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Rethinking the Area Approach: Immigrants and the Labor Market in California, 1960-2005.

Giovanni Peri
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August 05, 2009

Paper # 09-13

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Rethinking the Area Approach:

Immigrants and the Labor Market in California, 1960-2005.

Giovanni Peri, (University of California Davis, CESifo and NBER)*

August, 2009

Abstract

A series of recent influential papers has emphasized that in order to identify the wage effects of immigration one needs to consider national effects by skill level. The criticism to the so called "area approach" is based on the fact that native workers are mobile and would eliminate, in the long-run, local wage effects in a national market. A second criticism is that the small sizes of many local labor markets induces large measurement errors in the share of immigrants and attenuation bias in the estimates of their effects. In this paper we show that a production-function-based approach with skill differentiation and *integrated* national markets has predictions on the *employment effect* of immigrants at the local (state) level. Hence if we look at the employment (rather than wage) response to immigration by state, we can still estimate the substitutability-complemetariety between natives and immigrants and infer whether, other things constant, immigrants stimulate or depress the demand for native labor. Moreover, to avoid measurement error issues, we only consider California, as it is the largest state and the largest recipient of immigrants. To address further endogeneity issues we use demographic characteristics of Mexican migrants to the US to predict immigration by skill level in California. Looking at immigraton between 1960 and 2005 we find that: i) the assumption of a national integrated labor market by skill holds and ii) immigration did not have any negative employment effect on natives in any education-experience group in California. The estimated effects support the hypothesis that natives and immigrants in the same education-experience group are not perfectly substitutable. Specializing in different tasks and stimulating efficiency are the other likely mechanisms through which immigrants stimulate (rather than hurt) employment of natives.

Key Words: Immigration, Native Employment, Inter-state migration, Complementariety.

JEL Codes: F22, J61, J31, R13.

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1 Introduction

An interesting and influential recent development of the large literature that analyzes the effect of immigration on US labor markets has followed the lead of Borjas (2003). This branch of the literature recognizes that there can be small (or null) wage effects of differential immigration flows at the local level if native respond by moving out of the area (city or state). Hence, the search for long and short-run wage effects of immigration should be moved to the national level. This recent literature has also separated workers, more carefully, into a finer classification according to their observable skills (experience and education) and has looked at the impact of national immigration on national wage of natives by skill group. This multi-skill framework, based on a production function, needs some assumptions on the productive interactions across workers of different skills but enables economists to analyze substitutability and complementarities of workers across skills groups and to evaluate the effects of immigrants on wages of natives accounting for own and cross-skill group effects (Borjas and Katz, 2007, Ottaviano and Peri, 2008). There is disagreement, however, on the extent to which the supply of immigrant workers depresses (or stimulates) the demand for native workers overall and in each skill group. On one hand immigrant with similar education and experience compete with natives for jobs; on the other they attract investment, promote specialization, take different occupations and are different enough from natives in production that they may stimulate their demand.

In this paper we take an alternative approach to estimating the native-immigrants substitutability that determines the effect of immigrants on demand for native labor. The existence of an integrated national labor market by skill (in the long run) implies that *wage* effects should be studied at the national level. However if immigrants flow into different states in very different proportions relative to the native labor force one can use state *employment* data to infer the effect of immigrants on the *labor demand* for local workers, under the assumption (that we check empirically and then maintain) that native workers of each skill group move across states to equate their wages. Simply stated, in a model with inter-state mobility of workers, immigrants within a certain skill cell would have an effect on the employment of natives in that state and skill group by inducing them to move in or out of the state. If immigrants in a skill group depress, *ceteris paribus*, demand for native labor in that group, then their inflow in the state would decrease the employment of natives of similar skills by pushing them to leave the states. To the contrary if their inflow does not affect or affects positively the demand for native labor in the same skill group, *ceteris paribus,* then their inflow would be accompanied by no change or an increase in native employment in the state and skill group.

Importantly, we build on the same structural production function (nested CES with education and experience groups) used in Borjas and Katz (2007) and Ottaviano and Peri (2008) and we extend it to multiple open economies (U.S. states) with perfect long-run mobility of labor between them. From this framework we derive that the native employment response to an inflow of immigrants, appropriately estimated, is a function of the

elasticity of substitution between natives and immigrants in the same skill cell and of the elasticity of substitution between workers in different skill groups. This allows us to use our estimates of the native employment response to immigrants to infer the elasticity of substitution between native and immigrants of similar education and experience level. This method is theoretically consistent with the national approach (a' la Borjas 2003-Ottaviano and Peri 2008) and produces a new estimate of the immigrant-native elasticity using different data (based on employment in California rather than national wages).

This paper overcomes another criticism that has been raised to the area approach. Borjas and Aydemir (2007) have raised doubts on the cross-state regressions analyzing of the effect of immigration on employment and wages, as in many cases the measures of immigration at the state level are based on very few observations and likely to have very large measurement error. Such measurement error, they argue, can be a very important source of bias towards zero for the estimated coefficient. To avoid this issue in our analysis we only consider the largest US states, that is also, in absolute and relative terms, the major recipient of immigrants over the 1960-2005 period. Our analysis focuses on California. As we divide labor markets across skills-groups and we use several decades of Census data, we have as many observations as the national analysis to estimate our parameters. Moreover in each skill cell for each year, there are at least several thousands of observations of which at least few hundreds are immigrants. This guarantees that the measurement error for California data is essentially as small as for the national data and hence not a concern in the light of the Borjas and Aydemir (2007) critique. As mentioned above, we treat California as an open labor market relative to the rest of the US, in the long-run. This means that immigration in California for each skill group should not produce a lasting deviation of native wages in that skill group between California and the rest of the US. This is consistent with the national approach and is supported by the data 1960-2005 and will be maintained in the rest of the analysis. This also implies that the effects of immigration on the demand for native labor is captured by the employments effect of immigrants on natives by skill group.

We then estimate in many different ways the response of native hours worked, employment and population to immigrant inflows in different skill groups for California (relative to the average US). Being keenly aware that there could be several endogeneity and omitted variable problems, beginning with a simple panel estimate of changes in native employment on changes in immigrant employment (both as percentage of initial employment) by skill we estimate a set of progressively more demanding specifications. We first add several different sets of dummies to account for unobservable demand shocks, we use different measures of employment and hours worked, we group workers by skills in different ways, we select only some decades or some skill groups, we control for initial conditions and for lagged employment growth. Then, addressing the potential omitted variable problem with an instrumental variable approach, we use the initial presence of Latin immigrants in California (following a popular strategy first indicated by Card 2001) and exploit the change in demographic characteristics

of total migrants from Mexico and central America, to construct an instrument for immigrants in different cells. We also perform a series of other variations. While each of these specification may be criticized by itself, there is not a single estimate (out of several dozens) that finds a negative and significant effect of the increase in immigrant population on population, employment or worked hours of natives grouped by skill. Most of the estimates are statistically indistinguishable from 0 but a significant minority of them is positive and significant. Moreover, most of the employment effect estimated on the less educated groups (high school education or less) tend to be positive and mostly significant. Taken as a whole these result do not support the idea that immigrant depress labor demand for natives but to the contrary they may indicate that immigration, in the long run, stimulates such demand. In turn, using our structural production function, and assuming that immigration has no other effect on production, this implies that immigrant and natives have an elasticity of substitution that is similar to that between workers of different experience levels estimated between 4 and 14.

The last section of the paper is spent in presenting stylized evidence and reviewing previous literature that suggests some different channel through which immigrants complement native workers or may help the labor demand for natives also through a productivity effect. First, there is evidence that within a skill groups natives and immigrants are not perfect substitutes. While the immigrant-natives elasticity of substitution is larger when estimated using the wage-based method than with the employment-based method it is likely that at least part of the 0 employment effect is due to imperfect substitutability. Second there is evidence that immigrants at low levels of education take manual-intensive type of jobs and natives respond by specializing in communication intensive jobs, this increases overall efficiency and protects native from competition. We show that in California such a tendency to specialize of less educated natives has been much stronger than for any other states which may justify the lack of substitutability. Third immigration by promoting specialization, competition and skill variety may increase efficiency. Peri (2008) shows cross-state evidence of this phenomenon and we show TFP of California relative to average US which confirm high growth in period of high immigration. While these channels are likely to affect overall employment rather than relative employment of a skill group, they provide a mechanism through which immigration affect positively labor productivity and hence would not produce crowding out. Taken all together the evidence is consistent with a stimulating, rather than depressing, effect of immigration on native employment of the receiving state. New immigrants are absorbed without a negative impact on employment of native Californian workers.

The remaining of the paper is organized as follows. Section 2 presents the theoretical model and the derived empirical framework used to analyze the effect of immigration on the labor demand for natives. Section 3 describes the data on immigration, employment and wages in California, relative to the rest of the US and shows some tendencies and facts. Section 4 presents the estimates of the main parameter of interest: the effect of immigration on employment of US-born workers in California and derives the implications about the

substitutability between natives and immigrants. Section 5 presents some plausible alternative stories that explain the estimated null or small positive effect of immigrants on labor demand of native workers and shows some evidence (from the literature or from stylized data) in their support. Section 6 provides some concluding remarks.

2 The Framework: National Markets and Local Employment Response

Following the literature we consider that total output in California (or in any US state, s), Y_{st}, is produced combining Labor, N_{st}, Physical Capital, K_{st} and Productivity A_t that has no subscript s because we assume it to be common across states as technology is perfectly transferrable. The function we consider is the popular Cobb-Douglas production function, with elasticity of output to capital equal to α,hence we have:

$$Y_{st} = A_t N_{st}^{\alpha} K_{st}^{1-\alpha} \tag{1}$$

The innovation introduced by the recent literature is to consider the aggregate labor input N_{st} as a nested CES combination of hours worked by workers with different skills, where the relevant skills are education and potential experience, plus the attribute of being foreign-born or native. In particular, consistently with Ottaviano and Peri (2008) and hence similar to Borjas and Katz (2007) the aggregate labor input N_{st} is described by the following three CES nests:

$$N_{st} = \left[\sum_{i=1}^{4} \theta_{it} N_{sit}^{\frac{\sigma_{EDU}-1}{\sigma_{EDU}}} \right]^{\frac{\sigma_{EDU}}{\sigma_{EDU}-1}} \tag{2}$$

$$N_{skt} = \left[\sum_{j=1}^{8} \theta_{kj} N_{skjt}^{\frac{\sigma_{EXP}-1}{\sigma_{EXP}}} \right]^{\frac{\sigma_{EXP}}{\sigma_{EXP}-1}} \tag{3}$$

$$N_{skjt} = \left[\theta_{Dkj} D_{skjt}^{\frac{\sigma_{IMMI}-1}{\sigma_{IMMI}}} + \theta_{Fkj} F_{skjt}^{\frac{\sigma_{IMMI}-1}{\sigma_{IMMI}}} \right]^{\frac{\sigma_{IMMI}}{\sigma_{IMMI}-1}} \tag{4}$$

