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Immigration, Offshoring and American Jobs

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Abstract

How do offshoring and immigration affect the employment of native workers? What kinds of jobs suffer, or benefit, most from the competition created by offshore and immigrant workers? In contrast to the existing literature that has mostly looked at the effects of offshoring and immigration separately, we argue that one can gain useful insights by jointly investigating the interactions among native, immigrant and offshore workers. We develop our argument in three steps. First, we present some new facts on 58 U.S. manufacturing industries from 2000 to 2007. Second, we build on Grossman and Rossi-Hansberg (2008) to design a model of task assignment among heterogeneous native, immigrant and offshore workers that fits those facts. Third, we use the model to draw systematic predictions about the effects of immigration and offshoring on native workers and we test these predictions on the data. We find that, within the manufacturing sector, immigrants do not compete much with natives, as these two groups of workers are relatively specialized in tasks at opposite ends of the skill intensity spectrum. Offshore workers, on the other hand, seem to be specialized in tasks of intermediate skill intensity. We also find that offshoring has no effect on native employment in the aggregate, while the effect of immigration on native employment is positive. This hints at the presence of a "productivity effect" whereby offshoring and immigration improve industry efficiency, thereby creating new jobs.

Keywords: Employment, production tasks, immigrants, offshoring
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1 Introduction

The relocation of jobs abroad by multinationals and the increased labor market competition due to immigrant workers are often credited with the demise of many manufacturing jobs once held by American citizens. While it is certainly true that manufacturing production and employment, as a percentage of the total economy, have declined over recent decades in the U.S., measuring the impact of those two aspects of globalization on jobs has been difficult. This is due to the possible presence of two opposing effects. On the one hand, there is a direct “displacement effect”: offshoring some production processes or hiring immigrants to perform them directly reduces the demand for native workers. On the other hand, there is an indirect “productivity effect”: the cost savings associated with employing immigrant and offshore labor increases the efficiency of the production process, thus raising the demand for native workers—if not in the same tasks that are offshored or given to immigrant workers, then certainly in tasks that are complementary to them.

Several recent papers have emphasized the potential productivity effect of offshoring, arguing that this effect could offset or even reverse the displacement effect and thereby generate an overall non-negative effect on the wage or employment of native workers (Grossman and Rossi-Hansberg, 2008; Costinot and Vogel, 2010; Harrison and McMillan, 2011; Wright 2012). These papers focus on the patterns of substitutability between native and offshore workers. Other papers have suggested that immigrants may generate an analogous productivity effect by increasing the demand for native workers, especially in production tasks that are complementary to those performed by immigrants (Ottaviano and Peri, 2012; Peri, 2009; Peri and Sparber, 2009). These papers look at the patterns of substitutability between native and immigrant workers. Little attention has been paid so far to the simultaneous patterns of substitutability between native, immigrant and offshore workers.

In this paper we argue that the joint investigation of the interactions among these three groups of workers is useful in order to improve our understanding of the impact of globalization on the U.S. labor market and, in particular, to answer two hotly debated questions. First, how do declines in offshoring and immigration costs affect the employment of native workers? Second, what kinds of jobs suffer, or benefit, the most from the competition created by offshore and immigrant workers?

At the core of our argument are the observations that jobs (“tasks”) vary in terms of the relative intensity of use of workers’ skills, workers differ in terms of their relative abundance of those skills, and the relative abundance of workers with specific skills varies systematically across native, immigrant and offshore groups. As long as only natives are available, producers will do with the skill composition they have. Once immigrant and offshore workers become employable, efficiency gains can be reaped by hiring them to perform tasks in which they have a relative (“comparative”) advantage. This gives native workers the opportunity to specialize in the tasks in which they exhibit their own relative advantage. If strong enough, the productivity effect associated with this efficient pattern of task specialization may offset the displacement effect of immigration and offshoring

on native workers' employment.

We develop this argument in three steps. First, we present some new facts on 58 industries, which together comprise the U.S. manufacturing sector, from 2000 to 2007. We argue that these facts are consistent with a scenario in which: (a) there is stronger substitutability between immigrants and offshore workers than between immigrants and natives; (b) immigrant, native and offshore workers are relatively specialized in tasks of different skill complexity; and, in particular, (c) immigrants are relatively specialized in low complexity tasks, natives in high complexity tasks, and offshore workers in medium complexity tasks.¹ Unfortunately, the complexity of the tasks performed by offshore workers is not directly observable.

In the second step we build on Grossman and Rossi-Hansberg (2008) to design a partial equilibrium model of task assignment among heterogeneous native, immigrant and offshore workers within an industry that is consistent with the observed facts. We then use the model to draw systematic predictions of the effects of falling barriers to immigration and offshoring on the tasks, the employment share and the employment level of native workers. An important assumption of the model, not directly observable but consistent with a series of facts that we present, is that offshore workers specialize in "intermediate" tasks, in between immigrants and natives, on the task complexity spectrum. The model generates two main sets of predictions. On one hand—borrowing the terminology of Costinot and Vogel (2010)—a decline in immigration costs leads to "task upgrading" of immigrants as these workers are assigned some medium complexity tasks that were previously performed by offshore workers. Moreover, lower immigration costs have little impact on the task complexity of native workers, who are located at the high end of the task complexity spectrum. On the other hand a decline in offshoring costs simultaneously lead to task upgrading of natives and task downgrading of immigrants: offshore workers are assigned the most complex among the low complexity tasks previously performed by immigrants, as well as the least complex among the high complexity tasks previously performed by natives. In this case, the result is increased task polarization between immigrants and natives in the domestic labor market.

The other set of predictions concerns the response of industry employment following the reallocations of tasks described above. Employment shares move as dictated by the "displacement effect": a group of workers from which tasks are taken away sees its employment share fall; a group of workers to which new tasks are assigned sees its employment share increase. If the "productivity effect" is weak, employment levels move in the same direction as employment shares. On the other hand, when the efficiency gains from immigration or offshoring are strong enough, employment levels may increase for all groups of workers and not only for those whose employment shares go up. This happens because, thanks to the higher overall efficiency of the production process, the groups of workers whose employment shares go down get a smaller share but the size of the overall

¹The choice to focus on manufacturing and not include services reflects the research questions we have chosen to address. It is also forced on us by data availability as there is limited data on services offshoring. Moreover, the production function approach at the core of our analysis is much better understood in the context of manufacturing than in the context of services. Lastly, the range of skills spanned by tasks is richer in manufacturing than in services, leaving more room for gains due to their reallocation.

pie increases. Intuitively, the changes in employment *shares* are determined by movements along the relative labor demand curves of the different groups of workers, as dictated by changes in their relative efficiency. The changes in employment *levels*, however, are also affected by the outward shifts in labor demand produced by the increase in the overall efficiency of the production process.

In the end, whether the employment of natives rises or falls when immigration and offshoring become easier, and whether the observed change is consistent with our story, is an empirical issue. Thus, the third and last step of our argument brings the two sets of predictions derived from the theoretical model to the data. By using employment data on immigrants and natives from the American Community Survey (ACS) and on offshore workers by U.S. multinational affiliates from the Bureau of Economic Analysis (BEA), we indeed find that easier offshoring reduces the employment shares of both native and immigrant workers while easier immigration reduces the employment share of offshore workers only, with no impact on the employment share of natives. Nonetheless, when we look at employment levels (rather than shares), we find that easier offshoring does not have any significant effect whereas easier immigration has a positive and significant impact on natives. This is consistent with the existence of positive productivity effects due to immigration and offshoring.

By matching occupation data from the ACS with the manual, communication and cognitive skill content of tasks performed in each occupation (from the U.S. Department of Labor's *O*NET* abilities survey), we then assess the response of the skill intensity ("complexity") of those tasks to immigration and offshoring. Here we find that easier offshoring raises the average complexity of native tasks, increasing the gap between native and immigrant task complexity. In contrast, easier immigration has no effect on the average complexity of native tasks. Overall, our findings imply that immigrants do not compete much with natives and that the reason for this is that they are concentrated at opposite ends of the task complexity spectrum. Offshore workers, instead, are specialized in tasks of intermediate complexity (not directly observed) generating some competition with both immigrants and natives, revealed by the effect on employment shares and on task intensities of those two groups.

The rest of the paper is organized as follows. The next section describes the novel contributions of this paper in the context of the existing literature. Section 3 presents the data, highlighting some key facts that inform the subsequent analysis. Section 4 presents a theoretical model consistent with those facts, deriving predictions to be brought under econometric scrutiny. Section 5 produces the econometric evidence on the predictions of the theoretical model. Section 6 concludes.

2 Related Literature

Several recent papers have analyzed the effect of offshoring on the demand for domestic labor and are relevant to the present analysis. On the theoretical front, Grossman and Rossi-Hansberg (2008) provide a simple model

of trade in production tasks. As already mentioned, this model will serve as the framework for our analysis, though we will focus on employment rather than on wage effects as they instead do. It is worth mentioning that this theory owes much to previous work on trade in intermediates, including seminal work by Jones and Kierzkowski (1990) and Feenstra and Hanson (1996, 1999), who present models in which trade in intermediate goods has consequences for labor demand much like those described in Grossman and Rossi-Hansberg (2008). Recent and relevant empirical work includes Crinò (2010), Hummels, Jorgenson, Munch and Xiang (2010), Harrison and McMillan (2011) and Wright (2012), each of which have tested some of the implications of existing theories with respect to the wage and employment effects of offshoring. Crinò (2010), who focuses on services offshoring, and Hummels, Jorgenson, Munch and Xiang (2010), who focus on Denmark, both find positive wage and employment effects of offshoring for relatively skilled workers, especially for those performing more complex production tasks, but find that less skilled workers may suffer displacement. Wright (2012) finds a positive productivity effect of offshoring for domestic firms but, on net, an aggregate decline in low-skill employment. Harrison and McMillan (2011) find that a crucial distinction is between “horizontal” and “vertical” offshoring (the first aimed at locally serving foreign markets and the second aimed at producing intermediates that the multinational then re-imports to its domestic market), with the first hurting and the second stimulating domestic employment.

The present paper combines the above literature with the literature on the labor market effects of immigrants (e.g. Card, 2001; Card 2009; Borjas, 2003), proposing a common structure to think about offshoring and immigration within manufacturing industries. In particular, our theoretical model and empirical analysis address two sets of previously unanswered questions. First, are offshore workers primarily competing with natives or with immigrants? And, conversely, is hiring immigrant workers an alternative to offshoring jobs, or do immigrants compete directly with natives? Second, does hiring immigrants or moving jobs offshore increase productivity (by cutting costs) and hence expand production (and possibly total employment) in an industry? In so doing, we extend the offshoring model by Grossman and Rossi-Hansberg (2008) to allow for immigration, which provides a simple, though still rich, way of thinking about these two phenomena within a unified framework. While the immigration literature has also analyzed the impact of immigrants on task allocation and productivity (e.g., Peri and Sparber, 2009; Peri, 2012; Chassamboulli and Palivos, 2010), we expand on it by considering a multi-sector environment and an open economy.² What we find is that the joint analysis of immigration and offshoring indeed generates novel insights that are necessarily overlooked when considering each of those two phenomena in isolation.

The only other papers we are aware of that tackle the analysis of immigration and offshoring in a joint

²Blinder (2007), Jensen and Kletzer (2007), Levy and Murnane (2006), Becker, Ekholm and Muendler (2007) find that tasks that intensively use cognitive-communication and non-routine skills are harder to offshore. Peri and Sparber (2009) find that immigrants have a comparative disadvantage (lower productivity) in performing communication-intensive tasks. None of these contributions, however, tackles the issue of the joint effects of offshoring and immigration on the employment shares, the employment levels and the task assignment of native, immigrant and offshore workers as we do.

framework are Olney (2009) and Barba Navaretti, Bertola and Sembenelli (2008). The first paper assumes that immigrants are identical to natives and that their variation across U.S. states and industries is exogenous. Moreover, native workers are assumed to be immobile across states and industries so that the impacts of immigration or offshoring manifest themselves entirely through wages. We think our model and its derived empirical implementation constitute a step forward from the reduced form approach of that study. The second paper presents a model of immigration and offshoring and tests its implications on firm-level data for Italy. It does not look, however, at the skill endowments of workers and the skill intensity of tasks nor at industry-level employment effects.

The importance of assortative matching between the skill requirements of tasks and the skill endowments of workers has been recently stressed by Costinot and Vogel (2010). These authors tackle the thorny theoretical issue of how to determine factor allocation and factor prices in economies with a large number of goods and factors. By focusing on a Roy-like assignment model, in which a continuum of factors ("workers") are employed to produce a continuum of goods ("tasks"), they show that the comparative advantage of high skill workers in high complexity tasks provides sufficient conditions for rich comparative static predictions on the effects of various shocks to labor demand and supply. Among possible shocks, offshoring is explicitly analyzed. Following Grossman and Rossi-Hansberg (2008), Costinot and Vogel (2010) model easier offshoring as an increase in offshore labor productivity. Then, assuming that offshore workers have a comparative advantage in low complexity tasks, they conclude that easier offshoring induces task upgrading of all workers and rising wage inequality due to the increase in the effective supply of poorer low-skill workers. Costinot and Vogel (2010) do not consider immigration explicitly. They do, however, discuss the effects of changes in the composition of labor supply and these results can shed light on the effects of immigration. For example, if one assumes that immigrants are relatively less skilled than natives, immigration entails a rise in the relative number of low-skill workers in the labor force of the receiving country. The impact of immigration is then similar to the impact of offshoring: task upgrading for all workers and increasing wage inequality. Since our model also features a Roy-like assignment problem, their tools and techniques can be used to generalize our theoretical results, with two important differences. First, our focus is on the employment effects rather than on the wage effects. Second, our joint consideration of immigration and offshoring uncovers a differential response of native employment to shocks to the cost of immigrating or offshoring workers, a result that follows from the specialization of immigrants in tasks of low skill intensity and of offshore workers in tasks of medium skill intensity.

Costinot and Vogel (2010) are not the first to deal with assignment models in an international context. Applications to trade can be found, for instance, in Grossman and Maggi (2000), Grossman (2004), Yeaple (2005), Ohnsorge and Trefler (2007), Blanchard and Willmann (2008), Costinot (2009), Monte (2011), and Sly (2011). Examples of applications to offshoring are Kremer and Maskin (2006), Antras, Garicano, and Rossi-

Hansberg (2006), and Nocke and Yeaple (2008). None of these papers, however, deals jointly with offshoring and immigration.

Finally, also related to our paper are works that investigate the determinants of “job polarization”, defined as rising employment shares in the highest and the lowest wage occupations (Autor, Katz and Kearney, 2006; Goos and Manning, 2007). Three main explanations of job polarization have been put forth: the technological substitution of non-manual, routine jobs in the middle of the wage distribution (Autor and Katz, 1999; Autor, Levy and Murnane, 2003); the offshoring of these jobs (Blinder, 2007); or the “butlerization” or demand-driven explanation, whereby a rising income share at the top of the distribution leads to increased demand for low-skill services (Manning, 2004). In summarizing the findings of this literature, Goos, Manning and Salomons (2009) conclude that job polarization is hard to explain in terms of simple skill-biased technological change since one observes growth in employment in both the highest-skilled (professional and managerial) and lowest-skilled (personal services) occupations. Technical substitution of non-manual, routine jobs seems to be a better explanation of job polarization than offshoring and butlerization because of the pervasive effect of technology across sectors and countries. The present paper focuses on manufacturing jobs only while also bringing immigration into the picture. We provide a somewhat different characterization of polarization in the US market, defined as the increasing difference in the types of jobs performed by immigrants relative to those performed by natives.

3 Data and Descriptive Statistics

In this section we present simple statistical evidence on U.S. manufacturing industries that is consistent with a story of task specialization among native, immigrants and offshore workers according to a specific pattern of comparative advantages. In particular, the data show that natives and immigrants have revealed relative advantages in high and low complexity jobs, respectively. The revealed relative advantage of offshore workers is not directly observable. However two related facts are observed. First the cognitive and communication intensity of native jobs is higher (and the manual intensity lower) in manufacturing industries where offshoring is relatively large. Second, in manufacturing industries the cognitive, communication and manual intensities of native jobs are not related to the relative importance of immigration. Third, a positive and significant relation between immigration and the cognitive and communication intensities of native jobs exists in non-manufacturing industries where offshoring is negligible. These facts suggest a specific pattern of relative advantages in manufacturing industries. Immigrants specialize in low complexity tasks, natives specialize in high complexity tasks and offshore workers specialize in intermediate complexity tasks. Specialization according to relative advantages implies not only that immigration has a weaker “displacement effect” on natives than offshoring, but also that

immigration and offshoring may generate a positive “productivity effect”³.

We formalize this story in Section 4 through a simple theoretical model that, first, demonstrates the internal consistency of the story’s logic and, second, derives mutually consistent empirical predictions about the effects of immigration and offshoring on the employment share, the employment level and the job assignment of native workers. Section 5 then brings these predictions to the data. It should be noted that, while the theoretical model is designed to be consistent with the descriptive evidence of the present section, the econometric scrutiny will involve a more rigorous methodology and will test moments of the data different from those on which the assumptions of the model are based.

3.1 Employment

To measure the employment of native, immigrant and offshore workers in each industry-year using a consistent and comparable industry classification, we merge data on multinational employment from the Bureau of Economic Analysis (BEA) with data on native and foreign-born workers from the IPUMS samples (Ruggles et al 2008) of the Census and the American Community Survey (ACS). The only years in which this merger can be consistently and reliably done are those from 2000 to 2007. We therefore take these eight years as our period of observation.

