(15):

$$m^* = \underbrace{\left(\frac{\beta_L}{1-\beta_L} \right)^{\frac{\alpha\lambda}{(1-\alpha)\lambda+\alpha}}}_{B} \underbrace{\left[f\overline{(e_m)}_i^{\frac{1}{1-\alpha}} + (1-f) \left[g\overline{(e_m)}_{nw}^{\frac{1}{1-\alpha}} + (1-g)\overline{(e_m)}_{nm}^{\frac{1}{1-\alpha}} \right]^{\frac{1}{1-\alpha}} \right]^{\frac{\lambda(1-\alpha)}{(1-\alpha)\lambda+\alpha}}}_{H}^{\gamma}$$

$$\frac{\partial (m)^*}{\partial f} = B\gamma H^{\gamma-1} \frac{\partial H}{\partial f}$$

If we assume that g is not a function of f, since: $\overline{(e_m)}_i > \overline{(e_m)}_n$,then $\dfrac{\partial H}{\partial f} > 0$, as the term in brackets, i.e. $[g\overline{(e_m)}_{nw}^{\frac{1}{1-\alpha}} + (1-g)\overline{(e_m)}_{nm}]$, is the average efficiency of natives in manual as opposed to interactive tasks, i.e. $\overline{(e_m)}_n$, which is smaller than that for immigrants.

3. Hypothesis no. 2b: If, however, $\dfrac{\partial g}{\partial f} > 0$:

$$\frac{\partial H}{\partial f} = \overline{(e_m)}_i^{\frac{1}{1-\alpha}} - \left[1 \cdot \left[g \overline{(e_m)}_{nw}^{\frac{1}{1-\alpha}} + (1-g) \overline{(e_m)}_{nm}^{\frac{1}{1-\alpha}} \right]^{\frac{1}{1-\alpha}} + (1-f) \underbrace{\left(\overline{(e_m)}_{nw}^{\frac{1}{1-\alpha}} \frac{\partial g}{\partial f} - \overline{(e_m)}_{nm}^{\frac{1}{1-\alpha}} \frac{\partial g}{\partial f} \right)}_{K} \right]$$

However, given that $\overline{(e_m)}_{nw} < \overline{(e_m)}_{nm}$, K is clearly negative and H can be increasing or decreasing in f. If the partial derivative of H with respect to f cannot be clearly signed, the partial derivative of m* with respect to f cannot be clearly signed either.

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Table 1
Descriptive Statistics - Natives and Immigrants (1999-2007)

Variables	Natives	Recent Immigrants	All Immigrants
Average Age	39.2	33.1	35.3
Distribution by age categories (%):			
<30 years	26.7	44.1	36.08
31-35 years	12.9	19.4	19.2
36-40 years	13.7	14.7	16.6
41-45 years	13.8	10.2	11.8
>45 years	32.7	11.6	16.3
Percentage Female (%)	38.8	45.5	42.9
Education (%):			
Primary or Less	28.4	23.09	25.9
Secondary	44.9	55.04	52.05
University	26.5	21.04	21.9
Average Hourly Log Wage	6.78	(*)	6.00
	(4.40)		(5.05)
Observations (in Spanish CPS)	574,074	12,309	19,111

Note: Working individuals between 16 and 65 years of age. The sample of recent immigrants contains immigrants whose length of stay in Spain is at most 5 years. All features are taken from the Spanish Current Population Sample, except for Average Wages, which are taken from a pooled sample of 2004-2006 European Survey of Living Conditions for Spain. (*) We cannot report average wages of recent immigrants because the EU-SILK does not contain information on the length of stay of immigrants in Spain.

Table 2
Occupational Distribution (%) – Non-University Natives and Immigrants (1999-2007)

Occupations	Natives	Recent Immigrants	All Immigrants	Average Hourly Log Wage
Managers	7.71	2.49	5.12	10.76
Professionals	17.41	4.42	6.53	10.11
Technicians and professionals	13.11	4.15	5.61	7.84
Clerical support workers	10.63	3.56	4.24	6.61
Service and sales workers	15.15	20.65	20.38	6.24
Skilled agricultural/forestry/fishery workers	2.49	1.84	1.61	5.65
Craft and related trade workers	14.60	18.09	17.55	5.13
Plant/machine operators and assemblers	9.01	5.67	6.14	4.67
Elementary Occupations	9.89	39.12	32.83	4.39

Note: The Occupational Distribution is taken from a Pooled sample of 1999-2007 Current Population Survey. Data on average Hourly wage are taken from the 2004-2006 EU-SILK survey for Spain. Natives are of all working-age individuals with less than a university education. Recent Immigrants include only those with at most 5 years of stay in Spain.