Equation 2 implies that we consider four imperfectly substitutable education groups (workers with no degree, high school graduates, workers with some college education and college graduates) that enter production in a symmetric way[1]. Equation 3 implies that workers of similar education can be divided into 8 imperfectly

[1]Ottaviano and Peri (2008) as well as Card (2009) prefer a partition in two education groups only (high school equivalents and college equivalents) in analyzing the wage effects of immigrants. That would make a difference when we calculate the impact on wage of highly and less educated. However, in this paper we focus on the substitutability of immigrants and natives in an education-experience group, and on its effect on employment at the regional level and for these purposes the two specifications are equivalent, as we will see below. The further partition of education into four groups simply provides more potential skill groups to

substitutable skill groups according to their potential experience (eight five year intervals between 0 and 40). Equation 4 implies that domestic (native) workers D and foreign-born workers F are also potentially imperfectly substitutable. What elasticity of substitution prevails between natives and immigrants of similar education and experience, and whether it is finite or not, is what we would like to establish with the current empirical approach. The terms denoted with θ capture the efficiency-productivity of each group in production. As they do not have an s (state) subscript we assume that they are the same for all US states, as technology is fully transferrable across states[2]. Similarly, the elasticity of substitution across education groups, experience groups and native-immigrants ($\sigma_{EDU}, \sigma_{EXP}$ and σ_{IMMI}) are a technological parameter and are assumed to be equal for all states. We also impose a standardization at each level of aggregation so that $\sum \theta_{it} = 1, \sum \theta_{kjt} = 1$ for each k and $\theta_{Dkj} + \theta_{Fkj} = 1$ for each k and j. Notice also that (consistently with the previous literature) while the relative productivity/efficiency of education and experience groups is allowed to change over time we impose that the nativity-specific productivity may vary across skill groups but does not depend on time. Given this productive structure the wage of domestic workers in skill group k, j in state s and year t, calculated as the marginal productivity of a domestic worker is:

$$\ln w_{sDkjt} = \ln\left(\alpha A_t \kappa_{st}^{1-\alpha}\right) + \frac{1}{\sigma_{EDU}} \ln(N_{st}) + \ln \theta_{kt} - \left(\frac{1}{\sigma_{EDU}} - \frac{1}{\sigma_{EXP}}\right) \ln(N_{skt}) + \tag{5}$$

$$+ \ln \theta_{kjt} - \left(\frac{1}{\sigma_{EXP}} - \frac{1}{\sigma_{IMMI}}\right) \ln(N_{skjt}) + \ln \theta_{Dkj} - \frac{1}{\sigma_{IMMI}} \ln(D_{skjt}) \tag{6}$$

At this point we use the assumption of national labor markets for each skill-type (k, j) for native workers which implies that, in the long-run the wages, $\ln w_{sDkjt}$, are equated across all states s to the average US wage for that skill and also that any change in state-wages (relative to the average) driven by changes in in supply of immigrants (F_{skjt}) must be undone by corresponding state-change in native supply D_{skjt} to maintain the state-wage of the group equal to the national average for the group. Taking the total differential of equation (5) over time with respect to the logarithmic changes in immigrants, natives and productivity in each skill group k, j for California and for the US average, and subtracting one from the other ($d \ln w_{CALDkjt} - d \ln w_{USADkjt}$) should equal zero if the wage equalization condition across states holds for each skill in the long-run. We impose such condition and we use the fact that the total differential of the term $\ln\left(\alpha A_t \kappa_{st}^{1-\alpha}\right) + \frac{1}{\sigma_{EDU}} \ln(N_{st})$ which vary only over time is common to all skill groups, hence can be captured by a pure time-effect, ϕ_t and the total differential of the term $\ln \theta_{kt} - \left(\frac{1}{\sigma_{EDU}} - \frac{1}{\sigma_{EXP}}\right) \ln(N_{skt})$ varies only across education groups and years and hence is a education-by-year effect, ϕ_{kt}.Therefore the total (log) differential of (5) for California relative to the US average, imposing the equilibrium condition of 0 difference in wages over the long-run would be:

observe.

[2]This assumption is not needed for the empirical procedure to identify the parameter as long as we have an instrument correlated with the skill-specific supply of immigrants to California but not with the efficiency and skill-specific labor demand in California. We discuss in section XX what happens if productivity of a group is correlated with the share of immigrants.

$$0 = \phi_t + \phi_{kt} - \left(\frac{1}{\sigma_{EXP}} - \frac{1}{\sigma_{IMMI}}\right)\frac{\partial \ln(N_{skjt})}{\partial \ln(F_{skjt})}\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}} - \left(\frac{1}{\sigma_{EXP}} - \frac{1}{\sigma_{IMMI}}\right)\frac{\partial \ln(N_{skjt})}{\partial \ln(D_{skjt})}\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{D}_{skjt}} - \frac{1}{\sigma_{IMMI}}\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{D}_{skjt}} - \Delta \ln \widetilde{\theta}_{kjt} \tag{7}$$

The term $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}}$, $\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{D}_{skjt}}$ represent the discrete logarithmic change in foreign-born and native born (respectively) of group kj in California relative to the average US (the tilde ˜ indicates changes relative to the US average) over the inter-census period. It is easy to show that the partial derivative $\frac{\partial \ln(N_{skjt})}{\partial \ln(D_{skjt})}$ is equal to the share of wages going to native workers in the skill group kj that we can call $\varkappa_{kj}$ and if natives and immigrants in the same skill groups are paid roughly the same wage this is approximately equal to their share in employment; $D_{skjt}/(F_{skjt} + D_{skjt})$. Similarly $\frac{\partial \ln(N_{skjt})}{\partial \ln(F_{skjt})}$ the share of wages going to immigrants in skill group kj, is equal to $1 - \varkappa_{kj}$. Moreover $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}}$ can be re-written as $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}\frac{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}{\widetilde{F}_{skjt}}$ and $\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{D}_{skjt}} = \frac{\Delta \widetilde{D}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}\frac{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}{\widetilde{D}_{skjt}}$.Using these substitutions and approximations and simplifying we can re-write 7 as:

$$0 = \phi_t + \phi_{kt} - \left(\frac{1}{\sigma_{EXP}} - \frac{1}{\sigma_{IMMI}}\right)\left(\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt} + \widetilde{D}_{skjt}}\right) - \left(\frac{1}{\sigma_{EXP}} - \frac{1}{\sigma_{IMMI}} + \frac{1}{\varkappa_{kj}\sigma_{IMMI}}\right)\left(\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{F}_{skjt} + \widetilde{D}_{skjt}}\right) - \Delta \ln \widetilde{\theta}_{skjt} \tag{8}$$

Where $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ represents the change in hours worked due to immigrants in the skill group kj relative to the initial total hours worked in the skill group for California relative to the US average. Similarly $\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ represents the change in hours worked in skill group kj due to natives relative to initial hours worked in the group for California relative to the US average. From 8 we can solve for $\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$; assuming that the term $\varkappa_{kj}$ can be approximated by the average value across skill groups $\overline{x}$ that, because of its definition it is bounded between 0 and 1, and that the term $\Delta \ln \widetilde{\theta}_{kjt}$ is a random technology shock, uncorrelated with the inflow of immigrants, we can re-write equation 8 in the following form:

$$\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{F}_{skjt} + \widetilde{D}_{skjt}} = \Phi_t + \Phi_{kt} + \beta \frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt} + \widetilde{D}_{skjt}} + \nu_{skjt} \qquad \text{where} \quad \beta = -\frac{\sigma_{IMMI} - \sigma_{EXP}}{\sigma_{IMMI} + \left(\frac{1-\overline{x}}{\overline{x}}\right)\sigma_{EXP}} \tag{9}$$

Equation 9 is the basis of our empirical analysis. It provides a rigorous justification in terms of elasticity and production function parameter of a simple "employment" regression that, in similar formats, has been estimated by other studies (e.g. Card 2001, Card and Lewis 2007 or Ottaviano and Peri 2006). The terms Φ_t and Φ_{kt} capture the effect of immigration and of native response on the overall labor aggregate and on the aggregate within education, while ν_{kjt} is the California-specific and skill-specific productivity shock $\Delta \ln \widetilde{\theta}_{skjt}$. We allow this shock to have a common, a skill-specific and an education-time-specific component over time (absorbed by fixed effects). In order to estimate β consistently we would need the remaining variation of ν_{skjt} to be uncorrelated with $\Delta \widetilde{F}_{skjt}$ or, in the instrumental variable approach, we need to use as instrument a portion

of the variation of $\Delta\widetilde{F}_{skjt}$ that is uncorrelated with the productivity-demand shock specific to a skill group in California. The coefficient of interest, β, can therefore be estimated in a regression of the change in the labor supply of natives relative to the initial total supply in the skill group on the change in supply due to immigrants (also relative to initial supply) instrumented with a purely supply-driven change in immigrants. Both variables are expressed for California relative to the aggregate (average) US; the unit of observations are the changes for 32 skill (education by experience) groups over the periods 1960-70, 1970-80, 1980-90, 1990-2000 and 2000-2005.

The interesting feature of equation 9 is that the parameter β has an interpretation in terms of elasticity of substitution between native and immigrants in an education-experience group, σ_{IMMI} relative to the elasticity between workers of different experience groups σ_{EXP}. First, if natives and immigrants are perfectly substitutable within in the group ($\sigma_{IMMI} = \infty$), no matter what is the value of σ_{EXP} (as long as it is finite) we would obtain $\beta = -1$. The traditional literature has called this case the "full crowding-out" case. We can think that one immigrant displaces exactly one native due to their identical role in production and inflow of immigrants is accompanied by an equal outflow (decrease in labor supply) of natives in the state. Second, as the denominator of β is always positive the sign of the effect is determined by whether immigrants and natives are more or less substitutable than workers with different experience levels. If $\sigma_{IMMI} = \sigma_{EXP}$ then immigrants and natives in a group "complement" each other to the same extent as workers of different experience levels. In that case we will obtain an estimate of $\beta = 0$. If immigrants and natives are closer substitutes than workers with different experience levels ($\sigma_{IMMI} > \sigma_{EXP}$), but not perfect substitutes, we would obtain a negative value of β but smaller in absolute value than -1. Finally if natives and immigrants are less substitutable than workers of different experience levels then we would obtain a positive estimate of β.As in the labor literature several estimates of σ_{EXP} are available for the national US market (Card and Lemieux 2001, Borjas 2003, Ottaviano and Peri 2008) and the average $\overline{\varkappa}$ is measurable we could identify the values of σ_{IMMI} implied by the estimates of β from 9 and so provide some independent evidence (from California and US employment rather than wage data) on this parameter to inform the debate.