Information on offshore employment is obtained from the Bureau of Economic Analysis (BEA) U.S. Direct Investment Abroad dataset, which collects data on the operations of U.S. parent companies and their affiliates. From this dataset we obtain the total number of employees working abroad in foreign affiliates of U.S. parent companies, by industry of the U.S. parent. These are jobs directly generated abroad by multinationals⁴. Of additional and growing importance are jobs created as U.S. multinational firms outsource production to unaffiliated foreign sub-contractors, so-called *arm’s length* offshoring (see, e.g., Antras, 2003). We would have liked to include a direct measure of these jobs in the count of total offshore employment but, unfortunately, this is impossible due to lack of data. We do, however, construct a proxy for this variable, as follows. Assuming that a large part of the production output of these offshored jobs is subsequently imported as intermediate inputs by the U.S. parent company, we calculate the ratio of imports of intermediates by the U.S. parent coming from affiliates and employment in those affiliates. We then scale the imports of the U.S. parent coming from *non-affiliates* (data that are also available from the BEA) by this ratio to impute the employment in sub-contracting companies. This procedure assumes that the labor content per unit of production of sub-contracted intermediate inputs is the same as for production in U.S. affiliates in the same industry. Adding the imputed employment increases offshore employment by 60-80% in most industries, confirming the importance of arm’s length offshoring. While

³In non-manufacturing sectors offshoring tasks is relatively costly. Thus tasks are assigned primarily to natives or immigrants with a higher likelihood of substitution between them. The productivity effect may still exist, however.

⁴As is standard in this literature, here we do not include in the definition of offshoring jobs that are sub-contracted abroad by purely national firms.

we will also report the results with this more inclusive offshore employment measure in Section 5, here and there we prefer to emphasize the more conservative approach whereby we restrict the analysis only to workers directly employed abroad by multinationals.

Data on native and immigrant workers come from the ACS and Census IPUMS samples for the period 2000-2007.⁵ We add up all workers not living in group quarters, who worked at least one week during the year, weighting them by the sample weights assigned by the ACS in order to make the sample nationally representative. "Immigrants" are all foreign-born workers who were not citizens at birth. "Natives" are all other U.S. workers. The relevant industry classification in the Census-ACS data 2000-2007 is the INDNAICS classification, which is based on the North American Industry Classification System (NAICS). Since the BEA industries are also associated with unique 4-digit NAICS industries, we are able to develop a straightforward concordance between the two datasets.

The 58 industries on which we have data and their BEA codes are reported in Table A1 while Figure A1 reports the evolution of the employment shares of native, immigrant and offshore workers across industries in each year with the connecting lines showing averages over time. From 2000 to 2007 there was only a fairly modest increase in the overall share of immigrant and offshore employment in total manufacturing employment (the former increased from 12.8% to 14% and the latter from 22.3% to 29.3%). The figure also shows that, not only all industries hired immigrants and offshore workers but that the differences across them are potentially large enough to allow for the identification of the differential effects of immigration and offshoring over the period.

While the employment shares of the different groups of workers vary across industries, there are interesting patterns of co-variation. Panel (a) of Figure 1 depicts the correlations between native and immigrant employment shares over the period of observation. Panel (b) provides the same type of information for native and offshore workers. The figure reveals a lack of correlation between the shares of immigrant and native workers. In contrast, it highlights a strong negative correlation between the shares of offshore and native workers. These correlations suggest that competition for jobs may be tougher between natives and offshore workers than between natives and immigrants.

Figure 2 looks at yearly employment and wage growth rates. Panel (a) reveals a positive correlation between the growth rates of employment of natives and immigrants whereas panel (b) shows no correlation between growth of natives and offshore workers. This is again consistent with weaker natives-immigrants employment competition relative to natives-offshore workers in the presence of positive productivity effects associated with both immigration and offshoring. Panels (c) and (d) look at the correlations between changes in native wages and

⁵For year 2000 we use the 5% Census sample. For 2001 we use the 1-in-232 national random sample. For 2002, we use the 1-in-261 national random sample. For 2003 we use the 1-in-236 national random sample. For 2004 we use the 1-in-239 national random sample. For 2005, 2006 and 2007 the 1-in-100 national random samples are used.

changes in immigrant and offshore employment⁶. The two panels do not detect any significant correlation. We interpret this as consistent with native wages being largely exogenous to each of our manufacturing industries, because of worker mobility across them.

3.2 Tasks

Data on the tasks performed by immigrants and natives is constructed using the U.S. Department of Labor’s *O*NET* abilities survey, which provides information on the characteristics of each occupation. Based on the Standard Occupation Classification (SOC), the dataset assigns numerical values to describe the importance of distinct abilities (“skills”) required by different occupations (“tasks”). Each numerical value measures the intensity of a task in a given skill. Following Peri and Sparber (2009), we merge these task-specific values with individual workers in the 2000 Census, re-scaling each value so that it equals the percentile score in that year. This gives a measure of the relative importance of a given skill among U.S. workers ranging between 0 and 1. For instance, a task with a score of 0.02 for some skill indicates that only 2 percent of workers in the U.S. in 2000 were supplying that skill less intensively. We then assign these *O*NET* percentile scores to individuals from 2000 to 2007 using the ACS variable *occ1990*, which provides an occupational crosswalk over time.

We focus on three skill indices: Cognitive Intensity, Communication Intensity and Manual Intensity. These are constructed by averaging the relevant skill variables. Specifically, Cognitive Intensity includes ten variables classified as “cognitive and analytical” in *O*NET*. Communication Intensity includes four variables capturing written and oral expression as well as understanding. Manual Intensity includes nineteen variables capturing dexterity, strength and coordination.⁷ We have also calculated a synthetic Complexity index summarizing the intensity of a task in cognitive-communication skills *relative* to manual skills. This index is defined as: $\text{Complexity} = \ln((\text{Cognitive Intensity} + \text{Communication Intensity}) / \text{Manual Intensity})$. It ranges between $-\infty$ and $+\infty$.

Overall, our sample consists of 295 occupations in the manufacturing sector over the years 2000-2007. This type of information is available for immigrants and natives but unfortunately not for offshore workers. Absent direct information on the specific occupation of offshore workers, a crucial challenge for us will be to indirectly assess the average skill intensity of offshore tasks. The four panels of Figure 3 plot the share of hours worked by immigrants relative to the total number of hours worked by immigrant and native workers as a function of Cognitive Intensity, Communication Intensity, Manual Intensity and Complexity across occupations (tasks)-years. The figure clearly shows that immigrants are disproportionately represented in tasks characterized by low

⁶The wages of natives are constructed as follows. From the Census-ACS data we consider only U.S.-born individuals who are employed (i.e., who have worked at least one week in the year and at least one hour in the week) and who have non-zero wage income, excluding the self-employed. We take yearly wage income deflated by the consumption price index to constant 2005 dollars and average it at the industry level, weighting each individual by the corresponding sample weight in the Census.

⁷The variables used for each index are listed in Appendix C.

Cognitive Intensity, low Communication Intensity, high Manual Intensity and low overall Complexity. Figure 4 plots the same type of information but restricts the sample to workers with low educational attainment (i.e., workers with a high school diploma or less). The message is the same: even within the low educated, immigrants are relatively specialized in tasks with low cognitive and communication content, low complexity and high manual content. In this respect, the revealed relative advantage of immigrants in low complexity tasks seems to be pervasive⁸.

While the skill intensity of offshored tasks is unobservable, we can nonetheless gauge some indirect evidence from the way offshoring affects the skill intensity of native and immigrant tasks. Figure 5 reports this type of information in the case of all immigrants and natives. Figure 6 does the same for workers with a high school diploma or less. Both figures plot the change in the Complexity of tasks performed by natives and immigrants against the change in the shares of offshore and immigrant employment, across manufacturing industries over the period 2000-2007. Both figures convey a similar message, even though the message is clearer and stronger in the case of all workers. Increases in the share of offshore workers are associated with significant increases in the complexity of tasks performed by natives as well as decreases in the complexity of tasks performed by immigrants. In contrast, increases in the share of immigrants are not associated with any significant change in the complexity of native or immigrant tasks. Hence, a stronger presence of offshore workers is associated with a larger differential (polarization) in task complexity between natives and immigrants while a stronger presence of immigrants is unrelated with that differential. Similar patterns arise when we focus on Cognitive Intensity, Communication Intensity and Manual Intensity separately but we do not report them for conciseness.

The finding that changes in native complexity are not significantly correlated with changes in the share of immigrants may surprise readers familiar with Peri and Sparber (2009), as these authors find that native task complexity is sensitive to the share of immigrants. This can easily be explained, however and it is consistent with our theory. In this study we focus on (mostly tradable) manufacturing industries whereas Peri and Sparber (2009) consider all employment, most of which is in (non tradable) services. Since offshoring was still negligible outside the manufacturing sector during our period of observation, we interpret this discrepancy as a signal that, when viable, offshore workers play an important role in weakening the competition between immigrants and natives. Table 1 explores this interpretation by regressing native complexity on immigrants' complexity and employment share, distinguishing between manufacturing ("tradable") and non-manufacturing ("non-tradable") industries. All workers are included. The table shows significant positive correlation between native complexity and immigrant employment share within non-tradable industries (Column 2), but no correlation is detected between native complexity and immigrant employment share in tradable industries (Column 1)⁹. This supports

⁸This finding concurs with existing evidence. Peri and Sparber (2009) show that, due to their imperfect knowledge of language and local norms, immigrants have a relative advantage in tasks with high manual intensity and a relative disadvantage in tasks with high communication intensity.

⁹In the regressions in Table 1 we also control for the complexity of immigrant jobs and for time and industry fixed effects.

the idea that in non-tradable industries the competition between natives and immigrants is more direct and immigration pushes native workers to “upgrade” their jobs. In tradable industries, instead, this does not happen because offshore workers are those performing most of the intermediate-complex tasks and in direct competition with immigrants. While the results shown are not direct evidence of this they are consistent with this explanation.

To refine the analysis of the role of offshoring within manufacturing, Figure 7 compares two subsets of our 58 industries, partitioned according to the ratio of multinationals’ re-imports from affiliates to local sales—i.e., according to the degree of “vertical” (foreign production gets re-imported) versus “horizontal” (foreign production is sold locally) offshoring. Since across industries the median value of that ratio is 0.20 with standard deviation 0.10, we compare industries with ratios larger than 30 per cent with industries with ratios below 10 per cent, omitting industries with values between 0.1 and 0.3 in order to make the comparison starker. The figure shows that industries with high ratios exhibit a positive and significant correlation between the share of offshore workers and native complexity. There is, instead, no significant correlation in industries with low ratios. This is consistent with the idea that vertical offshoring is the one fitting better our story of offshoring tasks in the medium-complexity range (to reduce costs). Horizontal offshoring, instead, may be associated with sending abroad a larger range of tasks, specific also to marketing and sales, rather than only to production.

Our overall interpretation of the descriptive evidence presented in this section is that natives seem to compete more directly with offshore than immigrant workers. This can be explained by a specific pattern of relative advantages across the three groups of workers, with immigrants specializing in low complexity tasks, natives in high complexity tasks and offshore workers in intermediate complexity tasks.

4 A Labor Market Model of Task Allocation

A simple partial equilibrium model consistent with the descriptive evidence reported in the previous section can be designed following Grossman and Rossi-Hansberg (2008). Consider a small open economy that is active in several perfectly competitive sectors, indexed $s = 1, \dots, S$. We focus on one of these sectors and leave both the sector index s and the time dependence of variables t implicit for ease of notation. We will make them explicit when we get to the empirics.

The sector employs two primary factors, workers with employment level N_L and a sector-specific factor with endowment H . To match the descriptive evidence on wages in Section 3, the sector is small enough to face infinitely elastic labor supply at given wages.¹⁰ All workers are endowed with one unit of labor each but

¹⁰This leads to a crucial difference between our model and those by Grossman and Rossi-Hansberg (2008) and by Costinot and Vogel (2010). Both these models consider the general equilibrium effects of offshoring on wages under an economy-wide full employment constraint. In Appendix A we propose an extension of our model in which the assumption of perfectly elastic labor supply at given wages does not hold. There we show that, while with an endogenous native wage immigration and offshoring also have wage effects, the corresponding employment effects discussed in Section 4.3 remain qualitatively the same.

differ in terms of productivity. They are employed in the production of intermediates (“tasks”), which are then assembled in a composite labor input L . This, in turn, is transformed into final output Y according to the following Cobb-Douglas production function

$$Y = AL^\alpha H^{1-\alpha} \quad (1)$$

where $A \in (0, \infty)$ and $\alpha \in (0, 1)$ are technological parameters. The price of final output p_Y is set in the international market.

Specifically, the composite labor input L is produced by assembling a fixed measure of differentiated tasks, indexed $i \in [0, 1]$ in increasing order of skill intensity (“complexity”), through the following CES technology

$$L = \left[\int_0^1 L(i)^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}} \quad (2)$$

where $L(i)$ is the input of task i and $\sigma > 0$ is the elasticity of substitution between tasks.¹¹

4.1 Production Choices and Task Assignment

Each task can be managed in three modes: domestic production by native workers (D), domestic production by immigrant workers (M) and production abroad by offshore workers (O). The three groups of workers are perfect substitutes in the production of any task but differ in terms of their productivity as well as in terms of their wages, which we call w , \tilde{w} and w^* , respectively. To allow for a “productivity effect” to arise from both immigration and offshoring, we assume that employers can discriminate between the three groups of workers so that w , \tilde{w} and w^* may not be equal. We assume, however, that immigrant and offshore wages are linked, with a fixed gap between them determined by a differential “cost of hardship” immigrants face with respect to their fellow countrymen who stay at home. In particular, if a foreign worker immigrates, she incurs a frictional cost $\delta \geq 1$ in terms of foregone productivity. In other words, an immigrant endowed with one unit of labor in her country of origin is able to provide only $1/\delta$ units of labor in the country of destination. The migration decision therefore entails a choice between earning w^* in the country of origin or \tilde{w}/δ in the country of destination.¹² Positive supply of both immigrant and offshore workers then requires the migration indifference condition $\tilde{w} = w^* \delta$ to hold.¹³

¹¹In Grossman and Rossi-Hansberg (2008) tasks are not substitutable. This corresponds to the limit case of $\sigma = 0$ where (2) becomes a Leontief production function.

¹²For simplicity, in the theoretical model we consider only one country of origin for all immigrants.

¹³There is much empirical evidence that, for similar observable characteristics, immigrants are paid a lower wage than natives. Using data from the 2000 Census, Antecol, Cobb-Clark and Trejo (2001), Butcher and DiNardo (2002) and Chiswick, Lee and Miller (2005) all show that recent immigrants from non-English speaking countries earn on average 17 to 20% less than natives with identical observable characteristics. Our data provide estimates in the same ballpark. Hendricks (2002) also shows that the immigrant-native wage differential, controlling for observable characteristics, is highly correlated with the wage differential between the U.S. and their country of origin. See, however, Section 4.3 and Appendix B for a detailed discussion of how the predictions of

In light of the descriptive evidence reported in Section 3, we now introduce assumptions that ensure that immigrant, offshore and native workers specialize in low, medium and high complexity tasks, respectively. In so doing, we follow Grossman and Rossi-Hansberg (2008) and define tasks so that they all require the same unit labor requirement a_L when performed by native workers. Accordingly, the marginal cost of producing task i employing native workers is $c_D(i) = wa_L$. If task i is instead offshored, its unit input requirement is $\beta t(i)a_L$ with $\beta t(i) \geq 1$. This implies a marginal cost of producing task i employing offshore workers equal to $c_O(i) = w^*\beta t(i)a_L$. Lastly, if task i is assigned to immigrants, its unit input requirement is $\tau(i)a_L$ with $\tau(i) \geq 1$ so that the marginal cost of producing task i employing immigrants is $c_M(i) = \tilde{w}\tau(i)a_L = w^*\delta\tau(i)a_L$. Hence, in all tasks natives are more productive but, due to wage differences, not necessarily cheaper than immigrant and offshore workers. We interpret a lower value of the frictional parameter β as “easier offshoring” and a lower value of the frictional parameter δ as “easier immigration”.

As native, immigrant and offshore workers are perfectly substitutable, in equilibrium any task will be performed by only one type of workers: the one that entails the lowest marginal cost for that task.¹⁴ A task is offshored rather than performed by natives whenever the former option is cheaper so that $c_O(i) \leq c_D(i)$ or equivalently

$$w \geq w^*\beta t(i) \tag{3}$$

Analogously, a task is assigned to an immigrant rather than a native worker whenever it is cheaper to do so. This is the case whenever $c_M(i) \leq c_D(i)$ or equivalently

$$w \geq w^*\delta\tau(i) \tag{4}$$

Finally, a task is offshored rather than performed by immigrants whenever $c_O(i) \leq c_M(i)$ or equivalently

$$\beta t(i) \leq \delta\tau(i) \tag{5}$$

Necessary and sufficient conditions for the envisaged pattern of task specialization to materialize are as follows.

Imposing

$$t'(i) > 0 \text{ and } \frac{w}{w^*t(1)} < \beta < \frac{w}{w^*t(0)} \tag{6}$$

the model would change were firms assumed to be unable to discriminate between native and immigrants workers.