Table 3
Occupational Distribution (%) of Natives and Immigrants by Educational Level

Occupations	Secondary			Primary or less		
	Natives	Recent Immigrant	All Immigrants	Natives	Recent Immigrant	All Immigrants
Managers	7.8	1.6	3.87	9.0	1.1	4.63
Professionals	0.7	0.4	0.70	0.1	0	4.84
Technicians and professionals	9.6	2.4	3.53	2.3	0.4	4.41
Clerical support workers	10.4	2.6	3.54	2.8	1.1	3.55
Service and sales workers	20.1	22.2	22.63	12.2	12.4	18.56
Skilled agricultural/forestry/fishery workers	3.7	2.11	1.86	10.9	2.7	1.95
Craft and related trade workers	19.8	19.4	19.38	24.5	19.9	18.53
Plant/machine operators and assemblers	12.8	6.05	6.77	13.7	4.1	5.99
Elementary Occupations	14.8	43.21	37.73	24.4	58.1	37.54

Table 4
Average Log Wages of Natives and Immigrants across Skill Groups
Average Wage Gap within Skills

Skills	Natives		All Immigrants		
	Mean Log Wage	**Distribution across skills (%)**	**Mean Log Wage**	**Distribution across skills (%)**	**Average Wage Gap**
<30, Primary or less	4.50 (1.68)	9.44	4.55 (1.42)	9.20	-0.05
<30, Secondary	4.64 (1.95)	10.63	4.59 (1.69)	19.66	0.05
31-35, Primary or less	5.34 (1.87)	4.15	4.62 (1.35)	4.14	0.72
31-35, Secondary	5.66 (2.22)	4.65	5.10 (1.58)	6.70	0.56
36-40, Primary or less	5.53 (2.11)	4.21	4.96 (1.24)	2.51	0.57
36-40, Secondary	6.00 (2.59)	4.69	4.82 (2.35)	6.43	1.18
41-45, Primary or less	5.42 (2.28)	4.23	4.75 (1.31)	2.72	0.67
41-45, Secondary	6.77 (4.05)	4.62	5.60 (2.90)	4.63	1.17
>45, Primary or less	6.00 (2.74)	12.53	4.62 (1.93)	3.16	1.38
>45, Secondary	7.35 (4.14)	7.13	4.67 (1.73)	5.50	2.68

Source: 2004-2006 Pooled EU-SILK Survey for Spain.

Table 5
Tasks Intensity in Occupations with the lowest and largest share of immigrants

Occupations (CNO94 code)	EHF	DCP	ehf/((ehf+dcp)	No. of workers	Share of Foreign-born (%)
Occupations with the lowest share of immigrants (among occup. with at least 1% of workers)					
34	1.27	2.18	0.36	10092	0.26
40	0.20	1.94	0.09	5037	0.29
12	0.45	8.5	0.05	21332	0.45
14	1.38	9.06	0.13	6741	0.59
Occupations with the highest share of immigrants (among occup. with at least 1% of workers)					
50	0.93	0.96	0.49	18804	5.3
91	1.47	0.38	0.79	27287	7.9
96	2.51	0.01	0.99	10564	8.0
94	2.23	0.57	0.79	7988	10.4

Notes: The CNO94 codes listed above refer to the following occupations:
CNO94 no. 34: Professional administrative personnel.
CNO94 no. 40: Support personnel providing accounting, financial, and other similar services in the manufacturing and transportation sectors.
CNO94 no. 12: Direction of trade firms with less than 10 employees.
CNO94 no. 14: Direction of firms, other than trade firms listed above, with less than 10 employees.
CNO94 no. 50: Employees in restaurant and catering services.
CNO94 no. 91: Domestic employees and cleaning personnel in other buildings, e.g. hotels and offices.
CNO94 no. 96: Construction laborers.
CNO94 no. 94: Agriculture/Fishing laborers.

Table 6
Impact of the Share of Foreign Born and of the Share of Native Women on the Supply of Tasks

Dependent Variable (in Logs)	Task Measure 1					
	Share of Foreign-born		Share of Native Female Workers		Share Foreign	
	OLS	IV	OLS	IV	OLS	
Hypothesis 1: Relative Task Provision for Natives	-0.523 (0.14)	-0.563 (0.16)	---	---	-0.47 (0.18)	
Hypothesis 2a: Relative Task Provision for the Economy	0.07 (0.14)	0.11 (0.18)	-0.60 (0.13)	-0.61 (0.13)	-0.03 (0.18)	
Hypothesis 2b: Relative Task Provision for the Economy	0.03 (0.15)	0.07 (0.17)	---	---	-0.04 (0.18)	

Notes: *** indicates significant at the 1% level and ** indicates significant at the 5% level. Each reported coefficient is the impact of the share of foreign-born on each of the dependent variables stated in the left column. Each coefficient is the result of a different regression. All regressions include a full set of region dummies (51) plus controls for time (7 dummies). All regressions are weighted by the cell (province, year) size and standard errors are corrected for clustering at cell level. Instruments for the share of foreign-born and for the share of native female workers in the IV regressions are the share of non-recent immigrants with more than five years of residence and average fertility rates at the cell level, respectively.