3 Immigration to California: A Look at the Data

The inflow of foreign-born in California over the period 1960-2005 has been remarkable. Using data from the IPUMS relative to the Censuses 1960 (1% sample), 1970 (1% sample), 1980 (5% sample), 1990 (5% sample), 2000 (5% sample) and relative to the 1%ACS 2005, we measure that the Californian population between 18 and 65 years of age grew during those 45 years by 12.3 million people. Of them native had a net increase of 5.8 million while foreign-born by 6.5 million. Among the foreign-born (identified as individuals born abroad without US citizenship at birth) a net increase of 4 million was due to immigrants from Mexico and Central America. Hence more than half of the net adult population growth in California over the period 1960-2005 was

due to immigrants and full 30% of it was due to Latin immigrants. The evolution of immigrants as share of total employment in California vis-a-vis the whole US[3] is shown in Figure 1 and the actual percentage values, together with their breakdown by education group, are shown in Table 1[4]. Immigrants went from 9% (in 1960) to 36% (in 2005) of total employment in California while the corresponding percentages in the US were 5% (in 1960) and 16% (in 2005). Even more remarkably, Table 1 shows that the percentage of immigrants in the group of workers with no high school diploma went from 12% to 78% in California (versus an increase from 6% to 42% for the US as a whole). More than four fitfths of this remarkable 66% increase were due to inflow of Mexican and Central American[5]. By all accounts California experienced the extent and type of immigration that many politicians and journalists portray as disruptive of the job opportunities of natives, especially for native workers with low levels of education. Hence if there is a US state, or an economy in the world, where the labor market consequences of immigration should have been most dramatic that place must be California over the 45 years analyzed. California, however, is also a very open labor market vis-a-vis the rest of the United States. Every decade twenty to thirty percent of its population moves across the border to and from other states and certainly capital (if harder to measure) also flows in similar percentages in and out of the state. Hence, it would be very reasonable to expect that, in spite of these massive inflows of immigrant workers, unevenly distributed across skill groups, wages of natives in each skill group are not very different in California than in the rest of the Country. This does not mean that there are no labor market effect of immigrants. Native workers may move in response and equate wages in a national market. As we have shown in section 2 labor demand consequences of immigration on native workers in an open labor market are captured by employment, rather than wage, effects. Let us check, however, that the data on wages by skill group, are consistent with such "national market" assumption.

Let us begin with some simple evidence on correlations. We measure the percentage change in native wages for each education (k) and experience (j) group[6] over each inter-census period (1960-2000) plus 2000-2005, for California (relative to the US average) and we call this variable $\Delta\widetilde{w}_{Dkjt}/\widetilde{w}_{Dkjt}$[7]. We then plot it against $\Delta\widetilde{F}_{kjt}/(\widetilde{F}_{kjt}+\widetilde{D}_{kjt})$, the increase in hours worked due to immigrants in the same skill group (k,j) over the same inter-census plus 2000-2005 periods, divided by initial hours worked in the group (also relative to the US aggregate). The scatter-plot produced is reported in Figure 2. It suggests no correlation at all (point estimate

[3]The absolute number of immigrant and total employment in US and California is shown in Figures A1 and A2 in the tables and Figures Appendix.

[4]We consider as "employed" those individuals between 18 and 65 year of age who worked at least one week in the year of reference. Moreover we restrict the sample to those individual with not more than 40 years of potential experience.

[5]A consequence of this massive inflow is also that in each year the number of observations realtive to immigrant workers from the Census and the ACS data are several hundred thousands and each education-experience group has at least some hundreds of them. Measurement error issues are likely to be very small.

[6]The education and experience cells used are as defined in the previous section with four education and eight experience groups.

[7]The average wage by education-experience group in each year is calculated by averaging the weekly wage of all working individual, not self-employed, each one weighted by the number of hours worked times his sample weight (PERWT). The definition of four Education groups, eight experience groups and the selection of workeing individual and the exact procedure adopted to calculate the wages is idenitcal to Ottaviano and Peri (2008). The Appendix of that paper decribes all the details and the STATA codes to reproduce the selection and grouping are available at http://www.econ.ucdavis.edu/faculty/gperi/codesOP2008.htm

is slightly positive and not significant) between native wage changes and immigration rates by cell-decade. Moreover, the range of variation of immigration rates across skill groups (between -20% and +60% in a decade) is vastly larger than the range of variation of wage growth differential for skill groups (mostly between -10% and +10% in a decade).

Confirming this piece of evidence, Figure 3 shows the average yearly growth of wages in the 32 education-experience groups over the 1960-2005 period connected by a dark (for California) and a light (for the USA) solid line. We notice a very large range of overlap between the two lines; for most groups the average changes are similar in California and in the US and for only very few groups a difference of 0.3% or more exists, and such difference is in favor of California. To the contrary Figure 4 shows the average yearly growth of employment 1960-2005 due to immigrants for the same skill groups in California (light line) and in the US (dark line). In this case the line relative to California is much higher than the one relative to the US and for some groups of less educated workers the difference is as large as 1.5 to 2% per year. In the face of massively larger inflow of immigrants to California, especially in the groups of less educated workers the native wages for those workers remained very close to the wages of similarly skilled workers in the rest of the US. This is exactly what would happen in a national market when one of its regions receives an inflow of immigrants but through mobility of workers the effect is distributed throughout the national market.

Table 1 explores more systematically the proposition of no correlation between native wages and inflow of immigrants at the skill-group level by running the following weighted Least square regression, using as weights the employment size of each cell:

$$\frac{\Delta \widetilde{w}_{Dkjt}}{\widetilde{w}_{Dkjt}} = \phi_{kj} + \phi_{kt} + \gamma \frac{\Delta \widetilde{F}_{kjt}}{\widetilde{F}_{kjt} + \widetilde{D}_{kjt}} + \varepsilon_{kjt} \tag{10}$$

In specification (10) we control for education-experience effects ϕ_{kj} as well as education-time effect ϕ_{kt} to allow common wage trends depending on skill type and common decade effects by education group. ε_{kjt} is a zero mean random error. In the simple specification (column 1 of Table 1) we omit the fixed effects, in column 2 we include them, in column 3 we only limit our regressions to cells containing workers with high school degree or less, and in the last column we do not weight by cell size. Each entry of Table 1 reports the estimates of coefficient γ and the rows differ by the measure used for labor supply changes ($\frac{\Delta \widetilde{F}_{kjt}}{\widetilde{F}_{kjt}+\widetilde{D}_{kjt}}$) that is based, alternatively on inter-census changes of hours worked, employment or population of immigrants in a skill cell relative. Moreover the top part of the table only includes Males in the computations while the bottom part include males and females. The results could not be clearer. The estimated coefficient is always very small, very precisely estimated and not different from 0. The estimated correlations are very consistent with the idea that even extremely large inflows of immigrants in a skill cell (for California relative to the average US) has not been associated with any significant wage change for native California workers relative to native workers in the

rest of the US. For instance, taking the estimates of Column 2 (γ =0.02) that uses hours worked to measure supply, we obtain that an inflow of immigrants in a skill group equal to 60% of its initial employment, which is the largest observed data point for the whole period across cells, would be associated with a deviation of wages of Californian native workers (relative to US workers) by about 1% (and positive!) . More normal inflows would be associated with essentially no wage deviations. Hence the model of a national market by skill explains very well the null correlation between immigrants and wages in California and the small departures of wage changes between California and the rest of the country. Hence, the assumption incorporated in equation 8 stands and will be maintained in the rest of the analysis

4 The Response of California Employment to Immigrants

4.1 Basic Specification and Econometric issues

The main goal of this empirical section is to estimate the coefficient β in equation 9. As we discussed above that coefficient can be smaller than, equal to or larger than zero depending on the relative size of the elasticity of substitution between native and immigrants (of similar skills) and that between workers in different experience groups. Equation 9 is derived from the production function plus the wage equalization (across states) assumption as long as we interpret the error term ν_{skjt} as a California-specific, skill-group specific technological shock. Before navigating the details of the empirical estimation, let us provide a simple figure that essentially conveys the basic result, which will be confirmed time and again by more demanding specifications and 2SLS estimation techniques. Figure A3 in the Tables and Figures Appendix presents the scatter-plot of the changes in employment due to immigrants (horizontal axis) and the change in employment due to natives (vertical axis) as percentage of the group, by cell and decade for California. The visual impression is that there is essentially no correlation whatsoever between the native and immigrant employment change, which is essentially what accounts for the 0 coefficient that we estimate below. Moreover we also notice that the variation of native employment growth (ranging between -50% and +50% of group employment) is larger than the variation of immigrant employment (ranging between -20% and +40%). This implies that the standard error of the OLS estimates will be relatively large as the dependent variable exhibit much less variation than the explanatory variable.

The possibility of estimating β consistently, as the combination of parameters described in 9 rests on the possibility of controlling for all the factors that may induce a systematic correlation between the inflow of immigrants $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ and the technological shock $\Delta \ln \widetilde{\theta}_{skjt}$. Only if the remaining error is uncorrelated with the explanatory variable the OLS estimates of β are consistent. In our strategy we begin by assuming that the fixed effects Φ_{kt} (education by year) plus a set of systematic skill-specific factors Φ_{kj} would absorb the part of technological shocks correlated with immigration. The remaining variation of immigrants (within education-

experience cell over time) can be driven by supply factors. In Table 2 we present the estimates of β first (Column 1) in a simple OLS regression of $\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ on $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ and then (column 2) with the Φ_{kj} and Φ_{kt}fixed effects. We run these regressions using Hours worked, employment or population as measures of labor supply (of natives and immigrants) and also, alternatively, on male workers only (in the top panel) or on male and female together (in the bottom panel). All specifications, except for one, produce an estimate of β non significantly different from 0. Nine out of twelve point estimates are positive and the only significant estimate is positive. Also the estimates that include fixed effects (column 2) are systematically smaller than the "simple" estimates of column 1. This may indicate that without controlling for systematic California-specific skill-specific demand shocks one may obtain a slightly positive estimate due to spurious correlation. If there is some persistence in demand shocks, captured by the lagged native-employment growth, one should also include that lagged dependent variable in the regression. This is what we do in Specification 3) and we still obtain all estimates of β insignificantly different from 0. To inquire whether the more recent immigration had a different effect, we estimated specification (5) restricted to post 1980 years, and finally in (6) we did not weight cells for their employment size. Both specifications still produce very small estimates of β in absolute value not statistically different from 0. Worth mentioning is specification (4) where the sample is restricted to include only cells of less educated workers, defined as those with an high school degree or less. In this case we obtain positive estimates that are mostly significant at the 5% level. This would imply (if the coefficient estimate is confirmed in other specifications) that for cells with less educated workers, immigrants are less substitutable with natives than in cells with high education levels . We will come back to this point in section 4.2 below. Finally, as an estimate of β =0 seem to emerge as the potential "focal point" we remind the reader that most existing estimates of the elasticity of substitution across age groups (experience groups) for the US national market range between 4 and 14. More precisely Welch (1979) estimates elasticity of substitution between 4 and 12 (Welch 1979, Table 9 page 90) between US white male workers of different experience groups (one year cells). Card and Lemieux (2001) estimate an elasticity ranging from 4 to 10 (table V of Card and Lemieux, 2000) between US workers of different experience groups (five year cells) . Borjas (2003) estimates an elasticity of 3.5 between US workers of different experience groups (five year cells). Ottaviano and Peri (2008) estimate an elasticity ranging from 6.25 to 14 (Ottaviano and Peri 2008, Table 6) between US workers of different experience groups (five year cells). Our model, therefore implies a similar range for σ_{IMMI} the elasticity between natives and immigrants. In particular all those studies rule out perfect substitutability across age groups ($\sigma = \infty$) and this plus the results of our model imply rejection of perfect substitutability between natives and immigrants. We will discuss and compare this range with the direct measures of σ_{IMMI} in section 5.