¹⁴If native, immigrant and offshore workers were imperfectly substitutable, each task could be performed by “teams” consisting of the three types of workers. Then, rather than full specialization of workers’ types in different tasks, one would observe partial specialization, with the shares of the three types in each task inversely related to the corresponding marginal costs. While in reality several tasks are indeed performed by a combination of different types of workers, nonetheless the intuition behind the key results of the model is better served by assuming perfect substitutability.

ensures that there exists a unique “marginal offshore task” I_{NO} such that

$$w = w^* \beta t(I_{NO}) \tag{7}$$

Moreover it is cheaper to assign tasks of skill intensity $i < I_{NO}$ to offshore workers and tasks of skill intensity $i > I_{NO}$ to natives. The first condition in (6) implies that the productivity of offshore workers relative to natives decreases with the skill intensity of tasks. The second condition requires offshoring frictions to be neither too large nor too small in order to have a trade-off in the assignment of tasks between natives and offshore workers. Then, imposing

$$\delta \tau'(i) > \beta t'(i) \text{ and } \tau(0)/t(0) < \beta/\delta < \tau(I_{NO})/t(I_{NO}) \tag{8}$$

ensures that there exists a unique “marginal immigrant task” $I_{MO} < I_{NO}$ such that

$$\beta t(I_{MO}) = \delta \tau(I_{MO}) \tag{9}$$

being cheaper to assign tasks of skill intensity $i < I_{MO}$ to immigrants than to offshore workers. The first condition in (8) also implies that the productivity of immigrants falls with the skill intensity of tasks, but this happens faster than in the case of offshore workers. The second condition in (8) requires offshoring frictions to be neither too large nor too small relative to migration frictions in order to have a trade-off in the assignment of tasks between immigrants and offshore workers. Conditions (6) and (8) together thus imply that tasks of skill intensity $0 \leq i \leq I_{MO}$ are assigned to immigrants, tasks of skill intensity $I_{MO} < i \leq I_{NO}$ to offshore workers and tasks of skill intensity $I_{NO} < i \leq 1$ to natives, where marginal tasks have been arbitrarily assigned to break the tie.¹⁵

The allocation of tasks among the three groups of workers is portrayed in Figure 8, where the task index i is measured along the horizontal axis and the production costs along the vertical axis. The flat line corresponds to c_D and the upward sloping curves correspond to $c_M(i)$ and $c_O(i)$, with the former starting from below but steeper than the latter. Since each task employs only the type of workers yielding the lowest marginal cost, tasks from 0 to I_{MO} are assigned to immigrants, tasks from I_{MO} to I_{NO} are offshored, and tasks from I_{NO} to 1 are assigned to natives.

While (9) and (7) identify the marginal tasks as cutoffs between tasks performed by different groups of workers, the distinction is not so stark in reality as workers are heterogeneous also within groups and some

¹⁵Readers familiar with Costinot and Vogel (2010) will recognize the log-supermodularity of this assignment problem in which, due to their different skills, native, immigrant and offshore workers have a relative advantage in high, medium and low skill intensity tasks. Indeed, the approach of Costinot and Vogel could be used to go beyond the stark view expressed in our theory by introducing skill heterogeneity among the three groups of workers. This could be achieved by matching the assumption that higher skill workers have a comparative advantage in more skill intensive tasks (see Costinot and Vogel, 2010, Section III.A) with the assumption that natives are more skilled relative to offshore and immigrant workers (see Costinot and Vogel, 2010, Section VII.B).

overlap among individuals belonging to different groups are possible along the complexity spectrum.¹⁶ For the empirical analysis it is, therefore, also useful to characterize the “average task” performed by each group. This is defined as the employment-weighted average across the corresponding i 's:

$$\begin{aligned}
I_M &= \frac{\int_0^{I_{MO}} iN(i) di}{N_M} = \frac{\int_0^{I_{MO}} i\tau(i)^{1-\sigma} di}{\int_0^{I_{MO}} \tau(i)^{1-\sigma} di} \\
I_O &= I_{MO} + \frac{\int_{I_{MO}}^{I_{NO}} iN(i) di}{N_O} = I_{MO} + \frac{\int_{I_{MO}}^{I_{NO}} it(i)^{1-\sigma} di}{\int_{I_{MO}}^{I_{NO}} t(i)^{1-\sigma} di} \\
I_D &= I_{NO} + \frac{\int_{I_{NO}}^1 iN(i) di}{N_D} = \frac{I_{NO} + 1}{2}
\end{aligned} \tag{10}$$

4.2 Employment Levels and Shares

Given the above allocation of tasks, marginal cost pricing under perfect competition implies that tasks are priced as follows

$$p(i) = \begin{cases} c_M(i) = w^* \delta \tau(i) a_L & 0 \leq i < I_{MO} \\ c_O(i) = w^* \beta t(i) a_L & I_{MO} \leq i < I_{NO} \\ c_D = w a_L & I_{NO} < i \leq 1 \end{cases}$$

Then, by (1) and (2), the demand for task i is

$$L(i) = \left[\frac{p(i)}{P_L} \right]^{-\sigma} (P_L)^{-\frac{1}{1-\alpha}} (\alpha p_Y A)^{\frac{1}{1-\alpha}} H$$

where P_L is the exact price index of the labor composite, defined as

$$P_L = a_L \left\{ \int_0^{I_{MO}} [\delta \tau(i) w^*]^{1-\sigma} di + \int_{I_{MO}}^{I_{NO}} [\beta t(i) w^*]^{1-\sigma} di + (1 - I_{NO}) w^{1-\sigma} \right\}^{\frac{1}{1-\sigma}}$$

Since $i \in [0, 1]$, P_L is also the average price (and average marginal cost) of tasks. Using (7) we can rewrite it as $P_L = w a_L \Omega(I_{MO}, I_{NO})$ with

$$\Omega(I_{MO}, I_{NO}) = \left\{ \int_0^{I_{MO}} \left[\frac{\delta \tau(i)}{\beta t(I_{NO})} \right]^{1-\sigma} di + \int_{I_{MO}}^{I_{NO}} \left[\frac{t(i)}{t(I_{NO})} \right]^{1-\sigma} di + (1 - I_{NO}) \right\}^{\frac{1}{1-\sigma}} \tag{11}$$

This highlights the relationship between P_L and the bundling parameter Ω in Grossman and Rossi-Hansberg (2008), which we encompass as a limit case when σ goes to zero and δ goes to infinity — that is, when tasks are not substitutable and migration is prohibitively hard. Expression (11) shows that changes in the migration friction δ and the offshoring friction β that decrease $\Omega(I_{MO}, I_{NO})$ imply improved efficiency in labor usage.

¹⁶See the previous footnote on how the model could be extended to the case of within-group heterogeneity.

This is the source of the productivity effects of immigration and offshoring discussed in Section 4.3.

Taking into account the different marginal productivity of the three groups of workers, the amount of labor demanded to perform task i is

$$N(i) = \begin{cases} a_L \delta \tau(i) L(i) & 0 \leq i < I_{MO} \\ a_L \beta t(i) L(i) & I_{MO} \leq i < I_{NO} \\ a_L L(i) & I_{NO} < i \leq 1 \end{cases}$$

so that immigrant, offshore and native employment levels are given by

$$\begin{aligned} N_M &= \int_0^{I_{MO}} N(i) di = \frac{1}{w^*} \left(\frac{P_M}{P_L} \right)^{1-\sigma} (P_L)^{-\frac{\alpha}{1-\alpha}} B \\ N_O &= \int_{I_{MO}}^{I_{NO}} N(i) di = \frac{1}{w^*} \left(\frac{P_O}{P_L} \right)^{1-\sigma} (P_L)^{-\frac{\alpha}{1-\alpha}} B \\ N_D &= \int_{I_{NO}}^1 N(i) di = \frac{1}{w} \left(\frac{P_D}{P_L} \right)^{1-\sigma} (P_L)^{-\frac{\alpha}{1-\alpha}} B \end{aligned} \quad (12)$$

where $B = (\alpha p_Y A)^{\frac{1}{1-\alpha}} H > 0$ is a combination of parameters and exogenous variables, and the exact price indices of immigrant, offshore and native tasks are given by

$$P_M = a_L \left\{ \int_0^{I_{MO}} [\delta \tau(i) w^*]^{1-\sigma} di \right\}^{\frac{1}{1-\sigma}}, \quad P_O = a_L \left\{ \int_{I_{MO}}^{I_{NO}} [\beta t(i) w^*]^{1-\sigma} di \right\}^{\frac{1}{1-\sigma}}, \quad P_D = a_L \left\{ (1 - I_{NO}) w^{1-\sigma} \right\}^{\frac{1}{1-\sigma}} \quad (13)$$

Note that N_M is the number of immigrants employed whereas, due to the frictional migration cost, the corresponding number of units of immigrant labor is N_M/δ . Hence, sector employment is $N_L = N_M + N_O + N_D$.

The shares of the three groups of workers in sectorial employment are thus

$$\begin{aligned} s_M &= \frac{(P_M)^{1-\sigma}}{(P_M)^{1-\sigma} + (P_O)^{1-\sigma} + (P_D)^{1-\sigma} (w^*/w)} \\ s_O &= \frac{(P_O)^{1-\sigma}}{(P_M)^{1-\sigma} + (P_O)^{1-\sigma} + (P_D)^{1-\sigma} (w^*/w)} \\ s_D &= \frac{(w^*/w) (P_D)^{1-\sigma}}{(P_M)^{1-\sigma} + (P_O)^{1-\sigma} + (P_D)^{1-\sigma} (w^*/w)} \end{aligned} \quad (14)$$

4.3 Comparative Statics

We are interested in how marginal and average tasks, as well as employment shares and levels, vary across the three types of workers when offshoring and migration costs change.

Given (9) and (7), the solution of our task assignment problem implies that marginal tasks exhibit the

following properties:

$$\begin{aligned}\frac{\partial I_{NO}}{\partial \beta} &< 0, \frac{\partial I_{MO}}{\partial \beta} > 0 \\ \frac{\partial I_{NO}}{\partial \delta} &= 0, \frac{\partial I_{MO}}{\partial \delta} < 0\end{aligned}$$

These highlight the adjustments in employment occurring in terms of the number of tasks allocated to the three groups of workers. They can be readily interpreted using Figure 8. For example, a reduction in offshoring costs (lower β) shifts $c_O(i)$ downward, thus increasing the number of offshored tasks through a reduction in both the number of tasks assigned to immigrants ($\partial I_{MO}/\partial \beta > 0$) and the number of tasks assigned to natives ($\partial I_{NO}/\partial \beta < 0$). Analogously, a reduction in the migration costs (lower δ) shifts $c_M(i)$ downward, thus increasing the number of tasks assigned to immigrants through a decrease in the number of offshored tasks (higher I_{MO}). Accordingly, given (10) we also have the following properties for average tasks:

$$\begin{aligned}\frac{\partial I_D}{\partial \beta} &< 0, \frac{\partial I_M}{\partial \beta} > 0 \\ \frac{\partial I_D}{\partial \delta} &= 0, \frac{\partial I_M}{\partial \delta} < 0\end{aligned}\tag{15}$$

These are driven by compositional changes due to adjustments both in the number of tasks allocated to the three groups and in the employment shares of the different tasks allocated to the three groups. Note that changes in migration costs have also a negative impact on the average offshored task ($\partial I_O/\partial \delta < 0$). The impact of offshoring costs on the average offshore task ($\partial I_O/\partial \beta$) is, instead, ambiguous. This is due to opposing adjustments in the allocation of tasks given that, when β falls, some of the additional offshore tasks have low i (i.e. I_{MO} falls) while others have high i (i.e. I_{NO} rises).

Looking at (14), the impacts of declining β and δ on employment shares are all unambiguous. By making offshore workers more productive and thus reducing the price index of offshore tasks relative to all tasks, a lower offshoring cost, β , reallocates tasks from immigrants and natives to offshore workers. By reducing the price index of immigrant tasks relative to all tasks, a lower migration cost, δ , moves tasks away from offshore and native workers toward immigrants:

$$\begin{aligned}\frac{\partial s_M}{\partial \beta} &> 0, \frac{\partial s_O}{\partial \beta} < 0, \frac{\partial s_D}{\partial \beta} > 0 \\ \frac{\partial s_M}{\partial \delta} &< 0, \frac{\partial s_O}{\partial \delta} > 0, \frac{\partial s_D}{\partial \delta} > 0\end{aligned}\tag{16}$$

These results capture the signs of the “displacement effects” for the three groups of workers.

Turning to the impact of declining β and δ on employment levels, expressions (12) reveal an additional

effect beyond the substitution among groups of workers in terms of employment shares. This is due to the fact that lower β and δ ultimately cause a fall in the price index P_L of the labor composite because, as a whole, workers become more productive. This is the “productivity effect” of offshoring and immigration. Specifically, as highlighted by the term $(P_L)^{-\frac{1}{1-\alpha}}$ on the right hand side of (12), a fall in the price index of the labor composite has a positive impact on sectorial employment (due to the productivity effect), which is then distributed across groups depending on how the relative price indices P_M/P_L , P_O/P_L and P_D/P_L vary (due to the displacement effects). Note that, given $(P_L)^{1-\sigma} = (P_M)^{1-\sigma} + (P_O)^{1-\sigma} + (P_D)^{1-\sigma}$, P_L cannot change when P_M , P_O and P_D are all fixed. This is why we have chosen not to collect the P_L terms in (12) in order to disentangle the displacement and productivity effects.

The impact of declining β and δ on employment levels can be signed only when the productivity effect and the displacement effects go in the same direction. In particular, since $\partial P_L/\partial\beta > 0$ and $\partial P_L/\partial\delta > 0$, we have

$$\frac{\partial N_O}{\partial\beta} < 0, \frac{\partial N_M}{\partial\delta} < 0 \quad (17)$$

while the signs of $\partial N_M/\partial\beta$, $\partial N_D/\partial\beta$, $\partial N_O/\partial\delta$ and $\partial N_D/\partial\delta$ are generally ambiguous. In other words, whether the productivity effect is strong enough to offset the displacement effect for all groups of workers is an empirical question that we will address in the next section. Lower β and δ certainly raise total sector employment $N_L = N_M + N_O + N_D$, as long as there is a non-zero productivity effect.

As a final comment, it is worth stressing the fact that, as already mentioned, employers’ ability to discriminate between natives and immigrants is crucial for the productivity effects of immigration to materialize. Indeed, when employers are able to discriminate, they pay immigrant wages $\tilde{w} = w^*\delta$ so that any reduction in the migration cost δ allows them to reduce their payments to immigrants. This generates a cost saving effect both at the intensive margin of tasks already assigned to immigrants and at the extensive margin of new tasks shifted from offshore to immigrant workers. If employers were, instead, unable to discriminate, immigrants would always be paid native wages w earning rents $w - w^*\delta$. Thus, any reduction in δ would simply increase immigrants’ rents with no impact on firms’ costs. The difference between falling costs of immigration with and without discrimination is that in the former case they create rents for domestic firms whereas in the latter case they create rents for the immigrants. Note, however, that our assumption of perfect discrimination is not crucial to generate the productivity effect due to immigration since even partial discrimination generates rents for the firm.¹⁷

¹⁷See Appendix B for additional details.

5 Empirical Specifications and Econometric Results

In this section we bring the predictions of our model to the data. We target the three sets of predictions highlighted in the previous section about the effects of easier immigration and offshoring on the employment shares, the employment levels and the average task assignments of natives and of the other groups of workers, as highlighted in (15), (16), and (17), respectively.

The predictions of the model have been derived for a single industry leaving industry and time indices implicit for notational convenience. Hence, in order to implement (10), (12), and (14) empirically we begin by identifying the parameters that vary across industries (to be indexed by s) and over time (to be indexed by t) and those that do not (and carry no index). First, the offshoring and immigration cost parameters vary across industries and over time, and thus we label them β_{st} and δ_{st} . We motivate this in Section 5.1 in which we present our empirical measures. Second, we consider the specific factor endowment H_s to be industry-specific but not time-varying. The same holds for the baseline sector-specific total factor productivity A_s . We allow, however, for random productivity shocks through a possibly serially correlated error term ε_{st} . Both H_s and A_s will be captured by an industry fixed effect. Finally, as wages have been assumed to be equalized across industries, we allow them to vary only through time, writing w_t and w_t^* , which calls for a time effect.

To summarize, we will exploit differences in immigration and offshoring costs within industries over time in order to identify the impact on native and immigrant employment as well as on native and immigrant task specialization.

5.1 Costs of Immigration and Offshoring

Driving the shifts in β_{st} and δ_{st} are changes in the accessibility of offshore and immigrant workers. Since we do not observe industry-specific offshoring and immigration costs, we begin by using direct measures of the employment share of immigrant and offshore workers across industries and over time as explanatory variables. If the variation in costs, once we control for industry and time effects, is the main source of variation in immigration and offshoring within an industry, then the OLS regression will identify the effect on native outcomes of changes in the cost of immigration and offshoring. As we are aware that this is a heroic assumption, we instrument the share of immigrants and offshore workers with variables proxying their cross-industry costs and availability.