Table 7
Impact of the Share of Foreign-born on the Change in the Distribution of Natives across Occupations

Occupational Distribution	OLS	IV
Managers	0.050***	0.039
	(0.023)	(0.029)
Professionals	0.036*	0.019
	(0.019)	(0.023)
Technicians and professionals	0.176***	0.173***
	(0.025)	(0.031)
Clerical support workers	0.077***	0.084***
	(0.026)	(0.03)
Service and sales workers	0.127***	0.109***
	(0.031)	(0.039)
Craft and related trade workers	-0.076***	-0.136***
	(0.036)	(0.04)
Plant/machine operators and assemblers	-0.066***	-0.086***
	(0.029)	(0.035)
Elementary Occupations	-0.118***	-0.139***
	(0.031)	(0.04)

Notes: *** indicates significant at the 1% level and * indicates significant at the 10% level. The dependent variable is the change in the distribution of natives across occupations by province and year. The independent variable is the relative share of foreign-born in each cell (province year) and all estimations include region (province) and time (year) fixed effects. Instruments for the share of foreign-born include region and time dummies and the share of long term immigrants by cell. For Agricultural/forestry/fishery workers have been dropped from this analysis, given that less than 2% of workers are currently working in that occupational category.

Figure 1
Evolution of Employment Rate by Gender
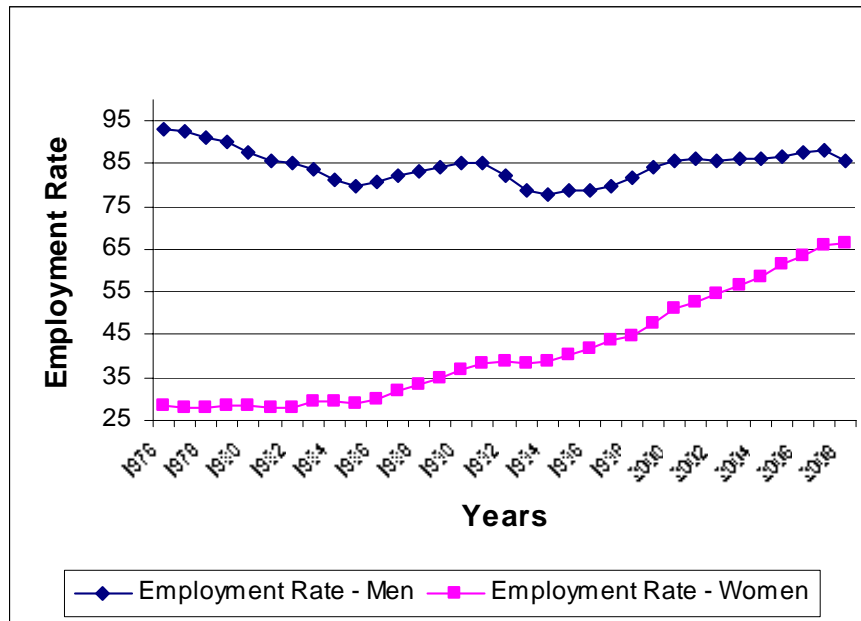
Source: EPA – All individuals between 16-65 years. Employment rate is the ratio between the total employed and the total number of working age individuals.

Figure 2
Employment Rate of Low Educated Native Women and of Foreign-Born
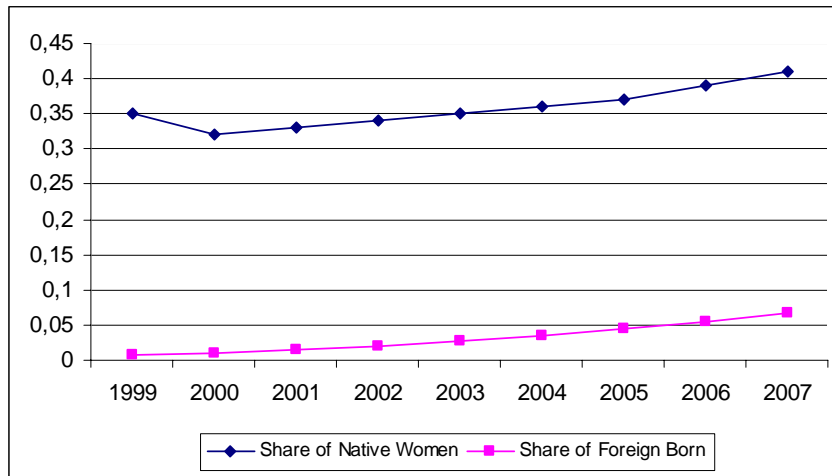
Source: EPA 1999-2007 – 2nd terms. The calculations are based on native individuals aged 16-65 with less than university education.