4.2 Instruments and 2SLS estimation

The OLS estimates of β produced in the previous section show no correlation between the change in immigrants and native labor across skill groups in California. One concern is that, in spite of the systematic fixed effects accounting for education by year and skill-group specific effects there might be some changes in the demand (productivity) of specific age-education groups in California over time. Such a change could attract immigrants as well as natives and induce a spurious positive correlation that offsets a potential negative crowding-out effect. To reduce these concerns we use an instrumental variable strategy in this section. California had a sizeable community of Mexicans and Central Americans as of 1960 for proximity reasons and due to the pre-existing Bracero program (1942-1964) that attracted agricultural workers. However, the inflow of those groups of immigrants increased much over the considered period, especially during the 1980's and 1990's. Those migrants, from Mexico and Central America had a specific age and education distribution. A baby boom generation was hitting the labor marked in Mexico in the 1980's and 1990's (see Hanson and McIntosh, 2009) and less educated workers did not have good job opportunities due to a stagnation of the Mexican economy. Hence total emigration of Mexican and Central American was characterized by a specific age-education distribution: many young poorly educated emigrated while few middle-aged better educated individuals did. This wave of emigrants from Mexico and Central America hit California disproportionately, relative to the rest of the country, for the presence of pre-existing Latin communities that attracted new immigrants. In the spirit of the "enclave" instrument used in Card (2001), Card (2009), and several other papers, we instrument the inflow to California (relative to average US) of immigrants by skill-cell in each decade with the distribution by skill-cell of Mexican-Central American immigrants to the whole US. To the extent that the skill-distribution of all migrants from Mexico and Central America to the US was not affected much by the skill-specific labor demand from California relative to the US, the instrument is a pure supply shock and should identify β, the effect of immigrant labor on native labor. Table 3 reports the estimates of β using 2SLS with different measures of labor supply (population, employment and hours worked) considering alternatively all workers or male only and for the same specifications as in Table 2. The lower part of the table shows the first stage coefficient and F-test of the instruments, and confirms that the instrument (Mexican immigrants in the US by cell) is working in the correct direction and strong (F-stats above 20 for the full sample). While the standard errors are larger than for the OLS estimates the magnitude and pattern of the 2SLS point-estimates is very similar to the OLS ones. The preferred specification with all fixed effects (column 2) shows for any measure and any sample an insignificant (usually positive) estimate of β. Including lagged native employment changes (column 3) or excluding the older period (column5) or dropping the regression weights does not change the estimates much. The estimates with no fixed effects tend to be positive and often significant indicating the potential presence of education-specific demand shocks in California correlated with the inflow of foreigners. However once fixed effects are introduced the point estimates are very

close to 0. The estimates including only less educated workers tend to be positive indicating, possibly, larger complementarity of immigrants to natives in these groups. The 2SLS results, therefore, uphold the findings of Table 2, confirming that an estimate of $\beta = 0$ cannot be rejected in most cases (when it can be rejected the preferred alternative is $\beta > 0$), and implying that the elasticity of substitution between natives and immigrants is between 5 and 20, equal, that is, to the estimated elasticity of substitution between workers of different experience groups, as reported in Card and Lemieux (2003), Borjas (2003) and Ottaviano and Peri (2008).

4.3 Effect on Black Native Workers

It is interesting to analyze specifically the employment effects of immigrants on African American workers. On one hand African American are more concentrated in the skill-groups (young and less educated) most affected by the inflow of immigrants. On the other hand their occupations and jobs, intensive in manual and physical tasks (as pointed out in Peri and Sparber 2009) can be in more direct competition with immigrants. Hence we estimate the same regression 9 using the same specifications and variable definitions as in Table 3, but restricting the measure of native employment change to African American employment. Figure A4, in the Tables and Figures appendix, shows the scatter-plot of changes in African American employment by decade (as percentage of initial cell employment) versus change of immigrant employment as percentage of initial cell-employment. We notice that in every cell and decade the changes in employment due to African-American in California are much smaller than changes due to immigrants and also that there is no apparent correlation (possibly a small positive one) between the two variables. Table 4 shows the estimates of β using the same specifications and methods as Table 3, but using the employment change of African Americans relative to the total initial employment as dependent variable. In particular all estimates use 2SLS method with the age-education composition of total Mexican immigration as instrument for the immigrant inflow by cell in California relative to the US. Consistently, in the specifications including fixed effects and all skill groups the estimates of β are insignificantly different from 0. In the case with no fixed effects (Column 1) or in the specification including less educated workers only (Column 4) , the parameter β is actually estimated to be positive and significant, between 0.10 and 0.20. The estimated effects on African American are even more convincing in ruling out a crowding-out of native employment by immigrants. In fact the point estimates are literally never smaller then -0.002 and the standard errors are between 0.03 and 0.09 which implies that in most case we can reject at the 5% level any negative effect of immigrants on native employment larger (in absolute value) than -0.1. To the contrary in several instances we cannot rule out positive effects in the order of 0.2-0.3. The response of African American employment to immigrants with similar age and education does not exhibit, similarly to the response of all natives, any evidence of even mild crowding out. In the interpretation of our model, based on the existence of a national market and mobility of natives, in the long-run, this implies that immigrants and natives are not perfect substitutes within a

skill group but their degree of substitution is similar to that of natives with different experience levels (elasticity of substitution between 5 and 20).

5 Explanations and Further Evidence

Summarizing the results of section 4 we can say that the inflow of immigrants to California within a certain skill cell stimulated the demand for labor of that type of skill enough that the jobs taken by immigrants did not crowd out any job for natives. In fact, possibly, the net effect was a small job creation for natives (especially in cells with low education) but never we find a job-destruction effect for natives. Interpreting the results in the light of the model of section 2 summarized in equation 9 there are two possible explanation for this phenomenon. The first, that we have privileged so far, is that immigrants and natives are not perfect substitutes in production, so that other things equal the inflow of immigrants not only affects the supply of that type of workers, but also affects the marginal productivity (and demand) for the native type of workers in that skill group positively. Given our controls for education-year effects, if the complementarity between immigrants and natives is equal to the complementarity between natives of different age groups, the implied push in demand for natives exactly compensate the increased competition from immigrants in the same age-education cell and we do not observe any employment effect.

An alternative possibility, however, is that the skill-specific productivity shock $\Delta \ln \widetilde{\theta}_{skjt}$, captured in equation 9 by the random error ν_{skjt} is, in actuality, systematically correlated with the inflow of immigrants for some structural reason even after we control for the education by time and education-experience effects. Combining the insight of Card and Lewis (2007) and Peri and Sparber (2009), it may be the case that in education-age cells with many immigrants manual-physical skills are particularly abundant relative to communication-interactive skills because immigrants have a comparative advantage in them. Hence in those cells, natives specialize in communication tasks (hence the imperfect substitution) improving their productivity and also the choice of technology and production methods is particularly efficient in using manual skills enhancing overall productivity of the group, $\ln \widetilde{\theta}_{skjt}$. In this case, the estimated coefficient of the empirical regression of $\frac{\Delta \widetilde{D}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ on the variable $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ would actually capture $\beta + \frac{1}{1-\overline{x}} \left(\frac{\Delta \ln \widetilde{\theta}_{skjt}}{\Delta \ln \widetilde{F}_{skjt}} \right)$. This includes the term depending on the native-immigrants elasticity of substitution β as well as the productivity effect of the inflow of immigrants $\frac{\Delta \ln \widetilde{\theta}_{skjt}}{\Delta \ln \widetilde{F}_{skjt}}$. In this section we present and review alternative estimates of σ_{IMMI} (from the US and for California) to see whether the *direct* evidence, from wage and employment data, is compatible with the indirect evidence, presented so far (based on employment changes) that suggests $\sigma_{IMMI} \approx \sigma_{EXP} \in [4, 14]$. We also present some stylized statistics that may indicate, following the specialization-productivity theory, that immigrants in California also stimulated specialization and productivity that may be part of the explanation for the zero

crowding-out, relying on a positive $\frac{\Delta \ln \widetilde{\theta}_{skjt}}{\Delta \ln \widetilde{F}_{skjt}}$ effect.

5.1 Imperfect Substitution Immigrants-Natives

There are two sets of estimates of the parameter σ_{IMMI} from the existing literature. One is from Ottaviano and Peri 2008 who use a national sample, a panel of 32 education-experience groups and Census years between 1960 and 2000 plus 2005, and obtain values that cluster around 20 (from their Table 2, Basic Specification). The other is from Card (2009) who uses cross-sectional city data in year 2000 and finds values ranging from 16 to 50, mostly around 25 when estimated using instrumental variables and always significantly different from infinity. In both cases, therefore, native and immigrants are found to be imperfect substitutes but with an elasticity larger than what implied by the current analysis (which would be as stated above between 4 and 14).

In fact we can also re-estimate the elasticity of substitution directly using California data and the same approach as in Ottaviano and Peri (2008). Even if natives are perfectly mobile across states and equate wages for each skill group, as long as immigrants have preference for high immigration states (so that they are willing to take a lower wage there) the response of relative native-immigrant wages in a skill cell to an exogenous change in relative native-immigrant employment (hours worked) can still identify the inverse elasticity of substitution. Hence using weekly wages of natives and immigrants by skill cell and relative native-immigrant labor supply in California we estimate directly (and consistently with our model) the following regression:

$$\ln(w_{Fkjt}/w_{Dkjt}) = I_{kj} - \frac{1}{\sigma_{IMMI}} \ln(F_{kjt}/D_{kjt}) + u_{kjt} \tag{11}$$

Table 5 reports the estimates of the coefficient $\frac{1}{\sigma_{IMMI}}$ from equation 11 estimated on Californian data, assuming that once we control for skill-cell effects and time effects the remaining variation is driven by supply of immigrants and hence identifies the elasticity coefficient correctly. The estimates, for different samples and different measures of labor supply (population, employment and hours worked) show mostly significant values between 0.04 and 0.05, which imply, consistently with Ottaviano and Peri (2008) and Card (2009) an elasticity immigrant-natives between 20 and 25. Hence, while both at the national level and using directly the estimates for California there is evidence of *imperfect substitutability* between natives and immigrants the estimated elasticities are larger using the direct method (around 20) than using the implications of the employment-based method (between 4 and 14). In the next section we describe some mechanisms that can be responsible for the systematic correlation between the inflow of immigrants, $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ and the productivity change of a skill group $\Delta \ln \widetilde{\theta}_{skjt}$. Namely we illustrate some mechanism and some stylized evidence that support the idea that production in California responded to immigration with efficient specialization of natives in production tasks enhancing productivity of those skill cells with larger inflow of immigrants.