The assumption that offshoring costs vary across industries departs from Grossman and Rossi-Hansberg (2008), who suggest that this cost is more or less the same across industries. This is probably true if one wants to stress, as they do, the technological dimension of offshoring costs, which implies very little variation across similar tasks in different industries. Our focus is, instead, on the trade cost dimension of offshoring, which hampers the re-import of the output generated by offshored tasks and is affected by industry-specific characteristics. In this respect, in order to capture exogenous variation in offshoring costs and generate an

instrument for offshore employment in an industry-year, we collect two types of U.S. tariff data, each by year and product: Most Favored Nation (MFN) tariffs and Information Technology Agreement (ITA) tariffs. These are then aggregated up to the BEA industry level for each year, weighting the tariffs by the value of imports in each detailed industry, where we obtain U.S. imports from Feenstra, Romalis and Schott (2002). The MFN tariffs are mandated for all WTO signatories, while the ITA tariffs had been adopted by 43 countries at the end of our period (2007), covering 97 percent of world trade in technology products. The ITA covers a range of manufactured technology products (see Appendix E for a full list of products and adopters) and, for our purposes, is an important source of time-series variation, as MFN tariffs do not change much within industries over our period.

The instrument we use to proxy cost-driven immigration by industry and year extends the method first proposed by Altonji and Card (1991) and Card, (2001) to identify cost-driven local shifts in immigrants. We exploit the fact that foreigners from different countries have increased or decreased their relative presence in the U.S. according to changes to the cost of migrating and to domestic conditions that are specific to their countries of origin. The different initial presence of immigrants from different origins in an industry makes that industry more or less subject to those shifts in origin-specific cost- and push-factors. Using these two facts we impute the population of each of 10 main groups of immigrants across industries over time¹⁸. Specifically, we use the initial share of immigrant workers, by origin-group, in each industry and we augment it by the aggregate growth rate, of the population of the group, in the U.S. relative to the US total population. Adding across origin-groups we then obtain the imputed share of foreign-born in employment. We call this measure "Imputed Immigration" and note that it varies across industry and time. This index is similar to the constructed shift-share instrument often used in studies of immigration in local labor markets (e.g., Card, 2001; Card and DiNardo, 2000; Peri and Sparber, 2009), except that it exploits differences in the presence of immigrant groups (from different countries) across industries, rather than across localities. There are some recent papers that document the existence of industry and occupation-specific immigrants networks (e.g. Patel and Vella 2007) , in part due to the geographic concentration of industries.

Our identification works if industries, as localities, are important vehicles for immigrants networks. This is likely to be stronger in industries that are geographically concentrated. In Section 5.5.3 we will focus exclusively on industries that are highly concentrated geographically. Because of localized ethnic networks (Bartel, 1989), we would expect that the initial distribution of immigrants in such industries would be an even stronger predictor of future immigration flows. This is indeed what we will find.

¹⁸The ten countries/regions of origin are: Mexico, Rest of Latin America, Canada-Australia-New Zealand, Western Europe, Eastern Europe, China, India, Rest of Asia, Africa, and Other.

5.2 Effects on Employment Shares

We begin by estimating the impacts of variation in immigration and offshoring costs on the *shares* of native, immigrant and offshore workers, thereby exploring the relative substitutability of these worker types through the extent to which they displace one another. In Section 5.3 we will then analyze the impact on the employment *levels* of these groups, which includes the productivity impact of the changing costs of immigration and offshoring. Finally, in Section 5.4, we will explore the impact on the *task specialization* of natives and immigrants. Using the same notation as we used in the theoretical model but making industry and time indices explicit as discussed above, we implement (14) empirically by estimating the following three regressions

$$s_{Dst} = \phi_s^D + \phi_t^D + b_{DO}(s_{Ost}) + b_{DM}(s_{Mst}) + \varepsilon_{st}^D \quad (18)$$

$$s_{Mst} = \phi_s^M + \phi_t^M + b_{MO}(s_{Ost}) + \varepsilon_{st}^M \quad (19)$$

$$s_{Ost} = \phi_s^O + \phi_t^O + b_{OM}(s_{Mst}) + \varepsilon_{st}^O \quad (20)$$

where s_{Ost} and s_{Mst} are the employment shares of offshore and immigrant workers in industry s at time t , the ϕ_s 's are industry fixed effects, the ϕ_t 's are time effects, and the ε_{st} 's are (potentially) serially correlated errors. Estimation is based on 2SLS using the instruments described in Section 5.1.

Equation (18) estimates the impact of variations in offshoring and immigration share driven by push and cost factors as captured by the instruments, on native workers' share of employment. By including industry effects we only exploit variation within a 4-digit NAICS manufacturing industry over time. We also control for common-year effects and, as a result, any time-invariant difference in offshoring costs across industries and any common trend in offshoring costs over time will not contribute to the identification of the effect. Equation (19) estimates the effect of variation in offshoring costs on the immigrant share of employment and, conversely, equation (20) estimates the effect on the share of offshore worker of a decrease in immigration costs.

From Section 4.3 the predictions of the model are as follows: $b_{DO} < 0$, $b_{DM} \approx 0$, $b_{MO} < 0$ and $b_{OM} < 0$. Table 2 reports the estimated effects. First, columns (1)-(4) show the 2SLS effects of increasing shares of immigrant and offshore workers on the share of native workers. Because the shares must sum to 1, the immigrant and offshore worker shares are collinear, and so we must estimate their effects separately (as the sole regressors in separate regressions). We therefore estimate each effect, first, using both instrumental variables (columns (1) and (2)) for offshoring or immigration and, then, using a single instrumental variable – i.e., only the imputed immigration measure for immigration shares and only tariffs for offshore worker shares (columns (3) and (4)). Column (5) adopts the more inclusive definition of offshoring – augmented by the arm's length component. Column (6) reports the effects of variation in offshoring costs on the share of immigrants and Column (7)

shows the effect of variation in immigration costs on the share of offshore workers. In each case we use the single relevant instrumental variable. The standard errors reported in each regression are heteroskedasticity robust and clustered at the sector level to account for the potential serial correlation of errors.

The results are interesting and encouraging as the four predictions of the model are mostly matched by the estimates. Looking along the first row, we see that increased immigration in an industry has an insignificant effect on the share of native employment in that industry and a negative (non significant) effect on the share of offshore employment (recall that the model predicted no effect on natives and a negative effect on immigrants, respectively). Stronger results are obtained in the second row, which shows that there is a negative effect of offshore employment on the share of both native and immigrant workers in an industry, exactly as predicted in (16). Each of the estimates is significantly different from zero. In addition, the coefficients on the two measures of offshore employment (Column 3 and 5) are nearly identical.

These findings suggest that immigrants and natives compete more with offshore workers than with each other. This is consistent with a large part of the labor literature (e.g., Card, 2001; or Ottaviano and Peri, 2008) that does not find a significant negative impact of immigrants on native employment. Conversely, if the share of immigrants were to decrease due to an increase in the cost of immigration – for instance, due to more restrictive immigration laws – our results imply that immigrants are more likely to be substituted by offshore workers than by native workers. As the decline in offshoring costs has a greater impact on natives than on immigrants, our results also suggest that over the 8 years considered (2000-2007) the tasks that were offshored were likely to be at the high end of the task spectrum for offshore workers.

5.3 Effects on Employment Levels

Another important implication of our model, highlighted in Section 4.3, is the existence of a “productivity effect” that results from hiring immigrant or offshore workers when the associated costs decline. Such an effect leads to an increase in the aggregate demand for all worker types. This productivity effect, combined with the effect on shares described in the previous section, should imply a mitigated, null, or perhaps even positive effect of offshoring on native employment and a positive effect of immigration on native employment. Table 3 presents the estimated coefficients from the following four regressions that empirically implement (12):

$$N_{Dst} = \phi_s^D + \phi_t^D + B_{DO}(N_{Ost}) + B_{DM}(N_{Mst}) + \varepsilon_{st}^D \quad (21)$$

$$N_{Mst} = \phi_s^M + \phi_t^M + B_{MO}(N_{Ost}) + \varepsilon_{st}^M \quad (22)$$

$$N_{Ost} = \phi_s^O + \phi_t^O + B_{OM}(N_{Mst}) + \varepsilon_{st}^O \quad (23)$$

where N_{Dst} , N_{Mst} and N_{Ost} are the logarithm of the employment levels of native, immigrant and offshore workers, respectively. The method of estimation used is 2SLS using the cost-driven offshoring and immigration instruments¹⁹. In Table 4 we then present the estimates for the aggregate employment regression:

$$N_{Lst} = \phi_s^L + \phi_t^L + B_{LO}(s_{Ost}) + B_{LM}(s_{Mst}) + \varepsilon_{st}^L \quad (24)$$

where N_{Lst} is aggregate logarithm of employment in industry s and year t . In all specifications, the ϕ_s 's are industry fixed effects, the ϕ_t 's are time effects, and ε_{st} 's are (possibly) serially correlated errors. The effects estimated in Table 3 combine the productivity effects with the displacement effects. Regression (24), instead, captures the pure productivity effects of offshoring and immigration at the industry level. A positive estimate of B_{LO} and B_{LM} would imply a positive overall productivity effect of a drop in offshoring and immigration costs. Estimation is performed by 2SLS and heteroskedasticity-robust standard errors clustered by industry are reported.

The results presented in Table 3 are in line with the predictions of the model. Firstly, it is important to note that the first-stage F-Statistics are not too large but usually above the less stringent Stock and Yogo test-statistic for weak instruments. In fact they are 4.79 when jointly estimated and 7.43 when estimated separately. The employment estimates seem to reveal a positive and significant productivity effect of immigration, and an implied positive productivity effect of offshoring, on native-born workers. A decline of the costs of immigration associated to a 1% increase in immigrants produces an increase in the employment of natives equal to 0.42% (Table 3, column (3)) and has no significant effect on the total employment of offshore workers (Table 3, column (7)). The productivity effect of offshoring is revealed by the fact that, whereas offshoring unambiguously reduced the share of natives in an industry (Table 2, columns (1) and (3)), it has no effect on aggregate employment of natives (Table 3, columns (1)-(5)). Thus, while offshore workers compete directly with natives, their employment generates productivity gains that "increase the size of the pie", leading to an overall neutral impact on native employment. Table 4 shows directly the results from specification (24) which are informative on the size and significance of the productivity effects. Those coefficients show the impact of decreasing costs of offshoring and immigration on the overall size of the "employment pie" to be distributed across workers. As evidenced by the 2SLS results, both offshoring and immigration have positive productivity effects on the industry, however such an effect is only statistically significant in the case of immigration²⁰. Columns (1) and (2) in Table 4 show that an increase in immigrant share equal to 1% increases aggregate employment by 3.9%, implying a significant expansion, driven by the productivity effect. This is a substantial effect, particularly if we keep in

¹⁹In specifications of Table 3 we include the logarithm of the level (rather than the share) of immigrants and offshore workers as explanatory variables to produce coefficients that can be interpreted as elasticities. As we use the same cost and push-driven instruments for immigration and tariffs for offshoring the identifying variation is the same as in the other tables.

²⁰The results on offshoring are broadly consistent with Amiti and Wei (2005), who also find evidence of productivity effects by estimating conditional and unconditional labor demand functions.

mind that manufacturing employment actually declined over this period. At the same time an increase in the share of offshore employment by 1% is associated with an increase in aggregate employment by 1.72%, but the effect (although large) is not significant. Column (3) and (4) of Table 4 show the direct OLS regression of the aggregate employment on the imputed share of immigrants (a measure of migration openness for the sector) and on sector specific tariffs (a measure of offshoring costs). The regression confirms that an increase in cost-driven availability of immigrants drives up significantly the employment of the sector. A decrease in off-shoring costs, on the other hand, has a positive, but not significant, effect on employment. Interestingly, the presence of productivity effects due to immigration and offshoring implies that, even taken together, these two forms of globalization of labor have not harmed native employment in industries most exposed to them. To the contrary, the cost savings obtained from the tasks performed by immigrants and offshore workers have promoted an expansion of these industries relative to others and have ultimately led to increased demand for native workers relative to a scenario in which all tasks were performed by natives.

5.4 Effects on Tasks

Finally, our model has predictions regarding the effects of offshoring and immigration costs on the skill intensity of the tasks performed by the three groups of workers. To see whether these predictions find support in the data, we focus on the average rather than the marginal task²¹ performed by each group, which we compute by weighting the individual indices of complexity described in Section 3 by hours worked.

Given that skill intensity measures are only available for natives and immigrants, we implement (10) empirically for these two groups by estimating the following two regressions

$$I_{Dst} = \phi_s^D + \phi_t^D + d_{DO}(s_{Ost}) + d_{DI}(s_{Mst}) + \varepsilon_{st}^D \quad (25)$$

$$I_{Mst} = \phi_s^M + \phi_t^M + d_{MO}(s_{Ost}) + d_{MI}(s_{Mst}) + \varepsilon_{st}^M \quad (26)$$

The variables I_{Dst} and I_{Mst} in (26) are the average skill intensities of tasks assigned to natives and immigrants, respectively; s_{Ost} and s_{Mst} are the employment shares of offshore and immigrant workers in industry s at time t . The ϕ_s 's represent industry fixed effects, the ϕ_t 's are time effects. Finally the ε_{st} 's are (possibly) serially correlated errors.

Table 5 shows the results from OLS and 2SLS specifications, where we use, as always, the instruments described in Section 5.1. We present the effects on the summary indices of Complexity, I_D and I_M , as well as the effect on Communication Intensity, Cognitive Intensity and Non-Manual Intensity (the inverse of the Manual index) separately. We focus on the 2SLS results, reported in the third and fourth row. The first stage

²¹For the reasons discussed in Section 4.1 the predictions on average tasks hold also in a probabilistic environment where there would be regions of task overlap between workers and hence no marginal task.

F-Statistics are quite strong (well above 10) and the first column in Table 5 shows a positive and significant effect of offshoring and no effect of immigration on the Complexity of native tasks. The same holds true for their Communication Intensity, Cognitive Intensity and Non-Manual Intensity. Again this is consistent with the predictions of the theoretical model. Columns (5) and (6) indicate that offshoring has little effect on the skill intensity of immigrant tasks but, at the same time, has a large positive impact on the gap between immigrant and native tasks ($I_D - I_M$). This suggests that the role of offshore workers hollowing out the task spectrum operates primarily by forcing native workers into more complex tasks. This confirms the results found on employment shares (of native and immigrants) in Table 2. Offshoring leads to increased polarization in native and immigrant specialization, mainly by pushing natives towards more complex jobs. The effect is not negligible. Since the standard deviation across sectors in the share of offshore workers during the period is around 14%, such difference multiplied by the coefficient on the complexity index estimated in column (1) implies a difference in task complexity of natives of 9%. This is about half of the standard deviation of complexity across sectors, and also half of the average difference in complexity of tasks performed by immigrants and natives.

5.5 Extensions and Checks

Before concluding we discuss three issues concerning three key assumptions of our theoretical framework: the type of offshoring we model; the lack of a wage response to increased offshoring and immigration; the strength of our immigration instrument when we restrict to industries that are relatively concentrated in space.

5.5.1 Horizontal versus Vertical Offshoring

A recent study by Harrison and McMillan (2011) emphasizes that, in order to identify the effects of offshore employment on domestic employment, one needs to distinguish between “horizontal” and “vertical” offshoring. In particular, they show that increased “horizontal” offshoring - through which production is moved abroad to serve the local market- hurts domestic jobs. In contrast, “vertical” offshoring - through which some intermediate stages of production are moved abroad and the intermediates are re-imported to the U.S. for further processing - is found to be beneficial to domestic employment. For this reason it is interesting to re-run our regressions of Table 5 on a sample of industries that are relatively intensive in vertical offshoring. This is also more consistent with our theoretical framework, which is a model of vertical rather than horizontal offshoring.

In our sample we are able to identify those industries for which re-exporting to the headquarters, as opposed to generating purely local sales, is a more important activity for the affiliates. Specifically, using the BEA data we can calculate the aggregate value of exports from affiliates to headquarters as well as the total value of local sales of affiliates. Then, we can rank industries in terms of their import-to-local-sales ratios, which we take as a measure of the intensity of vertical offshoring. Finally, we re-run our regressions focusing on industries whose

import-to-local-sales ratios are above some thresholds. Based on Harrison and McMillan (2011), as well as on the logic of our model, we expect to find stronger results for industries with higher import-to-local-sales ratios.

Table 6, columns (1)-(3), report the 2SLS effect of variation in offshoring costs on native task complexity when we limit the sample to industries with high intensity of vertical offshoring, as defined according to three different threshold values²². Since this procedure selects subsets of industries, in each case the sample of observations is reduced accordingly. The patterns identified in these columns reproduce the aggregate patterns from the previous section, with the primary difference being that, as expected, the effect is stronger for industries at the highest relative intensity of vertical offshoring. In columns (4)-(6), the corresponding estimates for industries with low intensity of vertical offshoring show instead a weak (not significant) effect on native task complexity. Hence, it is the vertical nature of offshoring activities that seems to generate competition between natives and offshore workers, thereby altering the allocation of production tasks within industries.

5.5.2 Wage Effects

Our model and empirical strategy have examined employment across industries in order to capture the productivity consequences of immigration and offshoring. However, in the presence of imperfect mobility of workers, or barriers to transferring skills from one industry to another, a portion of the industry-specific effects of immigration and offshoring could be captured by wage rather than employment differentials. In particular, while the U.S. labor force is mobile geographically, as well as across industries, in the short run wages may not be perfectly equalized.