Figure 3
Distribution of Immigrants in Native Wage Distribution – Non-University Workers
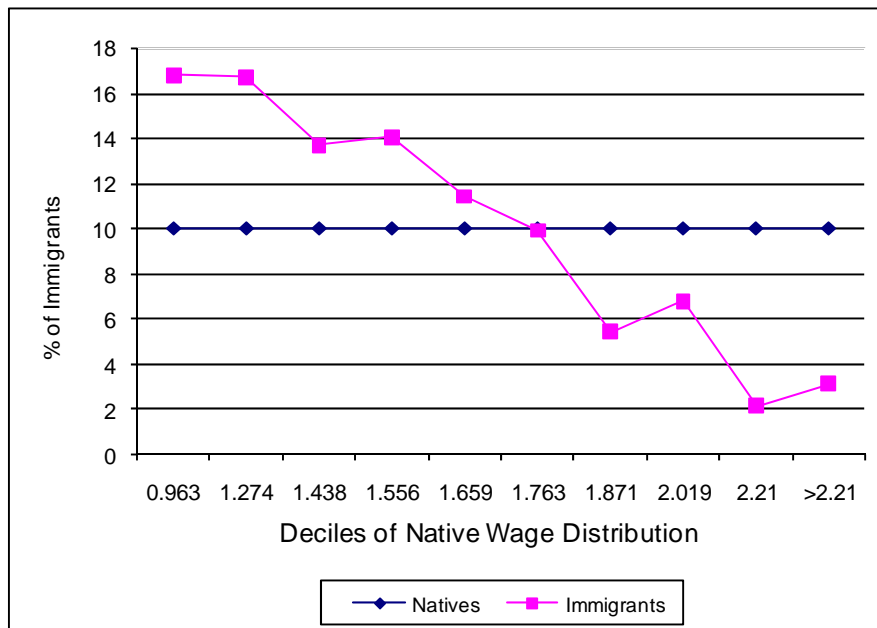
Source: European Survey of Living Conditions, Spain. Pooled 2004-2006 Data.

Figures 4a and 4b
Relative Manual to Interactive Task Supply by Native and Foreign-Born Workers