5.2 Specialization in tasks and productivity effects

Peri and Sparber (2009) show that among less educated workers immigrants in the last forty years have increasingly specialized in manual-intensive occupations, pushing natives to take communication-intensive jobs. Such reallocation mechanism, based on the productive comparative advantages of each group of workers, has been efficient. They show that the complementarity between the two type of tasks and the efficiency gains from the reallocation helped productivity and wages of natives. California is the state that has experienced immigration inflow and reallocation of natives to communication tasks to the largest extent. Figure 4, based on the data of Peri and Sparber (2009) updated to 2005, shows the strong and positive correlation between the share of immigrants among less educated workers and the degree of specialization of native workers in occupations with high Communication relative to Manual skills across 50 US states. The vertical axis of the graph reports the average use of Communication relative to Manual skills for native workers in a state, imputed by aggregating individual occupation data weighted by the intensity of Manual and Communication content of the occupations (as measured by the O*NET variables). The horizontal axis reports the share of immigrants among workers with high school degree or less. The observation relative to California shows the highest concentration of immigrants and the second highest specialization of natives in communication tasks, emphasizing that the specialization mechanism was at its strongest in California. Moreover Peri (2008) shows that, across US states, large immigration is associated (possibly causally) with higher total factor productivity growth, and particularly high growth in the productivity (efficiency) of workers with low education levels. Figure 6, based on data from Peri (2008) shows in fact that the total factor productivity in California has been larger and has grown faster relative to the national average, especially in the decades of high immigration (1980's and 1990's). While these are only aggregate correlations they are compatible with the idea that the large immigration flows produced a particularly large task specialization in California and this was associated with more efficient organization of production and higher productivity. These mechanisms suggest that when $\frac{\Delta \widetilde{F}_{skjt}}{\widetilde{F}_{skjt}+\widetilde{D}_{skjt}}$ was large for a skill group and-or a period $\Delta \ln \widetilde{\theta}_{skjt}$ was also larger for that group. Hence, the expected negative impact of immigration on employment of natives of similar skills, that would occur in an open economy where native and immigrants are perfect substitutes, does not occur in part due to imperfect substitutability between the two groups and in part because of possible positive specialization and productivity effects of immigration on the skill group.

6 Conclusions

This paper has revisited the "area" approach in analyzing the effects of immigrants on the labor demand for natives in the US. First, we have obtained an estimating equation relating native employment to immigrant in a skill group, directly from the production-function of a state plus the assumption of long-run mobility

of workers across states. This allows us to relate the estimated coefficients from the employment regression with the elasticity of substitution between workers in the production function. Second, we have focussed on California, the largest US state economy, and the largest immigrant destination. This should ensure no relevant measurement error in the estimates of the employment effects (based on cells of thousands of observations). Also if the crowding-out effect of immigrants becomes stronger as immigrants become a significant share of employment California should exhibit the strongest crowding-out effects with 33% of employment provided by immigrants. Third we have proposed a new instrument based on the age and education composition of migrants from Mexico, as affecting the supply of immigrants by skills in California relative to the US. Two separate results should be emphasized. First, the estimates of the employment effect of immigrants on natives in an education-experience group are never negative and significant. They are mostly zero and sometimes positive and significant. Independently of the structural interpretation driven by the model in our paper this results means no crowding-out of employment by immigrants. The second important result, is that adopting our model and assumptions, such zero estimate implies an elasticity between natives and immigrants of similar skills between 4 and 14, equal, that is, to the elasticity of substitution of workers with similar education across age cohorts. Such estimates are not inconsistent but somewhat smaller than the direct estimates of substitutability between natives and immigrants (around 20 as estimated in Ottaviano and Peri 2008) from national wage and employment data. Hence we raise the possibility that, on top of imperfect substitution, part of the stimulating labor demand effect from immigrants, that offsets the competition effect and leads to no negative employment effects on natives, can be due to an efficient specialization and positive productivity effect on the skill group, of the kind found in Peri and Sparber (2009) and Peri (2008).

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Figures and Tables

Table 1,
Correlation between Native Wage Changes and Inflow of Immigrants
Units of observation: Decennial changes 1960-2000 and 2000-2005 for 32 education-experience cells.

Measures of Immigrants' Labor Supply:	(1) Simple	(2) With Fixed Effects (FE)	(3) Low education groups only, with FE	(4) Non weighted with FE
		Males Only		
Hours Worked	0.003	0.02	0.02	-0.004
	(0.02)	(0.03)	(0.025)	(0.25)
Employment	0.006	0.058	0.01	-0.01
	(0.037)	(0.037)	(0.04)	(0.04)
Population	0.007	0.06	0.02	-0.006
	(0.03)	(0.05)	(0.05)	(0.04)
		Males and Females		
Hours Worked	-0.005	0.028	0.03	0.007
	(0.02)	(0.024)	(0.02)	(0.025)
Employment	0.001	0.04	0.05	0.01
	(0.04)	(0.04)	(0.04)	(0.04)
Population	-0.006	0.04	0.05	0.01
	(0.04)	(0.04)	(0.04)	(0.04)
Education-by-Experience Effects	No	Yes	Yes	Yes
Education-by-year effects	No	Yes	Yes	Yes
Observations	160	160	80	160

Note: Dependent variable: percentage change (inter-census 1960-2000 plus 2000-2005) in weekly wage of Native California workers relative to change of native workers in the US, measured across 32 skill cells. The method of estimation is weighted least squares with analytical weights equal to the employment (number of observations) in each cell. The standard errors reported in parentheses are heteroskedasticity-robust and clustered by education-experience group. Specification (1) does not include any fixed effect, specification (2) includes education-by-experience and education-by-year effects; Specification (3) includes only cells of workers with high school degree or less; Specification (4) does not weight cells in the least square estimates.

Table 2, OLS estimates
Change in Native Labor in response to Changes in Immigrant Labor
Units of observation: Decennial changes 1960-2000 and 2000-2005 for 32 education-experience cells.

Measures of Labor Supply:	(1) Simple	(2) With Fixed Effects (FE)	(3) FE plus lagged dependent variable	(4) Low education groups only, with FE	(5) 1980-2005 period only With FE	(6) Non weighted with FE
			Male Only			
Hours Worked	0.28**	0.17	0.15	0.29*	0.09	0.21*
	(0.08)	(0.12)	(0.15)	(0.10)	(0.12)	(0.10)
Employment	0.13	0.04	-0.04	0.19*	0.07	0.13
	(0.07)	(0.10)	(0.14)	(0.08)	(0.12)	(0.08)
Population	0.11	-0.02	-0.06	0.17*	0.04	0.10
	(0.07)	(0.10)	(0.12)	(0.07)	(0.11)	(0.08)
			Male and Female			
Hours Worked	0.23	0.13	0.12	0.34*	-0.07	0.20
	(0.14)	(0.20)	(0.22)	(0.15)	(0.19)	(0.16)
Employment	0.05	-0.06	-0.13	0.20*	-0.08	0.06
	(0.12)	(0.17)	(0.19)	(0.11)	(0.17)	(0.12)
Population	0.01	-0.08	-0.15	0.19*	-0.06	0.05
	(0.12)	(0.15)	(0.18)	(0.08)	(0.17)	(0.10)
Education-by-Experience Effects	No	Yes	Yes	Yes	*Yes*	Yes
Education-by-year effects	No	Yes	Yes	Yes	*Yes*	Yes
Observations	160	160	160	80	96	160

Note: Dependent variable is the change (inter-census 1960-2000 plus 2000-2005) in native employment relative to total initial employment in the skill group for California relative to the average US. Explanatory variable is the change in immigrant employment relative to total initial employment in the skill group for California relative to the average US. Each cell in the table shows the estimate of coefficient β from equation (9) in the main text. The method of estimation is weighted least squares with analytical weights equal to the employment (number of observations) in each cell.
The standard errors reported in parentheses are heteroskedasticity-robust and clustered by education-experience group. ** significant at 1%, * significant at 5%.

Table 3, 2SLS estimates
Change in Native Labor in response to Changes in Immigrant Labor
Units of observation: Decennial changes 1960-2000 and 2000-2005 for 32 education-experience cells.

	(1) Simple	(2) With Fixed Effects (FE)	(3) FE plus lagged dependent variable	(4) Low education groups only, with FE	(5) 1980-2005 period only With FE	(6) Non weighted with FE
			Male			
Hours Worked	0.81**	0.24	0.21	0.52**	0.15	0.35*
	(0.27)	(0.20)	(0.25)	(0.14)	(0.38)	(0.16)
Employment	0.85**	0.16	0.10	0.36**	0.13	0.24
	(0.28)	(0.25)	(0.29)	(0.13)	(0.39)	(0.15)
Population	0.67**	0.15	0.07	0.47*	0.13	0.33
	(0.21)	(0.24)	(0.29)	(0.18)	(0.42)	(0.20)
			Male and Female			
Hours Worked	0.77*	0.14	0.16	0.60**	-0.13	0.26
	(0.35)	(0.35)	(0.42)	(0.18)	(0.54)	(0.27)
Employment	0.84*	-0.01	-0.04	0.59*	-0.18	0.20
	(0.39)	(0.49)	(0.42)	(0.29)	(0.64)	(0.33)
Population	0.84*	0.01	-0.09	0.52**	-0.02	0.23
	(0.34)	(0.33)	(0.39)	(0.21)	(0.54)	(0.26)
Education-by-Experience Effects	No	Yes	Yes	Yes	*Yes*	Yes
Education-by-year effects	No	Yes	Yes	Yes	*Yes*	Yes
First Stage Statistics, Endogenous variable is Population, Male and Female,						
Change population by Cell of Mexican-Central American in the whole USA	1.01**	2.21**	2.34**	2.13**	1.33*	2.02**
	(0.19)	(0.47)	(0.47)	(0.51)	(0.60)	(0.53)
F-stat	26.17	22.91	24.12	17.36	5.01	14.52
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)
Observations	160	160	128	80	96	160

Note: Dependent variable is the change in native employment relative to total initial employment in the skill group for California relative to the average US. Explanatory variable is the change in immigrant employment relative to total initial employment in the skill group for California relative to the average US. Each cell in the table shows the estimate of coefficient β from equation (8) in the main text. The method of estimation is two stage least squares. The Instrument used is the Mexican-Central American population by cell in the US. The standard errors reported in parentheses are heteroskedasticity-robust and clustered by education-experience group. ** significant at 1%, * significant at 5%.

Table 4
Change in Native Black Labor in response to Change in Immigrant Labor
Units of observation: Decennial changes 1960-2000 and 2000-2005 for 32 education-experience cells.