To address this issue, we check directly whether industry wages are affected by offshoring and immigration by running a specification like (21), except using the average wage of natives instead of their employment as the dependent variable. The average wage is constructed from ACS data, as detailed in Section 3.1. The results reported in Table 7 are quite clear and consistent across each specification (with each effect estimated via separate regressions to be consistent with the specification in Table 2). While the point-estimates of the effect of increased offshoring and immigration on native wages are always positive, those effects are never significant. These results confirm that, while there may be a productivity effect of offshoring and immigration on wages, the assumption of inter-sector mobility of workers is reasonable as the adjustment to cross-sector productivity differences takes place mainly through employment reallocation.

5.5.3 Geographically Concentrated Industries

As discussed in Section 5.1, the immigration instrument we adopt is usually constructed using variation across localities rather than industries. As further check that industry-specific network effects of immigrants also

²²We choose thresholds of the ratio of re-imports to total local sales of 0.3, 0.2 and 0.1. This range spans the intermediate range of values as the median ratio in the whole sample is 0.2.

rely on geographic concentration of an industry, we re-run regression (21), focusing on industries that are particularly concentrated in space. Since our 2SLS approach relies on a strong relationship between the flow of immigrants from a particular country into an industry and the share of U.S. immigrants from the same country already working in that industry, the first-stage regression should show increased power for more geographically concentrated industries. The reason is that new immigrants tend to favor destinations where the costs of hardship are lower thanks to the presence of the ethnic networks created by previous immigrants (Card, 2001; Card and DiNardo, 2000; Peri and Sparber, 2009). A recent paper by Vella and Patel (2007) also shows a concentration of immigrants by location and type of occupation.

Specifically, in order to capture the degree to which an industry is concentrated within the U.S., we calculate a geographic Gini coefficient for each industry using data on state and industry employment in 2000. Interestingly, the manufacturing sector as a whole is significantly more concentrated than non-manufacturing, with an average Gini of 0.75 compared to 0.72, which bodes well for the validity of the instrument overall. In other words, an immigrant’s decision regarding which industry to work in may overlap with their choice of location, strengthening the network effects underlying our IV approach. We therefore take the manufacturing average as our threshold and reproduce the first-stage regression using only those industries with a Gini larger than 0.75, a value that is also near the median and so selects nearly 50% of the sample.

The corresponding findings are depicted in Table 8. Comparing the 2SLS results in columns (3) and (4) with the results for the entire sample in Table 3, we see that restricting the sample to more concentrated industries increases the estimated, average impact of immigrants on native employment. Note also that this is not true in the OLS estimates in columns (1) and (2) in which the estimated, average impact of immigrants on natives declines slightly. Combined with the relatively stronger first-stage coefficient shown in column (3) (to be compared with column (3) in Table 3) we interpret this as overall evidence that our immigration instrument has more power in for spatially concentrated industries and for those, the productivity effect of immigration is also somewhat stronger.

6 Conclusions

We have analyzed the effects of easier offshoring and immigration on the employment share, employment level and task specialization of native workers within the U.S. manufacturing sector from 2000 to 2007. As mentioned in the introduction, there are very few attempts to combine analyses of immigration and offshoring on labor markets. Analyzing each in isolation misses the possibility that hiring immigrants or offshoring productive tasks are alternatives that are simultaneously available to producers and may compete with each other or with hiring a native worker.

We have modeled and found empirical support for a scenario in which jobs (“tasks”) vary in terms of their

relative intensity of workers' skills and workers differ in terms of their relative endowment of those skills with a systematic component across native, immigrant or offshore groups. As long as only natives are available, producers will only employ them. Once immigrant and offshore workers become employable, efficiency gains can be reaped by hiring them to perform tasks in which, due to their skills, they have a relative advantage, giving native workers the opportunity to specialize in the tasks in which they exhibit their own relative advantage. If strong enough, the productivity effect associated with this improved task assignment may offset the displacement effect of immigration and offshoring on native workers' employment.

Despite the widely held belief that immigration and offshoring are reducing the job opportunities of U.S. natives, we have found instead that, during our period of observation, manufacturing industries with a larger increase in global exposure (through offshoring and immigration) fared better than those with lagging exposure in terms of native employment growth.

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A Appendix: Endogenous Native Wages

In the main text we have assumed that each sector is not large enough to affect the domestic wage w . Here we discuss how w would react if such an assumption did not hold.

Intuition is better served by focusing on the simple case of an economy with only two sectors indexed $s = 1, 2$. In each sector immigrant, offshore and native labor demands are given by expressions like (12) with corresponding price indices like (13). The two sectors may differ in terms of offshoring and immigration costs, technological parameters, demand parameters, goods prices, and specific factor endowments. As in the model in the main text, goods prices p_Y^s are exogenously determined in international markets and foreign workers are in infinitely elastic supply at foreign wage w^* . Their utility maximizing decisions determine whether they are employed as immigrants or offshore workers in the two sectors, or in some other non-modeled occupation abroad. In contrast to the model in the main text, native workers are now in fixed supply \bar{N}_D and their allocation between sectors is determined, together with their wage w , by the clearing of the native labor market: the sum of the two sectors' native labor demands has to equal native labor supply ($N_D^1 + N_D^2 = \bar{N}_D$). The equilibrium native wage then determines immigrant and offshore employment levels in the two sectors, N_M^1 and N_O^2 , through the corresponding labor demands as in (12).

Specifically, given (11), (12), and (13) native labor demand in sector s can be rewritten as

$$w = (N_D^s)^{-(1-\alpha^s)} (a_L^s)^{-\alpha^s} (1 - I_{NO}^s)^{1-\alpha^s} [\Omega^s(I_{MO}^s, I_{NO}^s)]^{(\sigma^s-1)(1-\alpha^s)-\alpha^s} (B^s)^{1-\alpha^s}$$

with $B^s = (\alpha p_Y^s A^s)^{\frac{1}{1-\alpha}} H^s$ and

$$\Omega^s(I_{MO}^s, I_{NO}^s) = \left\{ \int_0^{I_{MO}^s} \left[\frac{\delta^s \tau^s(i)}{\beta^s t^s(I_{NO}^s)} \right]^{1-\sigma^s} di + \int_{I_{MO}^s}^{I_{NO}^s} \left[\frac{t^s(i)}{t^s(I_{NO}^s)} \right]^{1-\sigma^s} di + (1 - I_{NO}^s) \right\}^{\frac{1}{1-\sigma^s}}.$$

Equilibrium in the native labor market is represented in Figure A2. This depicts a standard box diagram in which the horizontal dimension measures native labor supply \bar{N}_D , the vertical dimension measures the native wage, and (log-linearized) labor demands in the two sectors are depicted as decreasing in the native wage from their respective origins O_1 and O_2 . Accordingly, the equilibrium allocation of native workers between the two sectors and the corresponding common wage are to be found at the crossing of the two labor demand schedules where, by graphical construction, the native labor market clears. Figure A2 can be used to assess the effects of changes in migration and offshoring costs on the wage of native workers as well as on their sectoral allocation. For example, under our working assumptions, a fall in migration costs in sector 1 (lower δ^1) does not affect I_{NO}^1 and increases I_{MO}^1 . This leads to a fall in $\Omega^1(I_{MO}^1, I_{NO}^1)$. What then happens in the figure depends on whether $(\sigma^1 - 1)$ is larger or smaller than $\alpha^1 / (1 - \alpha^1)$, with the former measuring the substitutability of tasks and the

latter the importance of the task bundle for final production. When tasks are not easily substitutable (small σ^1) and the task bundle contributes a lot to final production (large α^1), so that $(\sigma^1 - 1) < \alpha^1 / (1 - \alpha^1)$, a lower $\Omega^1(I_{MO}^1, I_{NO}^1)$ shifts the labor demand schedule of sector 1 upwards increasing the wage of natives and their employment in sector 1. The opposite happens when tasks are easily substitutable (larger σ^1) and the task bundle does not contribute much to final production (small α^1), so that $(\sigma^1 - 1) > \alpha^1 / (1 - \alpha^1)$.

The effect of lower offshoring costs is, instead, more complex as a fall in β^1 not only decreases I_{MO}^1 but also increases I_{NO}^1 , thus reducing $\Omega^1(I_{MO}^1, I_{NO}^1)$. However, additionally, the native labor demand schedule shifts upward when tasks are not easily substitutable (small σ^1) and the task bundle contributes a lot to final production (large α^1), and vice-versa. So, whether easier migration and easier offshoring lead to higher employment and a higher native wage is, in the end, an empirical question that depends on sectoral characteristics.

B Appendix: No Discrimination between Natives and Immigrants

In the model presented in the main text, the productivity effect due to easier immigration stems from the fact that falling costs of immigration create rents for domestic firms $c_D - c_M(i) = wa_L - w^*\delta\tau(i)a_L$ per unit task for $i \in [0, I_{MO}]$, just as the productivity effect due to easier offshoring stems from the fact that falling costs of offshoring create rents for domestic firms $c_D - c_O(i) = wa_L - w^*\beta t(i)a_L$ per unit task for $i \in [I_{MO}, I_{NO}]$. These effects arise because we have assumed that firms can discriminate between immigrants and natives since they know the wage w^* in the country where immigrants come from as well as their common migration cost δ .

This ability to discriminate is crucial for the productivity effect due to easier immigration to materialize. The argument can be spelled out following Grossman and Rossi-Hansberg (2008). In discussing the different effects of easier offshoring and easier immigration, these authors assume, as we also do, that foreign workers can stay in the foreign country and earn the wage w^* or can move to the home country, at the cost of a fraction of their working time, and earn the wage \tilde{w} . To avoid the existence of corner outcomes with no migration or infinite migration, they also assume that foreign workers are heterogeneous in terms of their moving costs. Specifically, a foreign worker z captures only a fraction $1/\delta\mu(z)$ of \tilde{w} when she moves to the home country. Without loss of generality, foreign workers can be indexed in increasing order of moving costs so that $\mu'(z) > 0$. Moreover, Grossman and Rossi-Hansberg (2008) assume that immigrants are as productive as natives and that domestic firms are not able to discriminate between natives and immigrants nor between immigrants with different moving costs.

In terms of our notation, all these assumptions imply $\tau(i) = 1$ and $\tilde{w} = w$. They also imply that the marginal immigrant Z earns the same net income in both locations so that $w = w^*\delta\mu(Z)$. This replaces our condition $\tilde{w} = w^*\delta$ in the main text and uniquely determines Z , which in turn determines the number of immigrants given some distribution of foreign workers across moving costs.

To sum up, when firms are unable to discriminate, native, immigrant and offshore marginal costs become $c_D = wa_L$, $c_M(i) = w^*\delta\mu(Z)a_L = wa_L$ and $c_O(i) = w^*\beta t(i)a_L$, respectively. Accordingly, an inframarginal immigrant $z < Z$ earns rents $w - w^*\delta\mu(z)$. This implies that as the common immigration cost δ falls, additional rents are created at both the intensive and the extensive task margins. Accordingly, new immigrants enter the home country (Z increases). More rents also accrue to the incumbent immigrants, but not to the home firms whose profitability, therefore, does not change. "The difference between falling costs of offshoring and falling costs of immigration is that the former create rents for domestic firms ... whereas the latter create rents for the immigrants" (Grossman and Rossi-Hansberg, 2008).

In contrast, when firms can discriminate between natives and immigrants they fully appropriate the rents. Ruling out offshoring for simplicity, in our model the rents per unit task when cheaper immigrants are employed instead of natives amount to

$$c_D - c_M(i) = wa_L - w^*\delta\tau(i)a_L$$

so that total rents correspond to the striped area in Figure A3. Being entirely appropriated by firms, these rents are the source of the productivity effect due to immigration. Note that our assumption of perfect discrimination is not crucial in order to generate a productivity effect due to immigration—as long as there is any degree of discrimination some rent is generated.

C Appendix: Cognitive, Communication and Manual Intensities

The *O*NET* variables used to construct the cognitive, communication and manual intensity indices are the following. Cognitive Intensity is the average of 10 variables: Fluency of Ideas, Originality, Problem Sensitivity, Deductive Reasoning, Inductive Reasoning, Information Ordering, Category Flexibility, Mathematical Reasoning, Number Facility, Memorization. Each variable is the intensity of use of the skill associated to the occupation. The value of the variable is the percentile of the occupation in the ranking of workers according to that skill intensity. Communication Intensity is the average of 4 variables: Oral Comprehension, Written Comprehension, Oral Expression, Written Expression. Manual Intensity is the average of 19 variables: Arm-Hand Steadiness, Manual Dexterity, Finger Dexterity, Control Precision, Multilimb Coordination, Response Orientation, Rate Control, Reaction Time, Wrist-Finger Speed, Speed of Limb Movement, Static Strength, Explosive Strength, Dynamic Strength, Trunk Strength, Stamina, Extent Flexibility, Dynamic Flexibility, Gross Body Coordination, Gross Body Equilibrium.

D Appendix: Offshore Employment Variables

Our measures of offshore employment draw from data on the employment and exports of affiliates of U.S. multinational corporations (MNCs) from the BEA, U.S. Direct Investment Abroad: Operations of U.S. Parent Companies and Their Foreign Affiliates, 2000-2007. According to Mataloni and Yorgason (2006), MNC output in 1999 accounted for around half of manufacturing output and 63 percent of manufacturing exports. We also restrict the sample further by using only majority-owned, non-bank MNC affiliates, however this restriction is minor. The quality of this data has been investigated by Harrison and McMillan (2011) using inward FDI data from Germany and Sweden, and while the authors find some discrepancies, these seem to be at least somewhat explained by differences in the timing of reporting.

Specifically, we collect information on multinational affiliate employment by industry and year (58 manufacturing industries over 2000-2007), imports from MNC affiliates to their parents by industry and year, and imports from non-affiliates to U.S. MNCs by industry and year.

In order to calculate total offshore employment due to U.S. offshoring, by MNCs and at arm's length, we begin with the actual employment of multinational affiliates and the aggregate exports of those affiliates to the multinational parent firm. We then take the ratio of affiliate employment to affiliate exports for each industry and year. This ratio is then set aside as a scaling factor, or an export labor requirement, for each industry and year. Next, we multiply U.S. parent firm imports from non-affiliates by this scaling factor and the result is our imputed arm's length offshore employment. This is then combined with the affiliate employment values. As mentioned in the main text, this procedure assumes an equivalent labor requirement per unit of exports for affiliates and non-affiliates.

E Appendix: Information Technology Agreement Tariffs

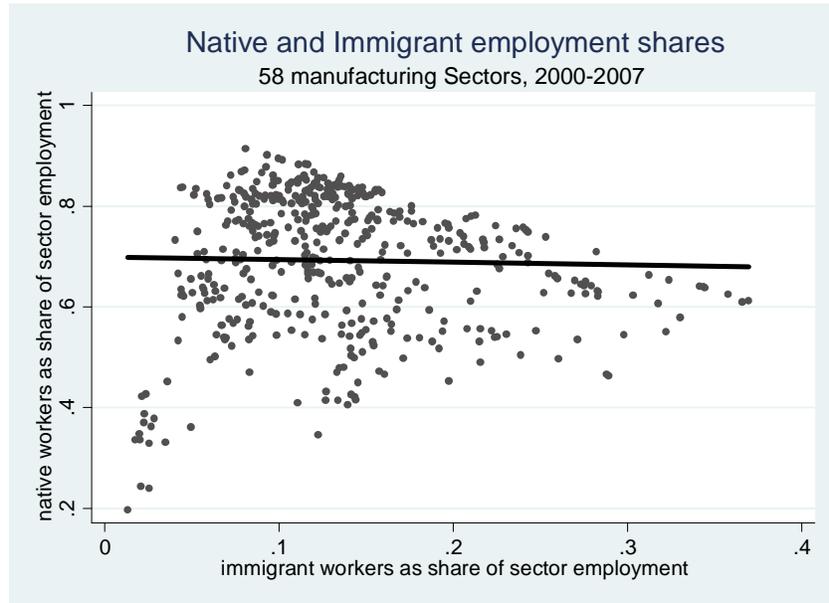
The Information Technology Agreement is a tariff cutting agreement enacted by several World Trade Organization members. The first stage reduction in tariffs under the ITA occurred on 1 July 1997. The number of signatories has steadily grown and now includes Albania, Australia, Bahrain, Bulgaria, Canada, China, Costa Rica, Croatia, Dominican Republic, Egypt, El Salvador, the European Community, Georgia, Guatemala, Honduras, Hong Kong, Iceland, India, Indonesia, Israel, Japan, Jordan, Korea, Kuwait, Kyrgyz Republic, Macao, Malaysia, Mauritius, Moldova, Morocco, New Zealand, Nicaragua, Norway, Oman, Panama, Peru, Philippines, Romania, Saudia Arabia, Singapore, Switzerland, Chinese Taipei, Thailand, Turkey, Ukraine, United Arab Emirates, United States, and Vietnam.

The products covered by the ITA include data processing and storage products, audio and visual devices, various electronics, various machines and parts and accessories to all of these. More specifically, the ITA

products are those under the following Harmonized System headings: 3818, 846911, 847010, 847021, 847029, 847030, 847040, 847050, 847090, 847110, 847130, 847141, 847149, 847150, 847160, 847170, 847180, 847190, 847290, 847321, 847329, 847330, 847350, 850440, 850450, 851711, 851719, 851721, 851722, 851730, 851750, 851780, 851790, 851810, 851830, 851829, 852020, 852311, 852312, 852313, 852320, 852390, 852431, 852439, 852440, 852491, 842499, 852510, 852520, 852540, 852790, 852910, 852990, 853120, 853190, 853210, 853221, 853222, 853223, 853224, 853225, 853229, 853230, 853290, 853310, 853321, 853329, 853331, 853339, 853340, 853390, 853650, 853650, 853650, 853669, 853690, 854110, 854121, 854129, 854130, 854140, 854150, 854160, 854190, 854212, 854213, 854214, 854219, 854230, 854240, 854250, 854290, 854381, 854389, 854441, 854449, 854451, 854470, 900911, 900921, 900990, 902610, 902620, 902680, 902690, 902720, 902730, 902750, 902780, 902790, 903040.