Figure 4a: Using [ehf/(ehf+dcp)]
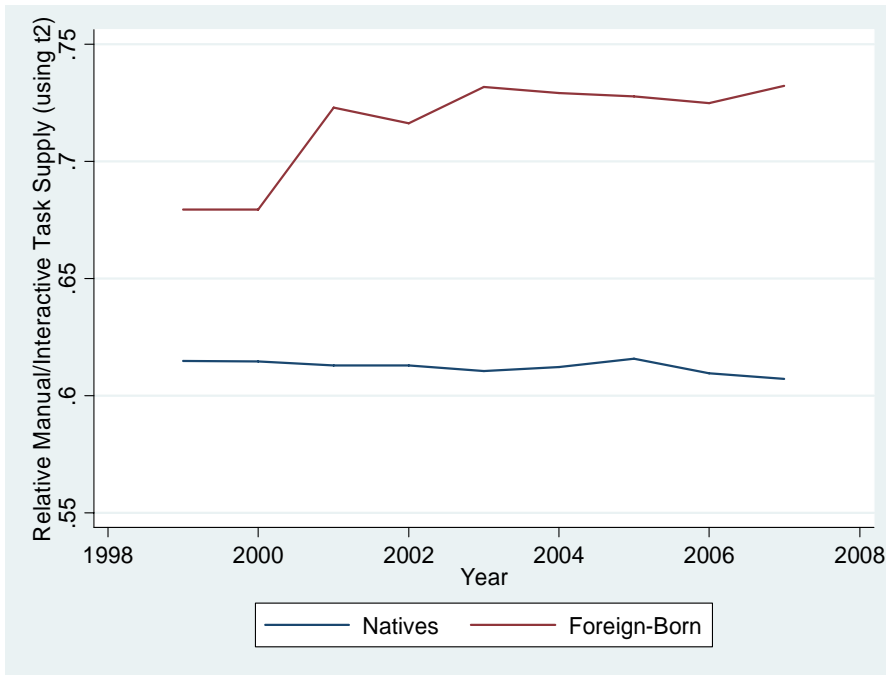
Figure 4b: Using [bc/(bc+wc)]
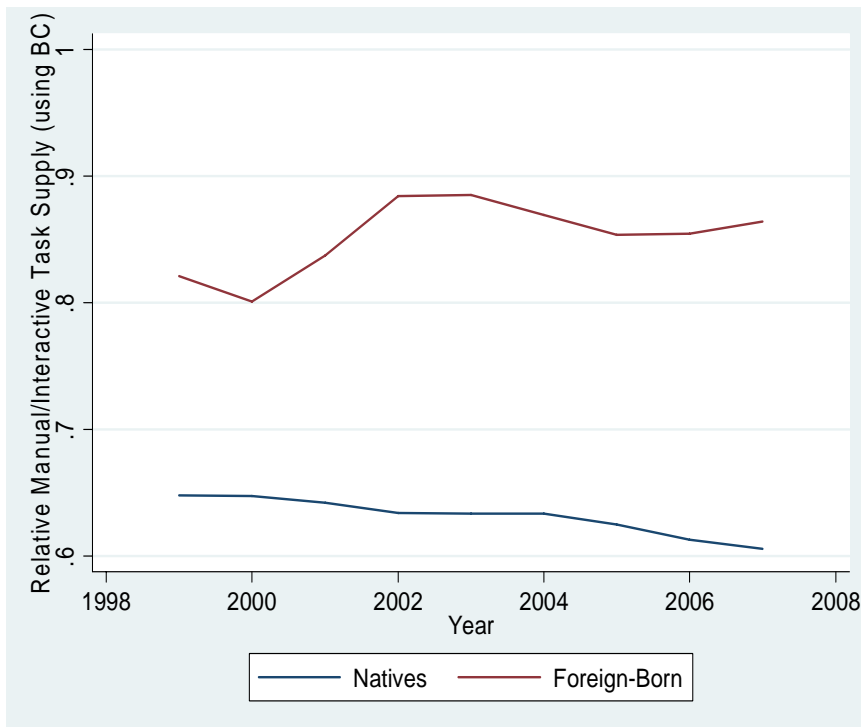
Figures 5a and 5b:
Relative Manual to Interactive Intensity of Native versus Immigrant Tasks

Figure 5a: Using [ehf/(ehf+dcp)]
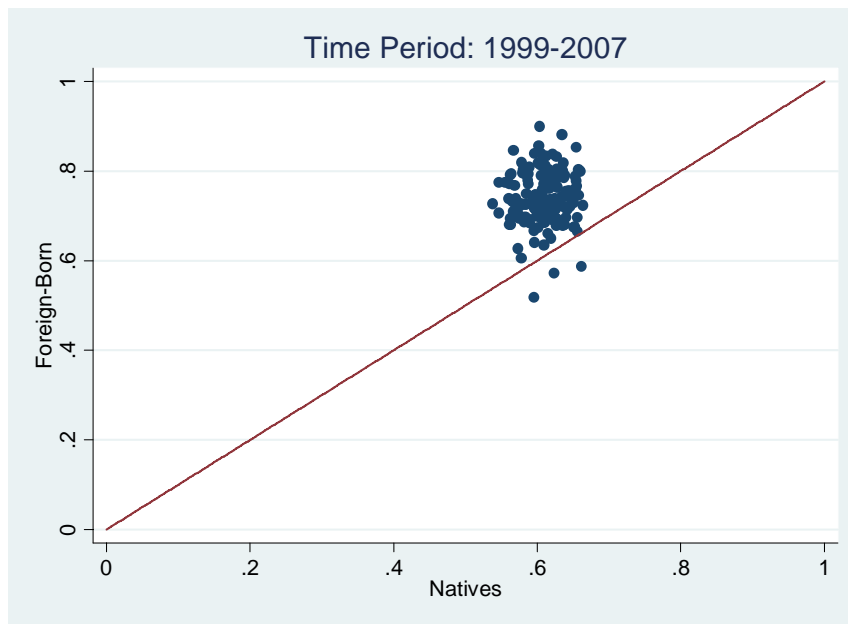
Figure 5b: Using [bc/(bc+wc)]
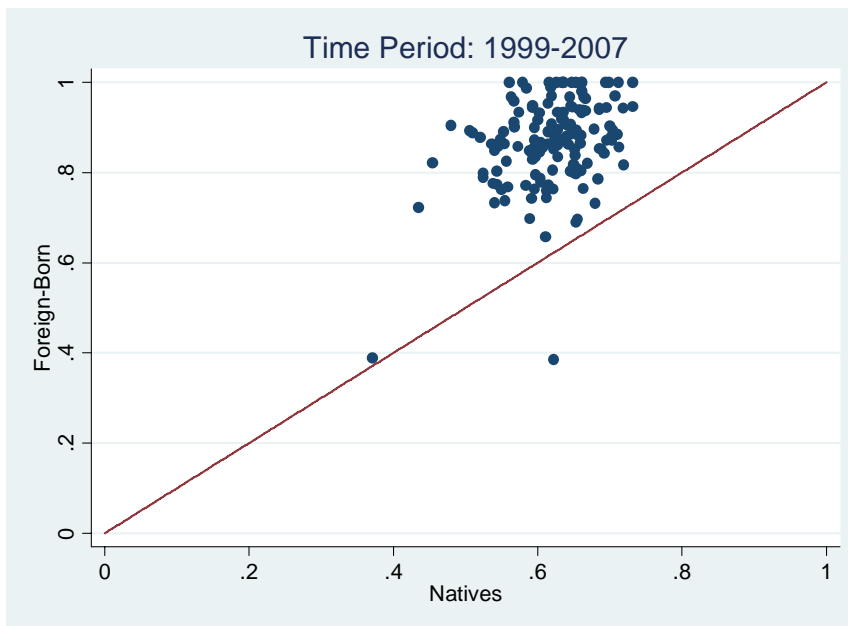
Note: Each dot represents a (province, year) cell for those Spanish provinces with at least 2.5 percent of foreign-born workers over the entire period.