	(1) Simple	(2) Basic With Fixed Effects (FE)	(3) FE plus lagged dependent variable	(4) Low education groups only, with FE	(5) 1980-2005 period only With FE	(6) Non weighted with FE
			Male			
Hours Worked	0.15**	0.05	0.05	0.10**	0.10	0.06*
	(0.05)	(0.026)	(0.028)	(0.02)	(0.07)	(0.02)
Employment	0.18*	0.044	0.042	0.08**	0.08	0.043
	(0.06)	(0.042)	(0.05)	(0.03)	(0.08)	(0.027)
			Male and female			
Hours Worked	0.17**	0.028	0.028	0.11**	0.06	0.043
	(0.07)	(0.058)	(0.053)	(0.02)	(0.12)	(0.039)
Employment	0.20**	0.005	-0.003	0.09*	0.02	0.02
	(0.08)	(0.07)	(0.09)	(0.03)	(0.011)	(0.04)
Education-by-Experience Effects	No	Yes	Yes	Yes	*Yes*	Yes
Education-by-year effects	No	Yes	Yes	Yes	*Yes*	Yes
First Stage Statistics, Population Male and Female as endogenous variable						
Change population by Cell of Mexican-Central American in the whole USA	1.01**	2.21**	2.34**	2.13**	1.33*	2.02**
	(0.19)	(0.47)	(0.47)	(0.51)	(0.60)	(0.53)
F-stat	26.17	22.91	24.12	17.36	5.01	14.52
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)
Observations	160	160	128	80	96	160

Note: Dependent variable is the change in employment of US-born African American relative to total initial employment in the skill group for California relative to the average US. Explanatory variable is the change in immigrant employment relative to total initial employment in the skill group for California relative to the average US. Each cell in the table shows the estimate of coefficient β from equation (8) in the main text. The method of estimation is two stage least squares. The Instrument used is the Mexican-Central American population by cell in the US. The standard errors reported in parentheses are heteroskedasticity-robust and clustered by education-experience group. ** significant at 1%, * significant at 5%.

Table 5

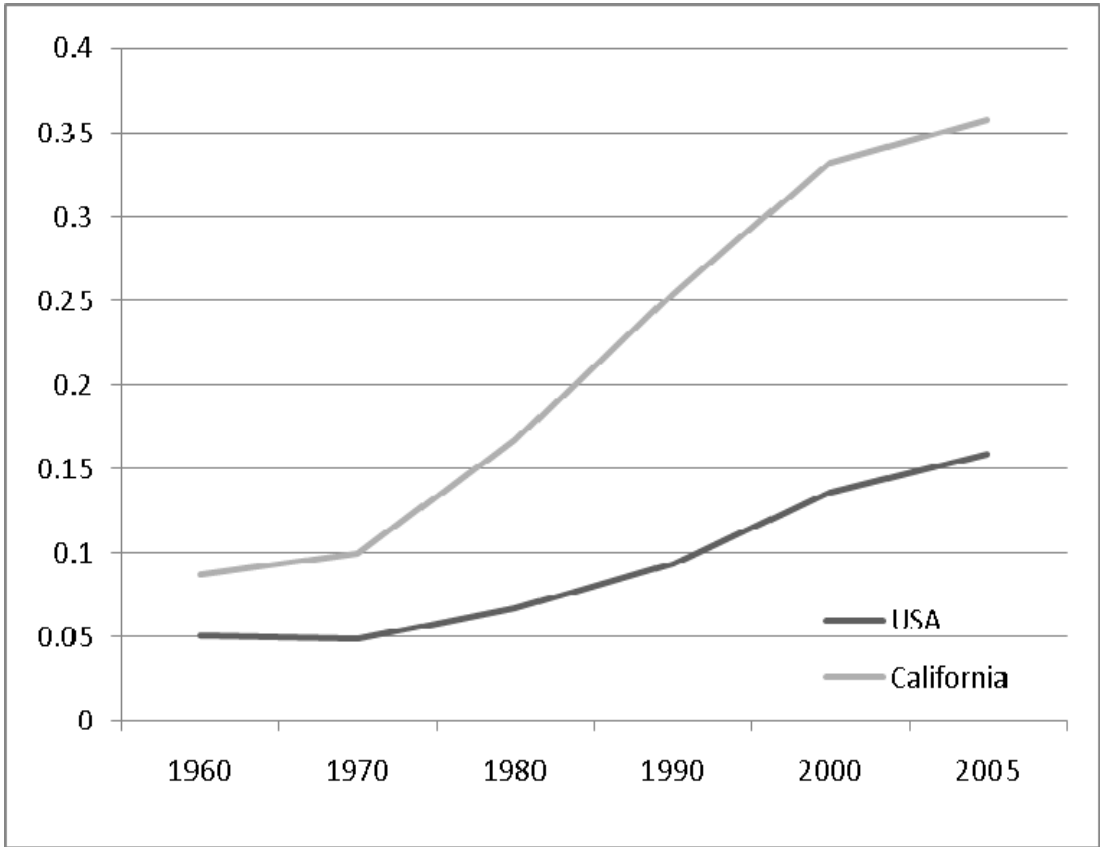
Native-Immigrant relative Wages Elasticity ($1/\sigma_{IMMI}$)

Panel 32 education-experience cell over the years 1960, 1970, 1980, 1990, 2000 and 2005

	Simple	**Basic With Fixed Effects (FE)**	**Non weighted with FE**
	Male Only		
Hours Worked	0.044**	0.035**	0.042*
	(0.008)	(0.018)	(0.023)
Employment	0.046**	0.040*	0.046*
	(0.017)	(0.018)	(0.024)
Population	0.048**	0.043**	0.049*
	(0.008)	(0.019)	(0.027)
	Male and females		
Hours Worked	0.038**	0.038*	0.032
	(0.08)	(0.019)	(0.020)
Employment	0.04**	0.038*	0.037
	(0.0007)	(0.019)	(0.023)
Population	0.041**	0.041**	0.037
	(0.007)	(0.020)	(0.02)
Education-by-Experience Effects	No	Yes	Yes
Year effects	Yes	Yes	Yes
Observations	160	160	160

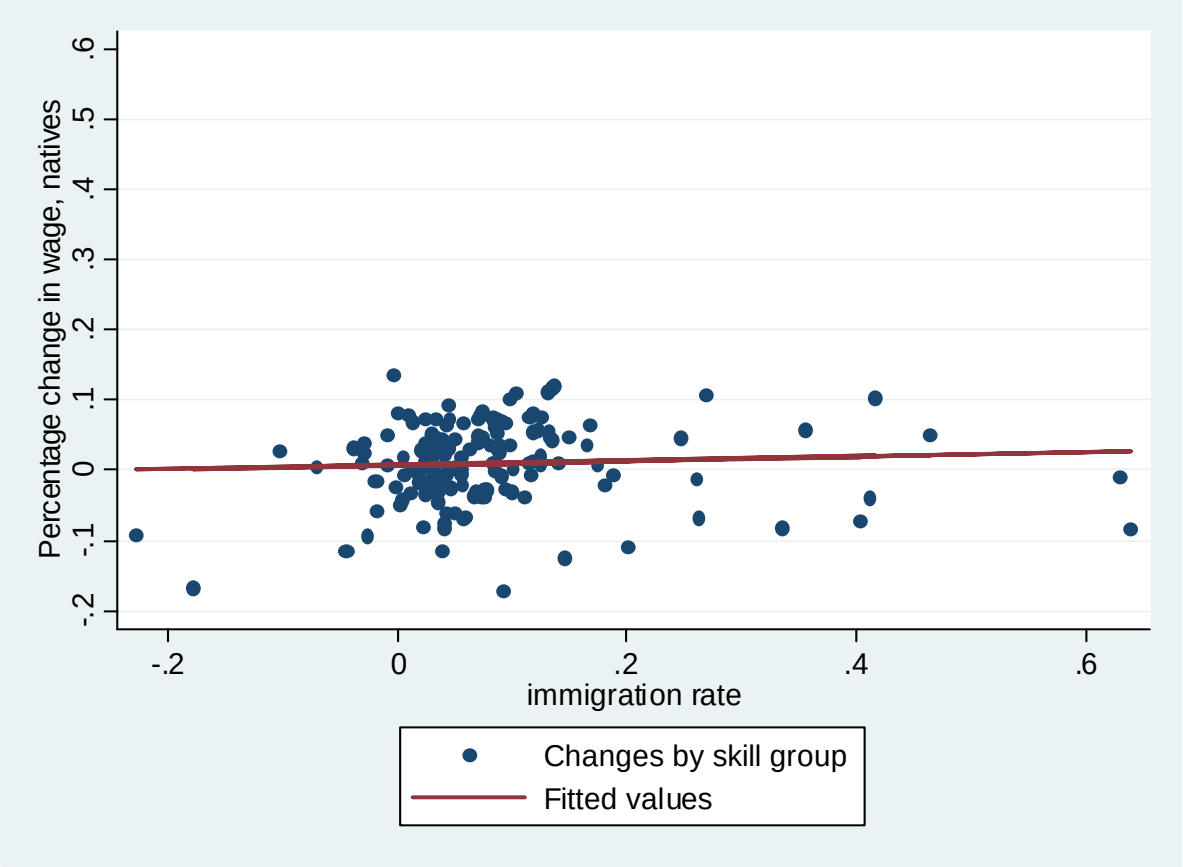
Note: The reported coefficient is the estimate of ($1/\sigma_{IMMI}$) from specification 11 in the text. The dependent variable is the weekly wage of native relative to immigrants in California in a skill group. The explanatory variable is the relative native-immigrant supply, measured (alternatively) as Hours worked, employment and population. The units of observation are 32 education-experience cells in 1960, 1970, 1980, 1990, 2000 and 2005. The standard errors reported in parentheses are heteroskedasticity-robust and clustered by education-experience group. ** significant at 1%, * significant at 5%.