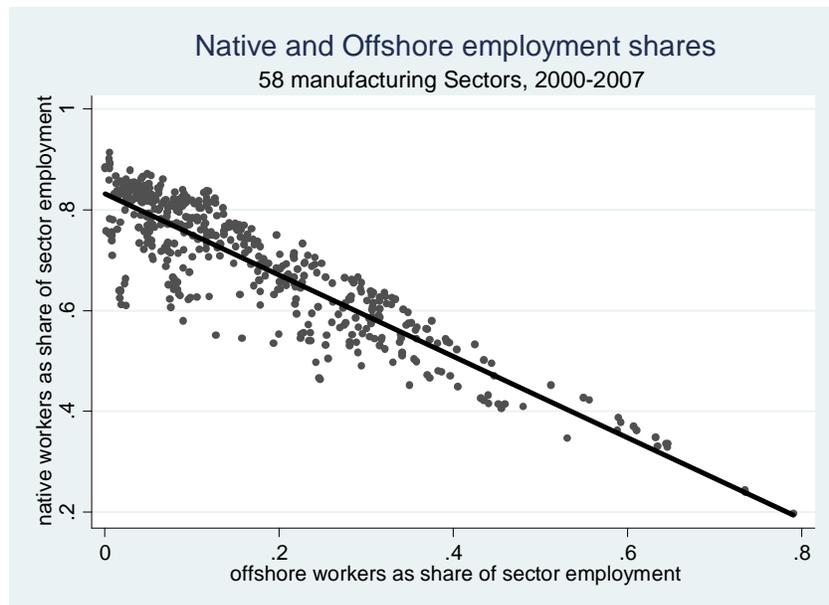
For more information on the ITA, see: http://www.wto.org/english/tratop_e/inftec_e/itaintro_e.htm

Figure 1 – Shares of immigrant, natives and offshore workers



Slope of the regression line: 0.05, Standard error: 0.10

(a)



Slope of the regression line: -0.80, Standard error: 0.02

(b)

Figure 2 – Growth rates of employment and wages

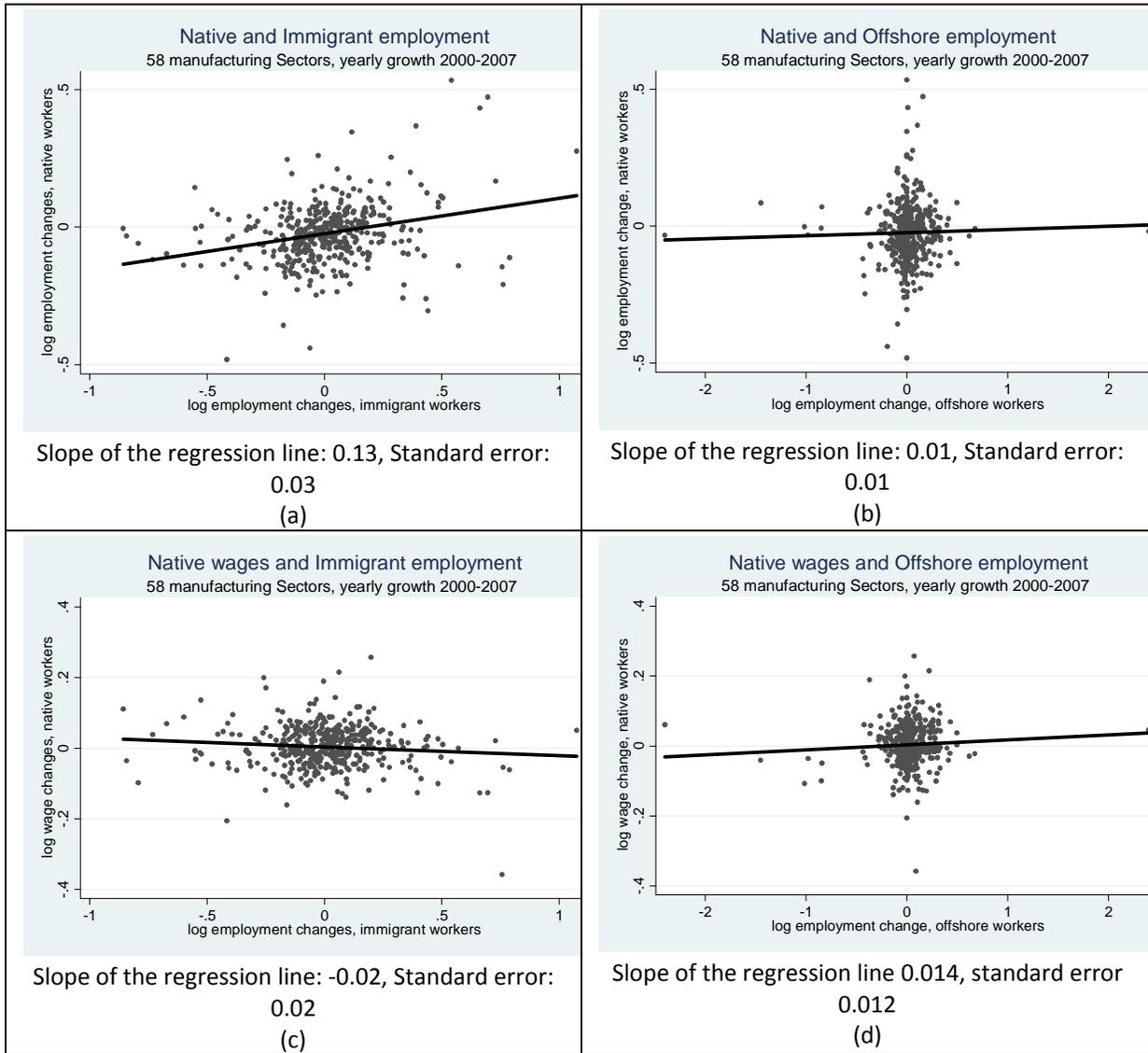
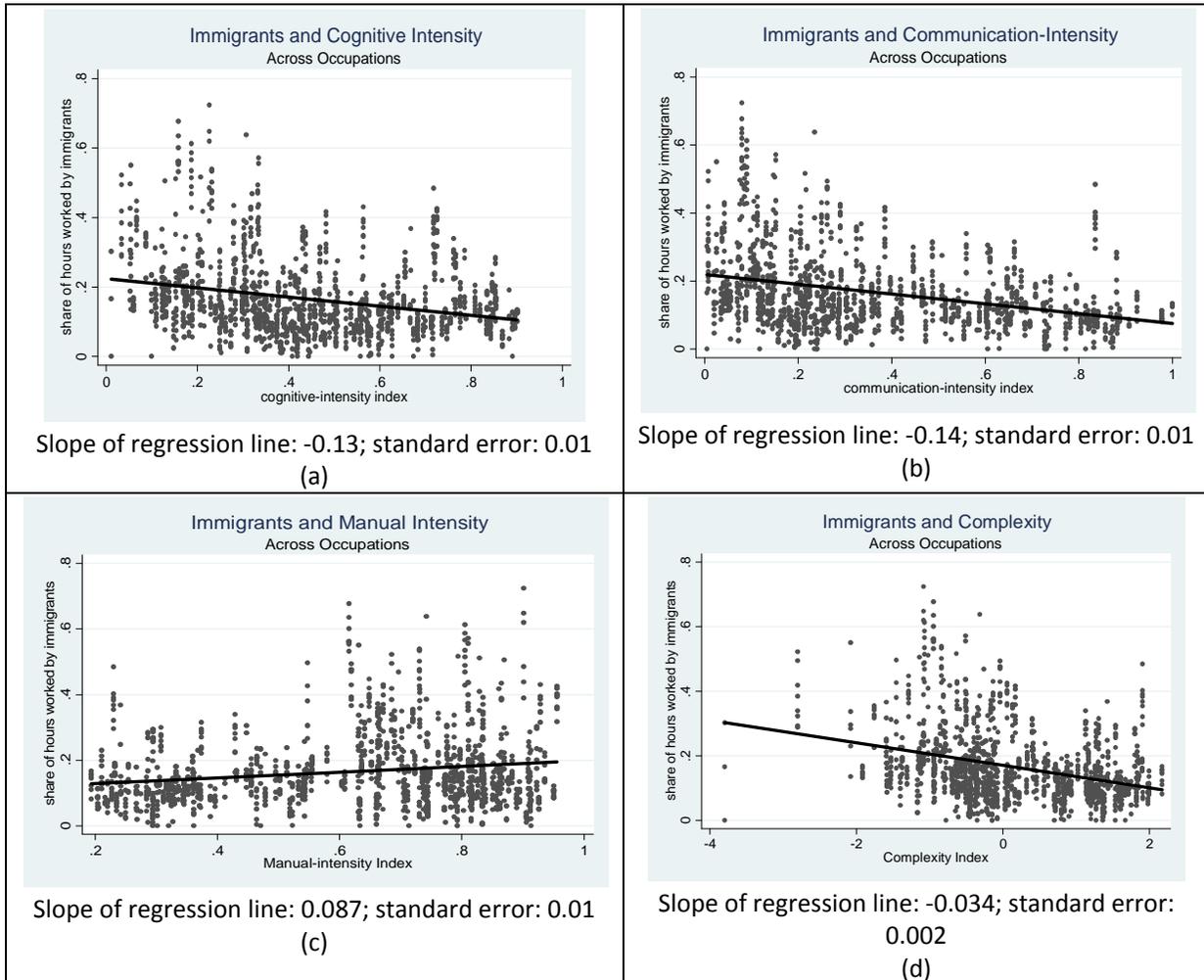
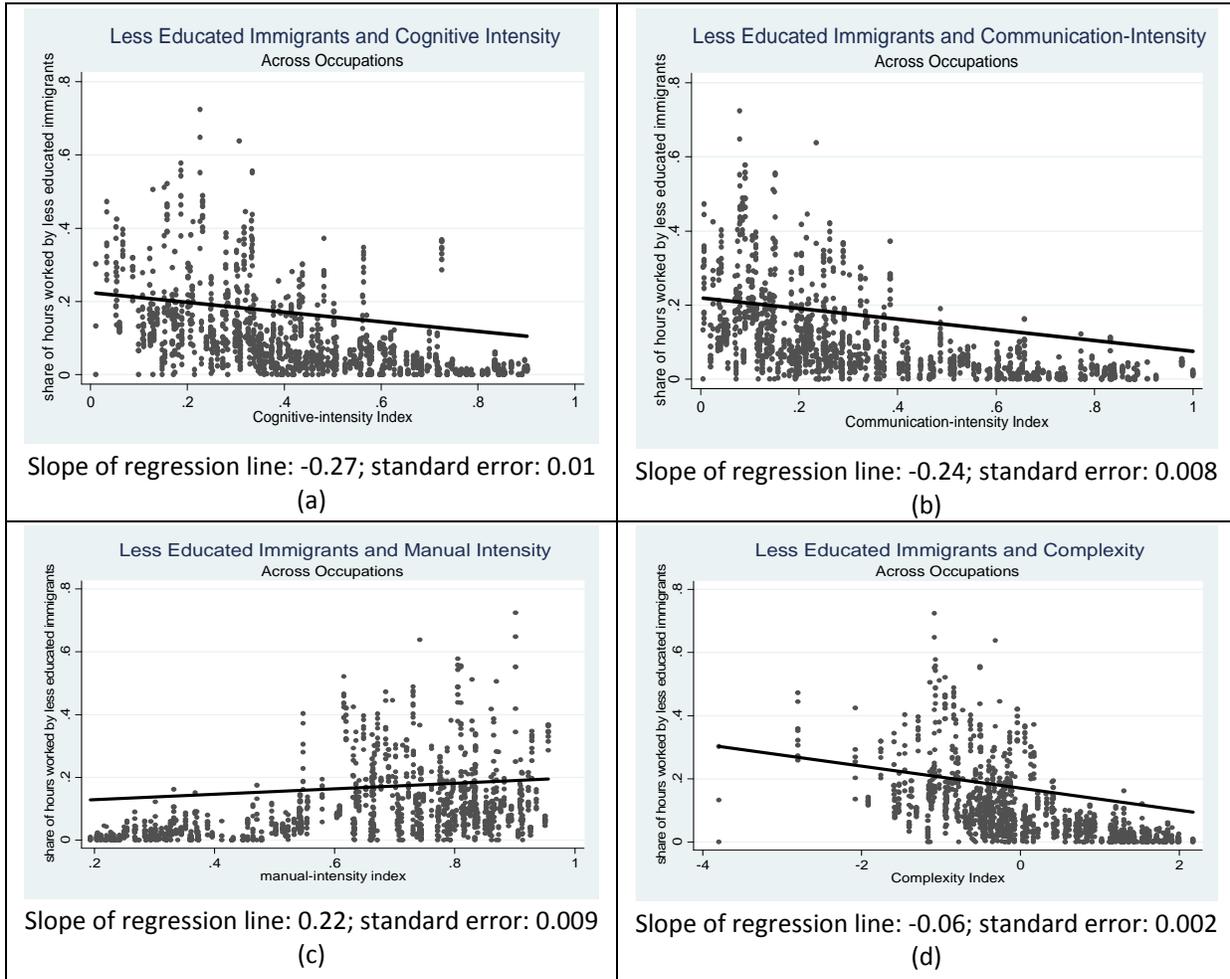


Figure 3: Immigrants and Task Complexity (all workers)



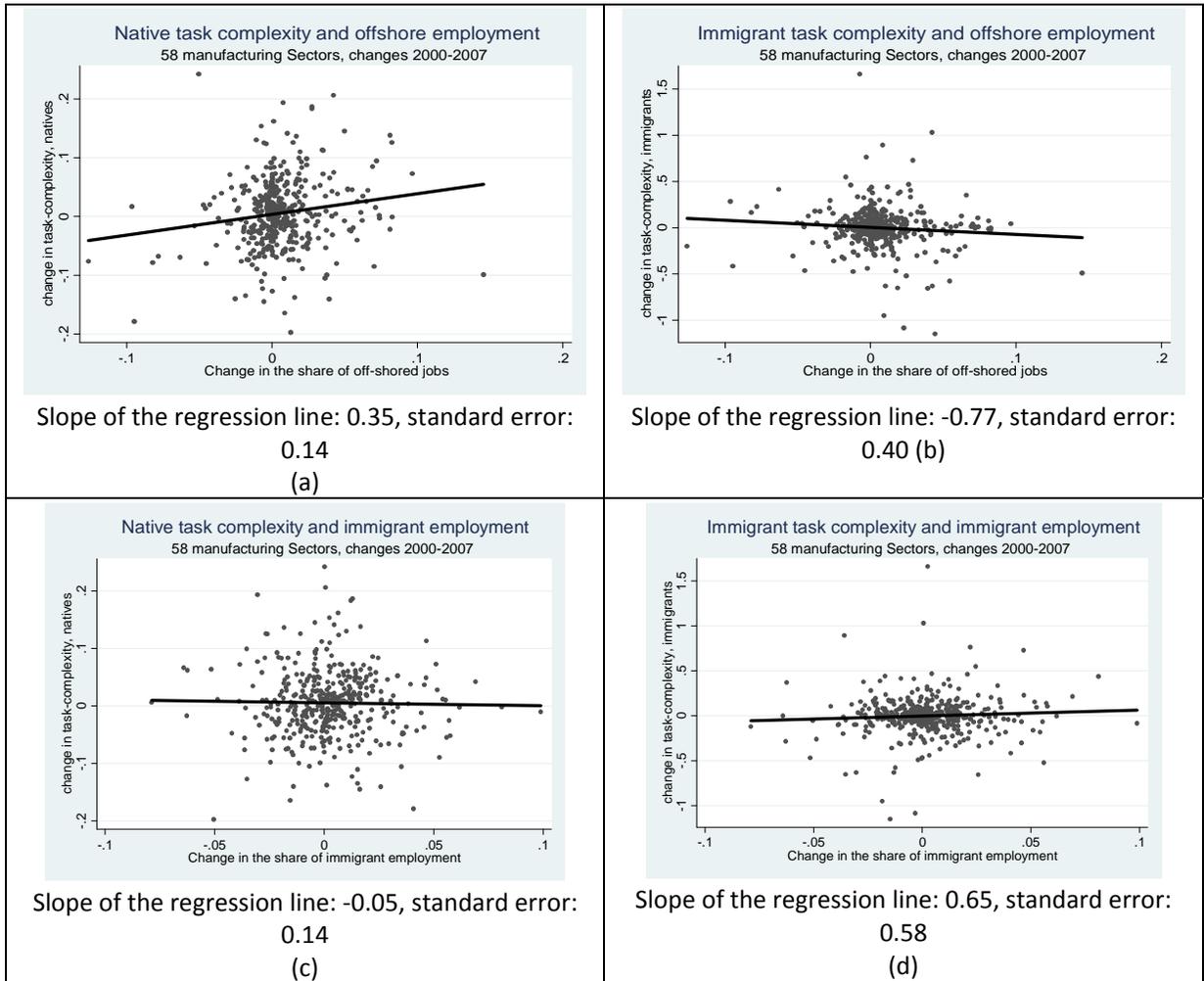
Note: Sample is 295 occupations over 2000-2007. Only occupations with over 5000 workers are reported.