Figure 6
Employment Rate of Low Educated Natives over the Sample Period
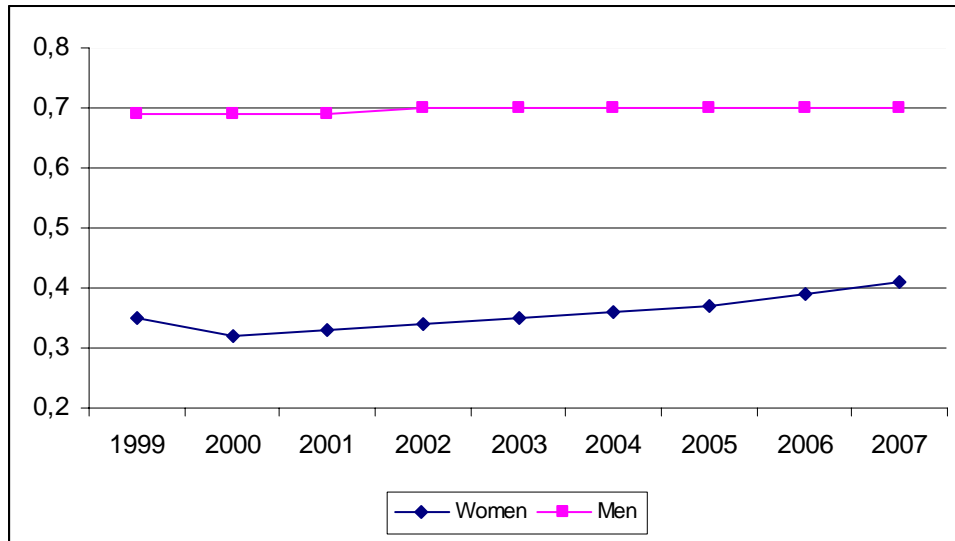
Source: EPA 1999-2007 – 2nd terms. The calculations are based on native individuals aged 16-65 with less than university education.