Figure 1
Share of Immigrants in Employment 1960-2005



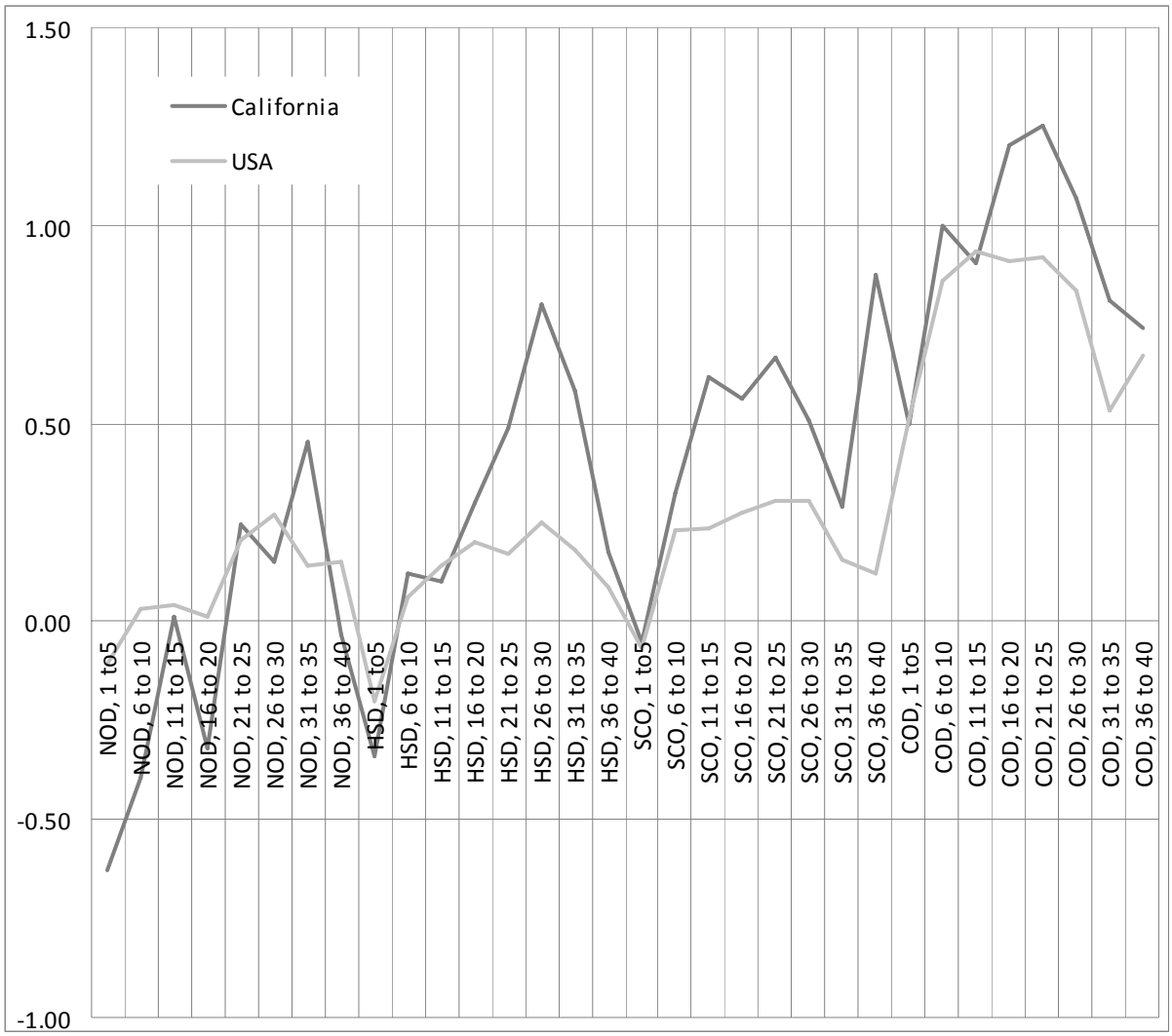
Note: The data are from Census 1960-2000 and ACS 2005. Employed workers are defined as the sum of individuals of ages between 18 and 65, not residing in group quarters and who worked at least one week during the preceding year with potential experience

Figure 2
Elasticity of Native wages to Immigrant Employment
32 skill groups, decade changes 1960-2000 plus 2000-2005 change



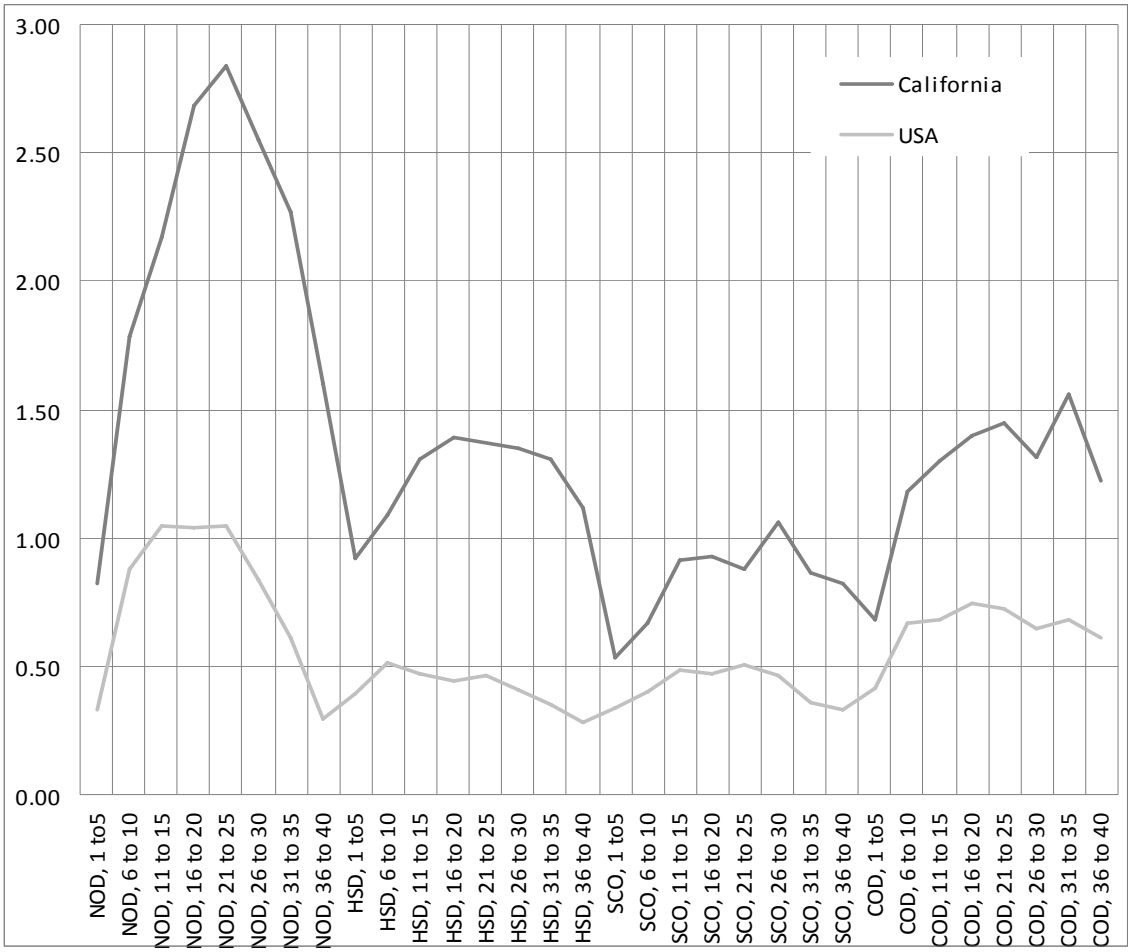
Note: The vertical axis measures the percentage change in weekly wages of native workers in the cell for each inter-census period (1960-2005) plus 2000-2005. The horizontal axis measures the percentage increase in employment in the cell due to immigrants for each inter-census period (1960-2005) plus 2000-2005.

Figure 3:
Annual average Percentage Change in Weekly wage of US-born males by Skill Group 1960-2005 California and Average USA



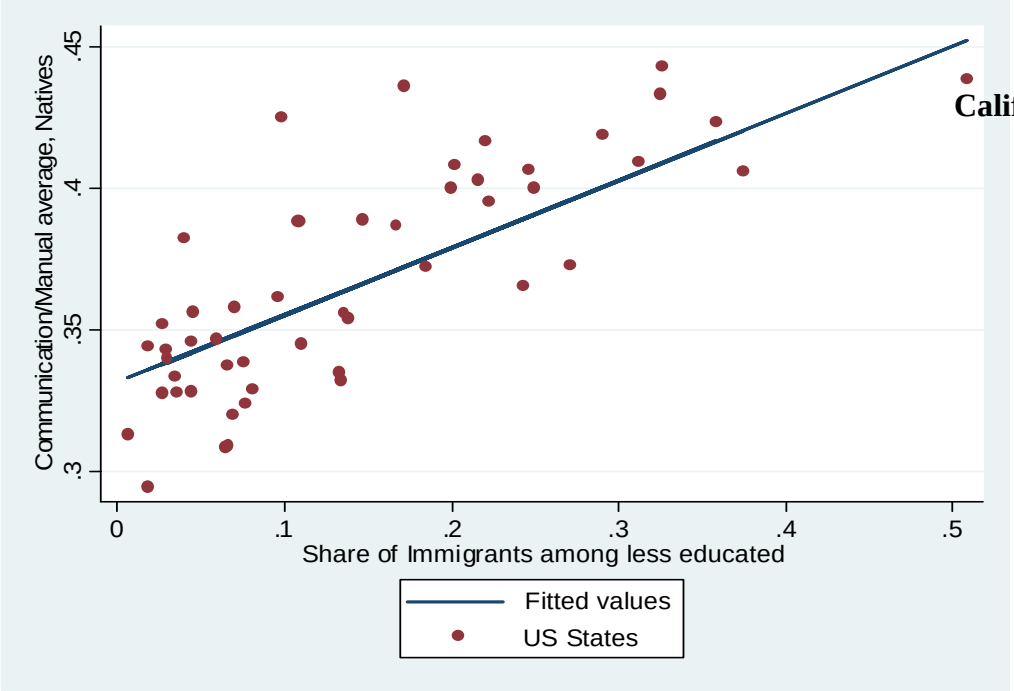
Note: The Skill groups are arranged from left to right by Education (NOD-NO degree, HSD=high school degree, SCO=some college and COG=college degree) and within each education group there are 8 groups arrayed by years of potential experience, increasing from left to right (0-5, 6-10, 11-15, 16-20, 21-15, 26-30, 31-35, 36-40).

Figure 4:
Annual average Percentage increase in Employment due to immigrants by Skill group 1960-2005 California and Average USA



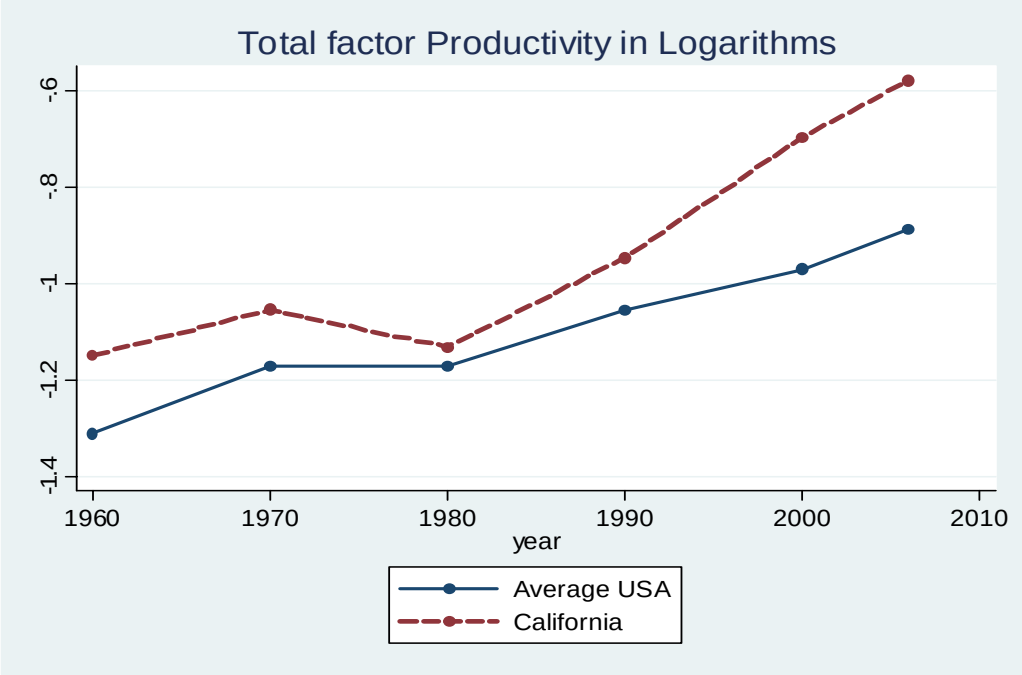
Note: The Skill groups are arranged from left to right by Education (NOD-NO degree, HSD=high school degree, SCO=some college and COG=college degree) and within each education group there are 8 groups arrayed by years of potential experience, increasing from left to right (0-5, 6-10, 11-15, 16-20, 21-15, 26-30, 31-35, 36-40).