Figure 4: Immigrants and Task Complexity (workers with a high school diploma or less)



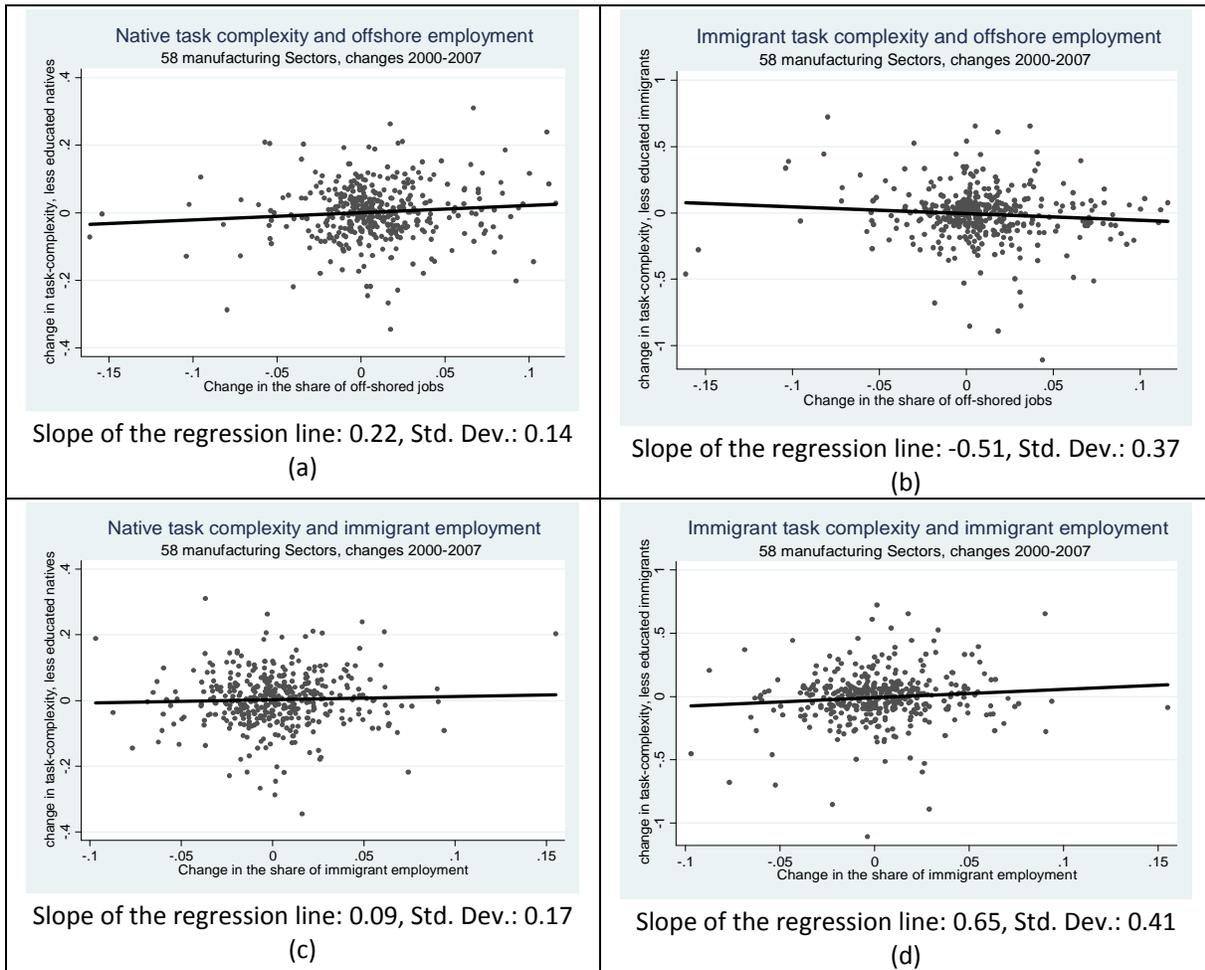
Note: Sample is 295 occupations over 2000-2007. Only occupations with over 5000 workers are reported.

Figure 5: Native Complexity, Immigration and Offshoring (all workers)



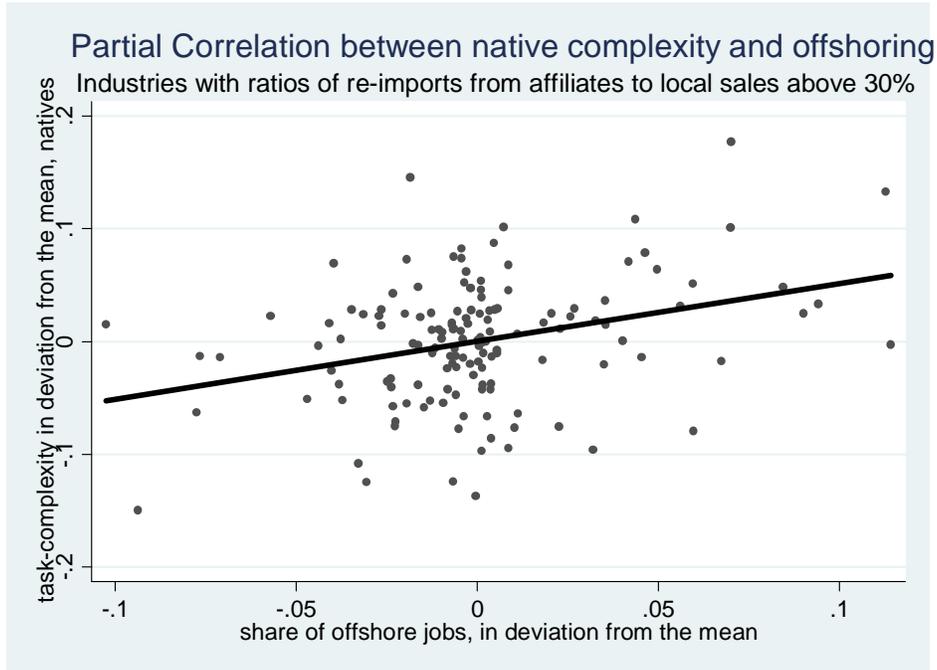
Note: Sample is 295 occupations over 2000-2007. Only occupations with over 5000 workers are reported.

Figure 6: Native Complexity, Immigration and Offshoring (workers with a high skill diploma or less)

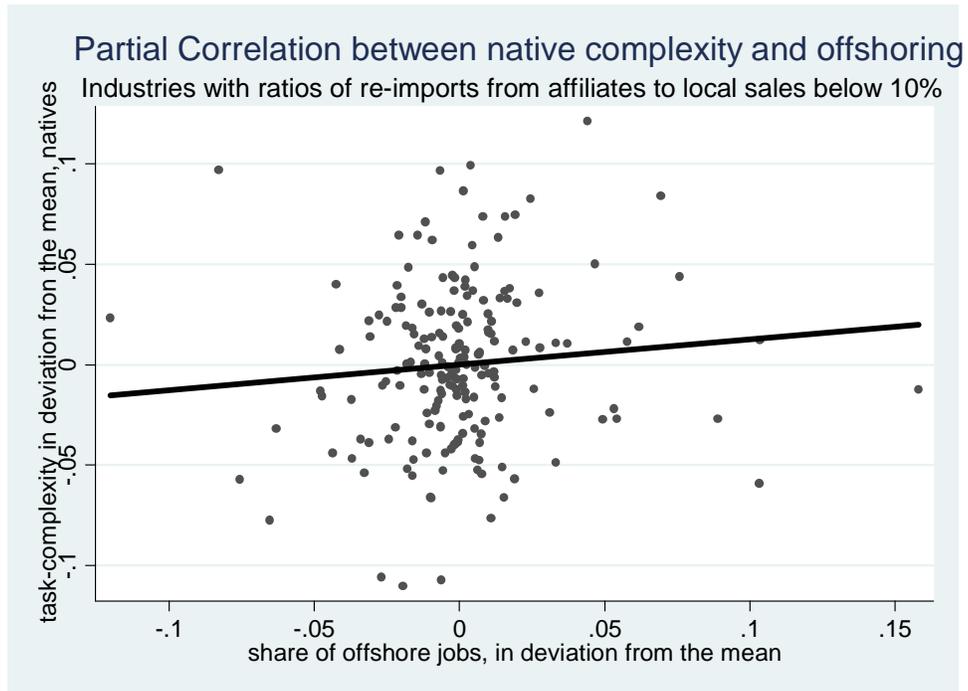


Note: Sample is 295 occupations over 2000-2007. Only occupations with over 5000 workers are reported.

Figure 7: Offshoring Intensity and Native Complexity



(a)



(b)

Figure 8: Task Assignment

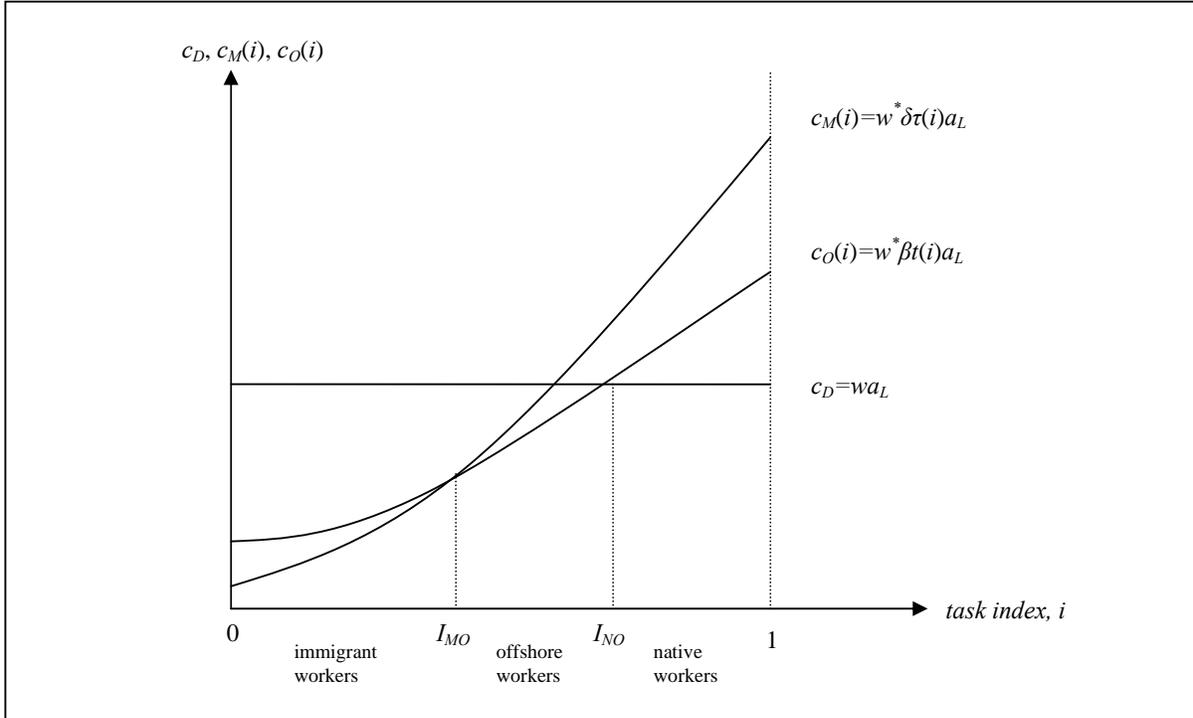


Table 1: Complexity of Native and Immigrant Tasks in Tradable vs. Non-Tradable industries

| Dep. Variable is the complexity index for natives | Complexity=Ln[(Cognitive + Communication) /Manual] | |
|---|--|---------------------------------|
| | (1) | (2) |
| | Tradable sectors, 2000-2007 | Non Tradable sectors, 2000-2007 |
| Complexity index for the foreign-born | 0.03 (0.03) | 0.07** (0.01) |
| Share of foreign-born | 0.01 (0.10) | 0.15** (0.06) |
| Industry effects | Yes | Yes |
| Time effects | Yes | Yes |
| Observations | 647 | 1456 |

Note: the estimation method is ordinary least squares including industry and time effects. Heteroskedasticity-robust standard errors, clustered at the sector level are reported. **, * significant at the 5, 10% level.

Table 2: Effects of Offshoring and Immigration on Employment Shares

| | Dependent Variable: native share of employment | | | | Dependent Variable: Immigrant share of employment | Dependent Variable: Offshore share of employment | |
|---|--|--|---|---|---|--|------------------------------|
| Specifications | Method of Estimation: 2SLS | | Method of Estimation: 2SLS | | Method of Estimation: 2SLS | | |
| | (1) Separately estimated, using both instruments per regression | (2) Separately estimated, using both instruments per regression | (3) Separately estimated using one instrument per regression | (4) Separately estimated using one instrument per regression | (5) Separately estimated including arms' length offshoring | (6) | (7) |
| Immigrant share of employment | | 0.85 (0.90) | | 0.46 (0.52) | | | -0.53 (0.43) |
| Offshore share of employment | -0.70** (0.14) | | -0.78** (0.11) | | -0.71** (0.31) | -0.22* (0.11) | |
| Industry Fixed effects | Yes | Yes | Yes | Yes | | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 464 | 464 | 464 | 464 | 464 | 464 | 464 |
| First Stage: | Immigrant share of employment | Offshore share of employment | Offshore share of employment | Immigrant share of employment | Offshore share of employment | Immigrant share of employment | Offshore share of employment |
| Imputed Sector-Specific Share of Immigrants | 2.12** (0.40) | -1.80** (0.80) | | 1.90** (0.48) | | 1.90** (0.48) | |
| Sector-Specific Tariffs | 0.01* (0.005) | -0.06** (0.008) | -0.06** (0.008) | | -0.03** (0.01) | | -0.06** (0.08) |
| F-test | 13.45 | 28.7 | 52.7 | 16.32 | 3.60 | 16.32 | 52.7 |

Note: The dependent variable in each regression is specified at the top of the relative columns. The units of observations are industry by year. All regressions include industry and year effects. Heteroskedasticity-robust standard errors, clustered at the sector level are reported. **, * significant at the 5, 10% level.

Table 3: Effects of Offshoring and Immigration on Employment Levels

| | Dependent Variable: Ln(Native employment) | | | | Dependent Variable: Ln(Immigrant employment) | Dependent Variable: Ln(Offshore employment) | |
|---|--|---|--------------------------------------|---|---|--|---------------------------|
| | Method of Estimation: OLS | | Method of Estimation: 2SLS | | Method of Estimation: 2SLS | | |
| Specifications | (1) Jointly Estimated | (2) Separately estimated | (3) Jointly Estimated | (4) Separately estimated | (5) Offshore includes arm-length | (6) | (7) |
| Ln(Employment Immigrants) | 0.33** (0.07) | 0.34** (0.07) | 0.42* (0.21) | 0.42* (0.22) | 0.43* (0.22) | | 0.14 (0.64) |
| Ln(Offshore employment) | 0.01 (0.03) | 0.03 (0.04) | -0.02 (0.18) | -0.11 (0.25) | 0.02 (0.19) | -0.32 (0.32) | |
| Industry Fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of observations | 464 | 464 | 464 | 464 | 464 | 464 | 464 |
| First Stage: | | | Ln(Employment Immigrants) | Ln(Offshore employment) | Ln(Offshore employment) | Ln(Offshore employment) | Ln(Employment Immigrants) |
| Imputed sector-specific Share of immigrants | | | 15.1** (5.7) | -1.6 (7.4) | 3.39 (711) | | 14.01** (5.5) |
| Sector-specific tariffs | | | 0.01 (0.006) | -0.04** (0.008) | -0.03** (0.01) | -0.04** (0.008) | |
| F-test | | | 4.79 | 7.43 | 2.37 | 14.72 | 6.11 |

Note: The dependent variable in each regression is specified at the top of the relative columns. The units of observations are industry by year. All regressions include industry and year effects. Heteroskedasticity-robust standard errors, clustered at the sector level are reported. **, * significant at the 5, 10% level.

Table 4: Effects of Offshoring and Immigration on Total Employment: The Productivity Effect

| Dependent Variable: Ln(total employment) | | | | |
|---|------------------------------|-------------------------------|-----------------|-------------------|
| | | 2SLS | | Direct OLS |
| Specifications | (1) | (2) | (3) | (4) |
| Immigrant share of employment | | 3.90** (2.00) | | |
| Offshore share of employment | 1.72 (1.19) | | | |
| Industry Fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Number of observations | 464 | 464 | 464 | 464 |
| First Stage: | Offshore share of employment | Immigrant share of employment | | |
| Imputed sector-specific Share of immigrants | | 1.90** (0.48) | | 7.53** (2.80) |
| Sector-specific tariffs | -0.06** (0.08) | | -0.12 (0.08) | |
| F-test | 52.7 | 16.32 | | |

Note: The dependent variable in each regression is the logarithm of total (native+immigrant+offshore) employment in the sector. The units of observations are industry by year. All regressions include industry and year effects. Heteroskedasticity-robust standard errors, clustered at the sector level are reported. **, * significant at the 5, 10% level.