Figures 7a and 7b
Relative Manual to Interactive Task Supply by Native Men and Women
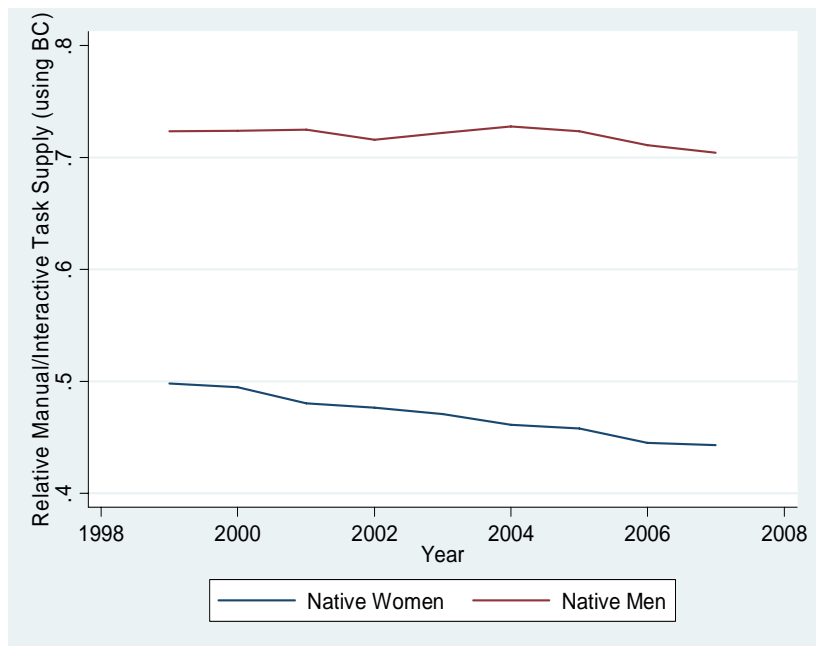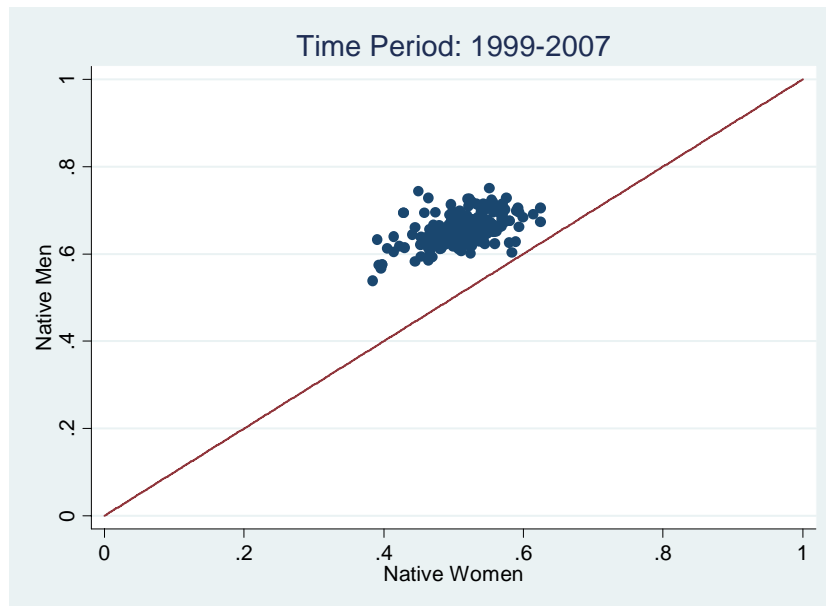
Figure 7a: Using [ehf/(ehf+dcp)]
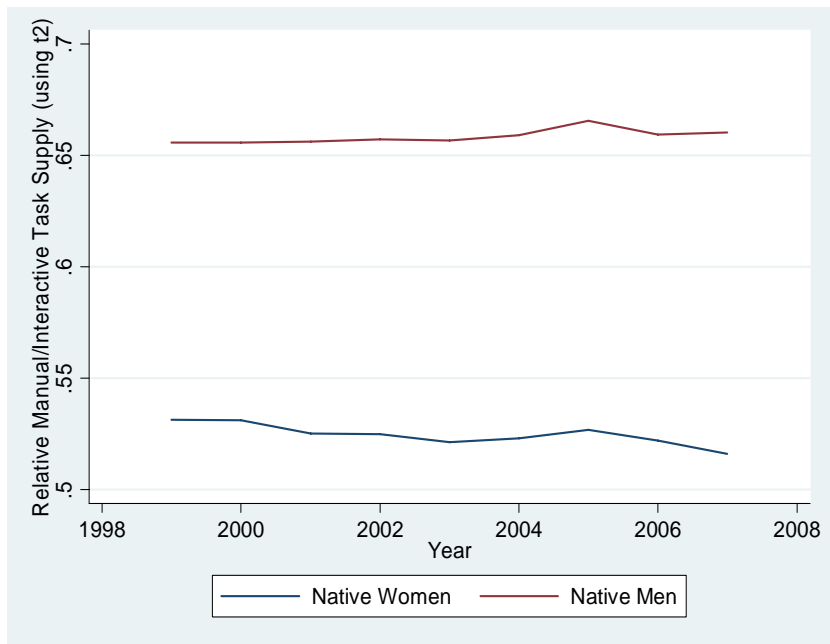
Figure 7b: Using [bc/(bc+wc)]