Figure 5
Communication/Manual skill supply of Natives and immigrants among less educated workers
US States, 2005



Note: The data on average Communication/Manual skills by state are from Peri and Sparber (2009), obtained from the manual and communication intensity of occupations, weighted according to the distributional occupation of natives.

Figure 6
TFP in California and USA 1960-2005



Note: TFP for the US and California is calculate in Peri (2008)

Tables and Figure Appendix

Figure A1
Total Employment of natives and immigrants,
California 1960-2005

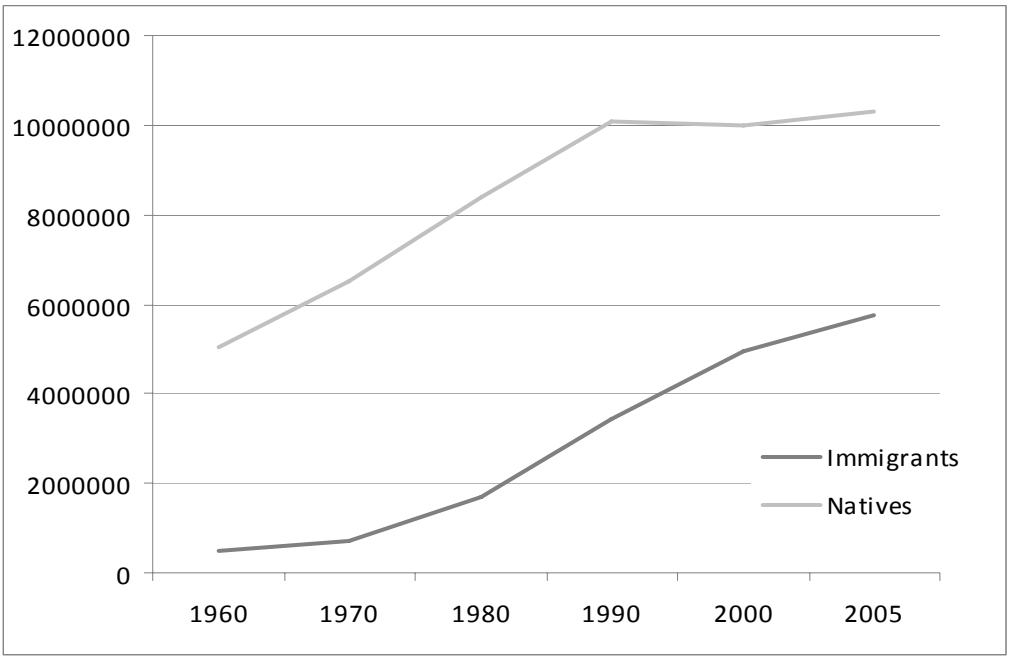


Figure A2
Total Employment of natives and immigrants,
USA 1960-2005

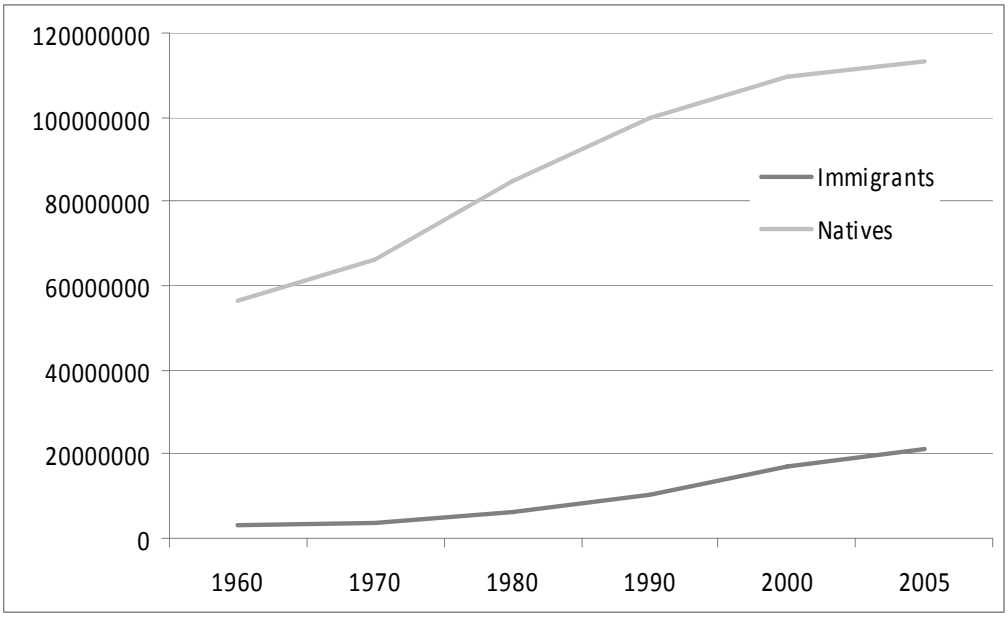


Figure A3
Relative employment change: Immigrants and US-born
California relative to average US, by skill and decade

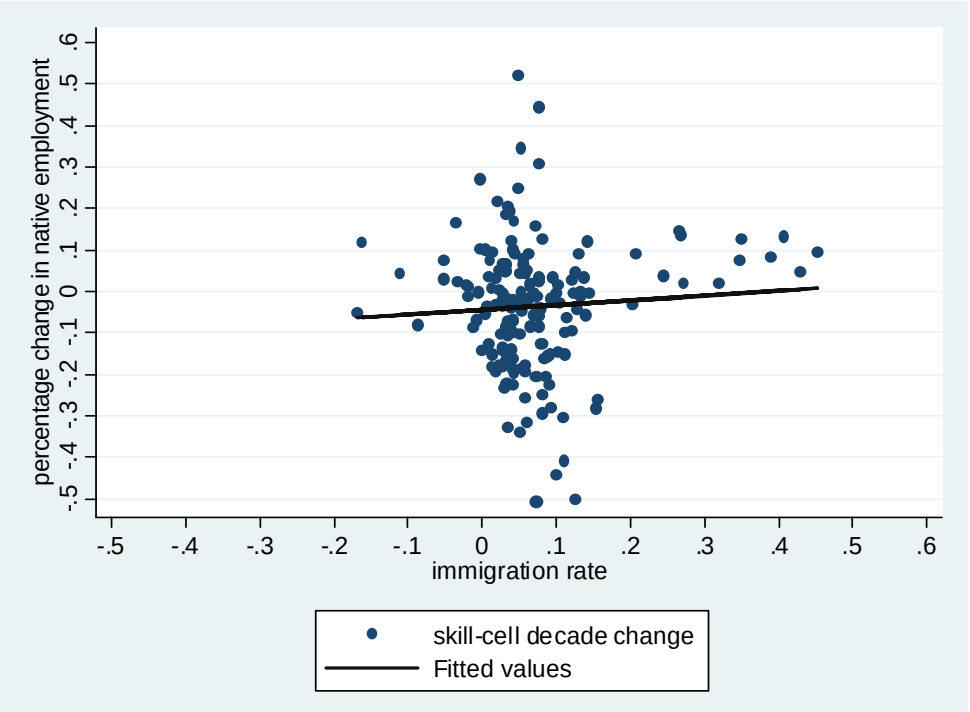


Figure A4
Relative employment change: Immigrants and Black
US-born. California relative to average US, by skill and decade

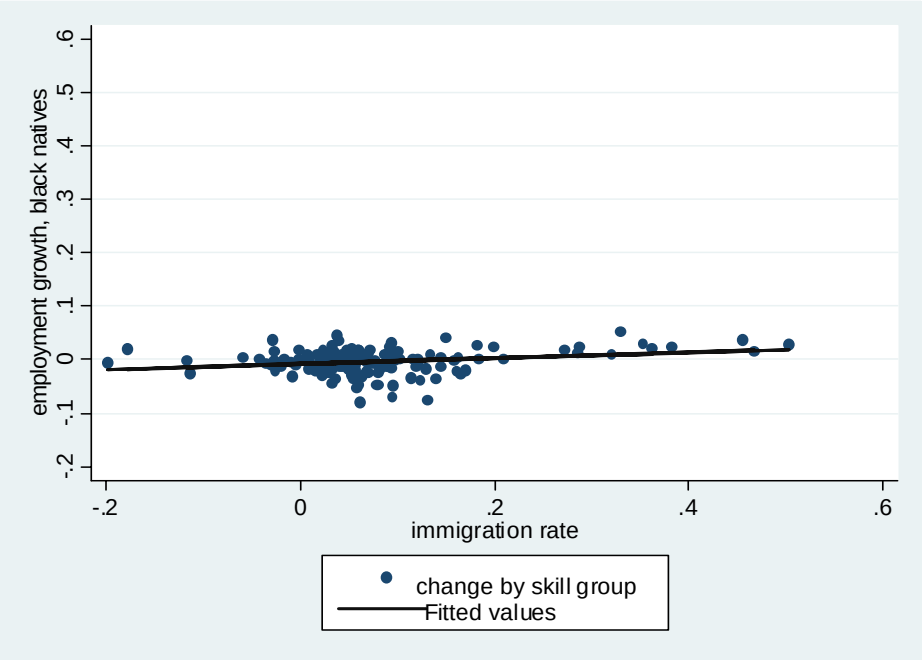


Table A1:
Share of foreign Born Workers by Schooling, USA and California 1960-2005

Schooling	1960 Census	1970 Census	1980 Census	1990 Census	2000 Census	2005 ACS
			California			
No Degree	0.12	0.16	0.37	0.65	0.75	0.78
High School Degree	0.06	0.07	0.11	0.22	0.33	0.36
Some College Education	0.07	0.08	0.11	0.16	0.21	0.23
College Degree	0.07	0.08	0.14	0.19	0.26	0.29
Average	*0.09*	*0.10*	*0.17*	*0.25*	*0.33*	*0.36*
			USA			
No Degree	0.06	0.06	0.11	0.22	0.36	0.42
High School Degree	0.04	0.03	0.05	0.07	0.11	0.14
Some College Education	0.05	0.05	0.06	0.07	0.09	0.10
College Degree	0.05	0.06	0.07	0.09	0.13	0.15
Average	*0.05*	*0.05*	*0.07*	*0.09*	*0.14*	*0.16*

Note: Author's calculation using Census 1960-2000 and American Community Survey 2005 IPUMS data. Employment is calculated as the sum of individuals of ages between 18 and 65, not residing in group quarters, and who worked at least one week during the preceding year with potential experience between 1 and 40 years. Population in working age is calculated as the sum of all individuals aged 17 to 66 not residing in group quarters with potential experience between 1 and 40 years.