Table 5: Effects of Offshoring and Immigration on the Skill Intensity of Native and Immigrant Tasks

| Specification: | Dependent Variable: | | | | | |
|--|--------------------------------------|---------------------------------------|--|--|--|---|
| | (1) Complexity Index, Natives | (2) Cognitive Index, Natives | (3) Communication Index, Natives | (4) Non-Manual Index, Natives | (5) Complexity Index, Foreign- Born | (6) Difference in Complexity Natives- Foreign born |
| OLS Estimates | | | | | | |
| Immigrant share of employment | 0.15 (0.19) | 0.15 (0.13) | 0.18 (0.15) | 0.07 (0.06) | | |
| Offshore share of employment | 0.33** (0.13) | 0.24** (0.08) | 0.27** (0.10) | 0.10* (0.05) | -0.06 (0.25) | 0.38* (0.21) |
| 2SLS Estimates | | | | | | |
| Immigrant share of employment | 0.04 (0.66) | 0.04 (0.43) | 0.12 (0.51) | 0.01 (0.22) | | |
| Offshore share of employment | 0.64** (0.30) | 0.38** (0.18) | 0.41** (0.20) | 0.26* (0.14) | -0.10 (0.55) | 0.75** (0.31) |
| First Stage | | | | | | |
| | Immigrants share of Employment | Offshore share of employment | | | Offshore share of employment | Offshore share of employment |
| Imputed sector-specific Share of immigrants | 2.12** (0.40) | -1.80** (0.80) | | | | |
| Sector-specific tariffs | 0.01* (0.005) | -0.06** (0.008) | | | -0.06** (0.08) | -0.06** (0.08) |
| F-stat | 13.45 | 28.7 | | | 52.7 | 52.7 |
| Number of observations | 464 | 464 | 464 | 464 | 464 | 464 |
| Industry Fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |

Note: The Upper part of the Table shows the coefficients from an OLS estimation, the lower part from a 2SLS estimation. The units of observations are industry by year. All regressions include industry and year effects. Standard errors are heteroskedasticity robust and clustered at the sector level. **, * = significant at the 5%, 10% level.

Table 6: Vertical versus Horizontal Offshoring

| Dependent Variable: Complexity of Native jobs | | | | | | |
|--|--|--|--|--|--|--|
| Specification: | (1) Industries with import/local sales>0.3 | (2) Industries with import/local sales>0.2 | (3) Industries with import/local sales>0.1 | (4) Industries with import/local sales<0.3 | (5) Industries with import/local sales<0.3 | (6) Industries with import/local sales<0.3 |
| 2SLS Estimates | | | | | | |
| Offshore share of employment | 1.10** (0.56) | 0.94* (0.50) | 0.96** (0.46) | 0.20 (0.25) | 0.22 (0.25) | 0.23 (0.25) |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of observations | 144 | 200 | 272 | 320 | 264 | 192 |
| Industry Fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| First Stage | | | | | | |
| | Offshore share of employment | Offshore share of employment | Offshore share of employment | Offshore share of employment | Offshore share of employment | Offshore share of employment |
| Imputed sector-specific Share of immigrants | -0.01** (0.004) | -0.008** (0.002) | -0.009** (0.002) | -0.0065** (0.001) | -0.0066** (0.001) | -0.007** (0.001) |
| Sector-specific tariffs | -2.43 (1.27) | -2.48 (1.27) | -2.41 (1.27) | -1.06 (0.93) | -1.34 (1.10) | -1.32 (1.10) |
| F-stat | 7.49 | 6.59 | 9.02 | 27.65 | 26.04 | 24.87 |

Note: The Upper part of the Table shows the coefficients from an OLS estimation, the lower part from a 2SLS estimation. All regressions include industry and year fixed effects. Standard errors are heteroskedasticity robust and clustered at the sector level. **, * = significant at the 5%, 10% level.

Table 7: Effects of Offshoring and Immigration on Native Wages, 2SLS Estimates

| Method of estimation: 2SLS | Dependent Variable: logarithm of native wage in the sector | | | | Dependent Variable: logarithm of Immigrant wage in the sector |
|--|--|--|--|--|--|
| Specifications | (1) Separately estimated, using both instruments per regression | (2) Separately estimated, using both instruments per regression | (3) Separately estimated using one instrument per regression | (4) Separately estimated using one instrument per regression | (5) |
| Immigrant share of employment | 0.82 (0.81) | | 0.82 (0.82) | | |
| Offshore share of employment | | 0.28 (0.47) | | 0.24 (0.43) | 0.02 (0.78) |
| Industry Fixed effects | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes |
| Number of observations | 464 | 464 | 464 | 464 | 464 |
| First Stage: | Immigrant share of employment | Offshore share of employment | Immigrant share of employment | Offshore share of employment | Immigrant share of employment |
| Imputed sector-specific Share of immigrants | 2.12** (0.40) | -1.80** (0.80) | 1.90** (0.48) | | 1.90** (0.48) |
| Sector-specific tariffs | 0.01* (0.005) | -0.06** (0.008) | | -0.06** (0.08) | |
| F-staistic | 13.45 | 28.7 | 16.32 | 52.7 | 16.32 |

Note: The dependent variable in each regression is specified at the top of the Table. The units of observations are industry by year. All regressions include industry and year effects. Heteroskedasticity-robust standard errors, clustered at the sector level are reported. **, * significant at the 5, 10% level.

Table 8: Employment Regressions for Geographically concentrated industries

| Dependent Variable: Ln(Native employment) | | | | |
|---|---------------------------|-----------------------------|----------------------------|-----------------------------|
| Specifications | Method of Estimation: OLS | | Method of Estimation: 2SLS | |
| | (1) Jointly Estimated | (2) Separately estimated | (3) Jointly Estimated | (4) Separately estimated |
| Ln(Employment Immigrants) | 0.28** (0.07) | 0.28** (0.07) | 0.50* (0.25) | 0.44* (0.24) |
| Ln(Offshore employment) | -0.01 (0.05) | 0.01 (0.04) | -0.12 (0.18) | -0.09 (0.12) |
| Industry Fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Number of observations | 200 | 200 | 200 | 200 |
| First Stage: | | | Ln(Employment Immigrants) | Ln(Offshore employment) |
| Imputed sector-specific Share of immigrants | | | 14.10** (5.44) | |
| Sector-specific tariffs | | | | -0.044** (0.008) |
| F-test | | | 6.70 | 22.08 |

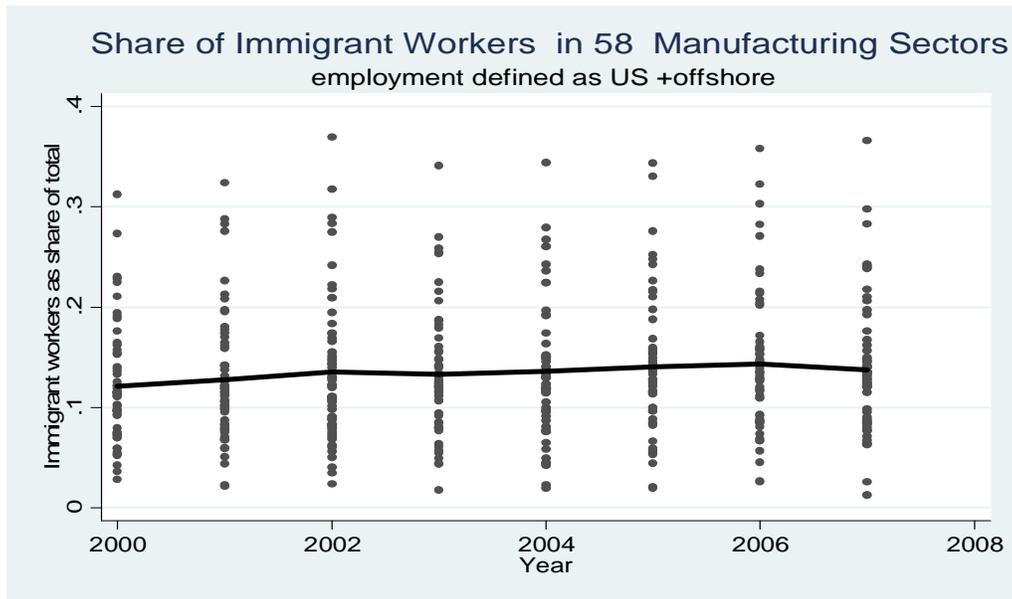
Note: The dependent variable in each regression is the logarithm of native employment. We only include the manufacturing sectors with gini coefficient of geographic concentration across states larger than 0.75 which is the average for the Gini in the manufacturing. Heteroskedasticity-robust standard errors, clustered at the sector level are reported. **, * significant at the 5, 10% level.

Tables and Figures Appendix

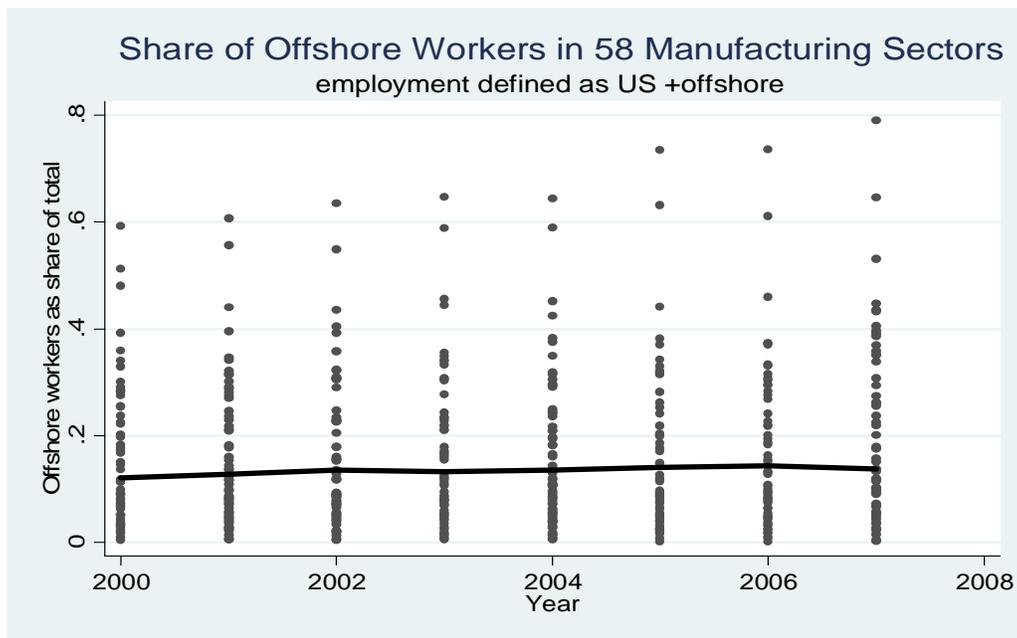
Table A1 – Industries and Code

| BEA Industry Code | Description | BEA Industry Code | Description | BEA Industry Code | Description |
|-------------------|---|-------------------|--|-------------------|--|
| 1 | Animal foods, Grain and oilseed milling | 28 | Paints, coatings, and adhesives | 54 | Metalworking machinery |
| 3 | Sugar and confectionery products | 30 | Plastics products | 55 | Engines, turbines, and power transmission equipment |
| 4 | Fruit and vegetable preserving and specialty foods | 31 | Rubber products | 57 | Computers and peripheral equipment |
| 5 | Dairy products | 32 | Clay products and refractory | 58 | Communications equipment, Audio and video equipment |
| 6 | Animal slaughtering and processing | 33 | Glass and glass products | 60 | Semiconductors and other electronic components, Magnetic and optical media |
| 7 | Seafood product preparation and packaging and Other food products | 34 | Cement and concrete products, Lime and gypsum products | 61 | Navigational, measuring, and other instruments |
| 8 | Bakeries and tortillas | 36 | Other nonmetallic mineral products | 64 | Electric lighting equipment, Electrical equipment, Other electrical equipment and components |
| 10 | Beverages | 37 | Iron and steel mills and ferroalloys, Steel products from purchased steel | 65 | Household appliances |
| 11 | Tobacco products | 39 | Alumina and aluminum production and processing | 68 | Motor vehicles, Motor vehicle parts |
| 12 | Apparel and Textile mills | 40 | Nonferrous metal (except aluminum) production and processing | 71 | Aerospace products and parts |
| 13 | Textile product mills | 41 | Foundries | 72 | Railroad rolling stock |
| 15 | Leather and allied products | 42 | Forging and stamping | 73 | Ship and boat building |
| 16 | Wood products | 43 | Cutlery and hand-tools | 74 | Other transportation equipment |
| 17 | Pulp, paper, and paperboard mills | 44 | Architectural and structural metals, Boilers, tanks, and shipping containers | 75 | Furniture and related products |
| 18 | Converted paper products | 46 | Hardware, Spring and wire products and Other fabricated metal products | 76 | Medical equipment and supplies |
| 19 | Printing and related support activities | 48 | Machine shops, turned products, and screws, nuts, and bolts | 77 | Other miscellaneous manufacturing |
| 23 | Basic chemicals and Other chemical products and preparations | 49 | Coating, engraving, heat treating, and allied activities | | |
| 24 | Resins and synthetic rubber, fibers, and filaments | 50 | Other fabricated metal products | | |
| 25 | Pharmaceuticals and medicines | 51 | Agriculture, construction, and mining machinery | | |
| 26 | Soap, cleaning compounds, and toilet preparations | 52 | Commercial and service industry machinery | | |
| 27 | Pesticides, fertilizers, and other agricultural chemicals | 53 | Ventilation, heating, air-conditioning, and commercial refrigeration equipment and Other general purpose machinery | | |

Figure A1 – Shares of immigrants and offshore workers in US manufacturing industries (2000-2007)



(a)



(b)

Figure A2 – Endogenous Determination of Native Wages

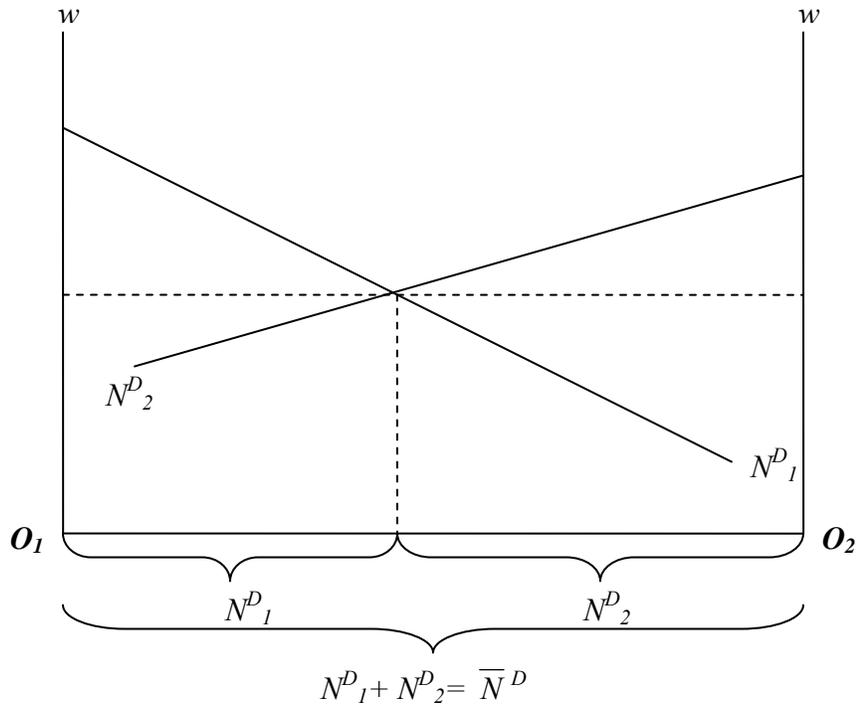
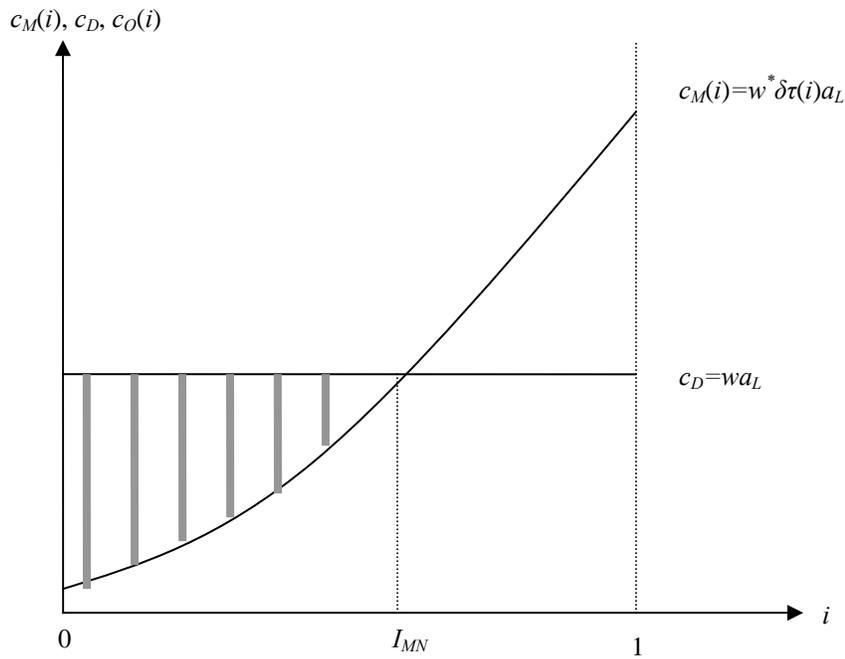


Figure A3 – Immigration, Discrimination and Rents



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