Figures 8a and 8b:
Relative Manual to Interactive Intensity of Native Male and Female Tasks
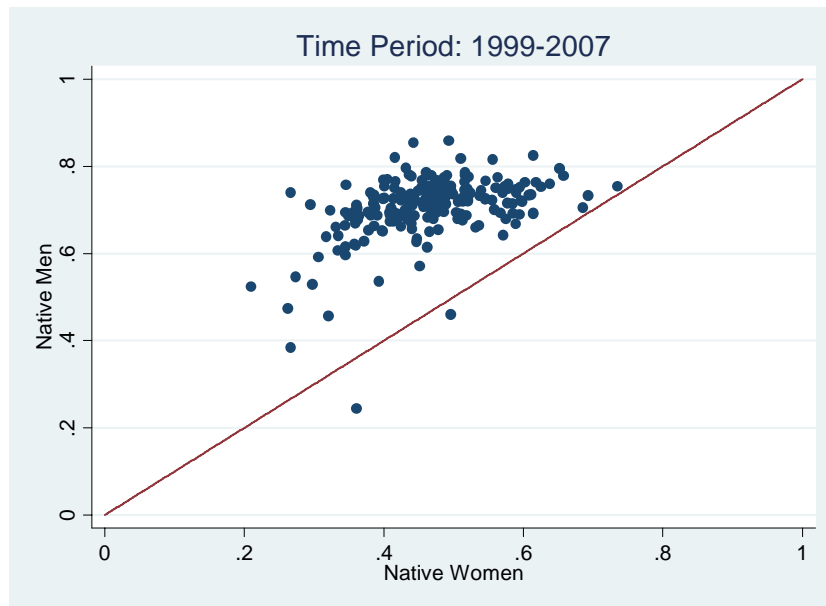
Figure 8a: Using [ehf/(ehf+dcp)]

Figure 8b: Using [bc/(bc+wc)]

Note: Each dot represents a (province, year) cell for those Spanish provinces with at least 2.5 percent of foreign-born workers over the entire period.

Figure A
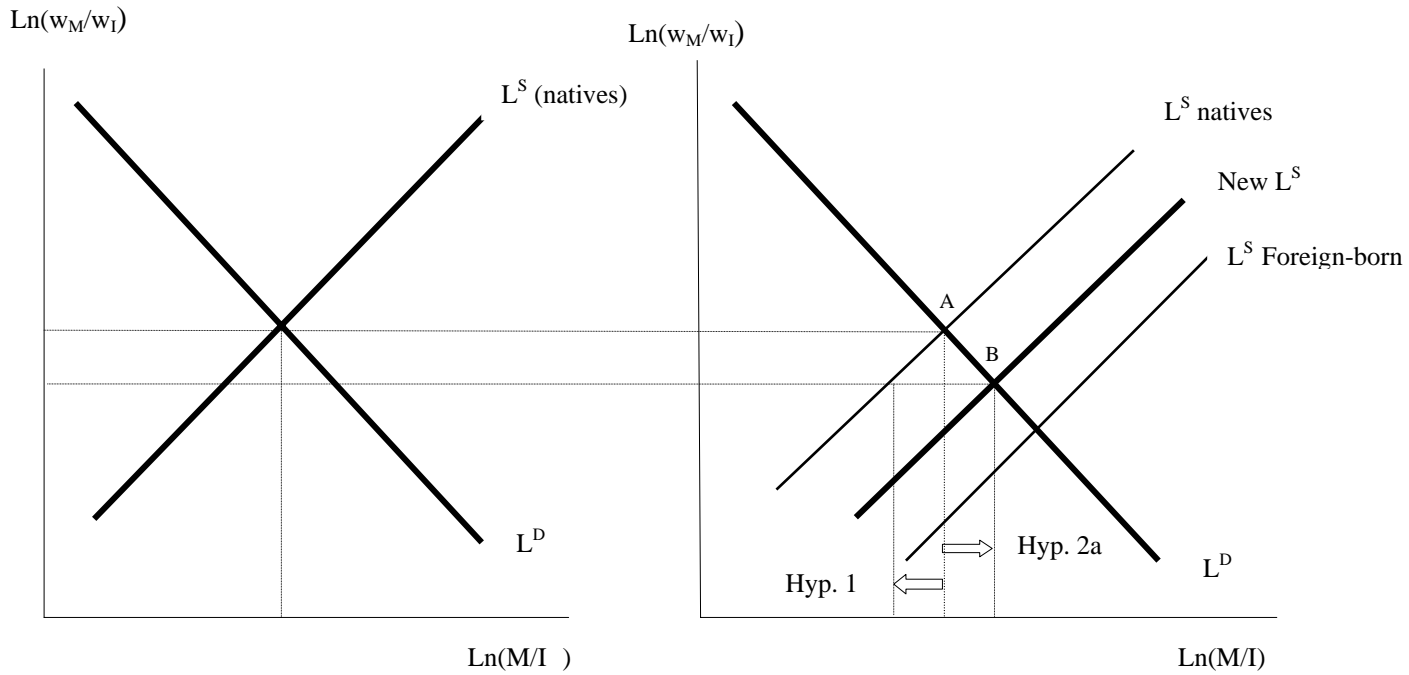**Impact of an Increase in Foreign-born Workers**

Figure B
Impact of an Increase in Foreign-Born and Native Female Workers