Offshoring and Immigrant Employment: Firm-level theory and evidence

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Abstract: In an Italian dataset with firm-level information on the share of foreign production in total sales and that of immigrant workers in domestic employment, we document a negative and significant relationship between those two variables across firms within each province and industry. We propose and solve a simple model where firms may relocate abroad only productions stages that in domestic plants would be disproportionately performed by immigrant workers. In the model, such offshoring is profitable only if variable cost savings more than offset the fixed cost of delocation. In the data, instrumental variable regressions indicate that firm-specific productivity and managerial structure indicators are important determinants of firm-level propensities to offshore and, through that channel, of the size and composition of domestic employment.

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1. Introduction

Offshoring of production to low-wage countries is often blamed for job destruction and immigrant inflows also appear to threaten the employment opportunities of unskilled workers in rich countries. The causes of these phenomena and the policy reactions motivated by employment and wage concerns are tightly related (as discussed in e.g. Jones, 2005). Liberalization of trade in goods triggers relocation of production from advanced to less developed countries if foreign labor costs are low. But the extent to which foreign wages fall short of domestic ones also affects migration incentives, and reflects obstacles to migration flows. Immigration may or may not affects domestic wages and employment (as discussed in Borjas 2003, Ottaviano and Peri 2005 and 2006, Peri and Sparber 2007), and may through that and other channels influence the attractiveness of offshoring options and the viability of manufacturing production in developed countries.

This paper takes empirical and theoretical steps towards a better understanding of firm-level links within this intricate set of interactions. A survey of Italian manufacturing firms offers valuable information on the incidence of production offshoring and the share of foreign born workers in domestic plants. The descriptive statistics we examine in Section 2 indicate that only some firms offshore production, that these firms are larger and more efficient, and that they employ a smaller share of blue-collar workers (and relatively more foreign-born workers). In Section 3 we characterize theoretically the relationship between these variables in a model of firm-level decisions to offshore portions of the production process. We suppose that offshoring production entails a fixed cost, and is therefore optimal only for highly productive (hence larger) firms; that only a subset of a firm's variable production activities are candidates for offshoring; and that these activities employ differently skilled workers. Section 4 confronts with the data the model's predictions regarding the roles of heterogeneity across firms of marginal costs and fixed offshoring costs in selecting firms that do and do not offshore within a local labor market, and of labor skill differences across different production activities and across domestic and immigrant workers in explaining why the two groups of firms employ different shares of foreign-born workers. Controlling for provincial location and industry, regression evidence indicates that indicators of firm-level productivity and managerial structure are significantly and sensibly related to offshoring decisions, and have statistically and economically significant effects on firms' propensity to employ immigrant workers. Section 5 concludes discussing the results' implications for broader issues and further research.

1.2. Related literature

Much has been written on the impact of offshoring and other forms of internationalization on the relative demand for skills. In a representative-firm Hecksher-Ohlin framework, Feenstra and Hanson (1996) show that fragmentation leads to an increase in the relative demand for skills and in wage differentials in the North. Many empirical studies have tried to estimate these effects on data where the wage gap between skilled and unskilled workers in advanced countries grows in parallel with flows of imports of manufactured products from developing countries. This literature generally measures offshoring either on the basis of input-output tables or of trade data (by looking at intraindustry trade) or by combining the two. Some consider the aggregate of all imported inputs; others distinguish between inputs originating from developing countries and from industrialized countries. Usually, a translog cost function specification is estimated, adding measures of offshoring and of technical change or R&D investment to control for the effect of skilled biased technical change on the skilled-labor cost share. Feenstra and Hanson (1996a, 1996b and 1999) and many follow-up studies on US data find evidence of a role for offshoring that is sizable, if not as important as that of technical change, in determining increases in the wage share of skilled workers.[1]

We build on a recent highly influential strand of literature, reviewed in Helpman (2006), which studies the role of heterogeneous firm-level competitiveness in shaping international activities. Melitz (2003) and Helpman, Melitz, and Yeaple (2004) focus on the choice of the output market (home vs. foreign) and of how to serve it (exports vs. FDI); Antras and Helpman (2004) on the choice of where to source inputs (inshoring vs. offshoring) and how (insourcing vs. outsourcing); Grossman, Helpman and Szeidl (2006) explore the joint choice of both

[1] Slaughter (2000) is also on the US; Ekholm and Hakkala (2005) on Sweden; Egger and Egger (2003) on Austria; Anderton and Brenton (1998) and Hijen, Gorg and Hine (2005) on the UK; Helg and Tajoli (2005), on Italy and Germany; Falk and Koebel (2002) also on Germany and Strauss-Khan (2003) on France. Amiti and Wei (2005a,b) on the US and the UK look at the effects on total labor demand and productivity of service offshoring; Egger and Egger (2006) examine the effects on the productivity of low skill workers.

internationalization patterns. In the equilibrium of these and other models, only the more productive firms find it optimal to engage in international activities entailing a fixed cost.[2] Our main focus is on the choice to offshore part of the production process to a foreign country. We model the choice in terms of a tradeoff between lower production costs in the foreign location and the cost of coordinating fragmented production (see Jones and Kierzkovski, 1990; Jones, 2005 for discussions of the structure of such costs).

We disregard organizational choices and assume a single integrated output market, in order to focus on the impact of offshoring on the level and skill composition of employment in domestic plants.[3] Yeaple (2005) similarly aims at characterizing the interaction between international activities and domestic employment, in the presence of firm and/or worker heterogeneity. We focus on imperfect substitutability across different types of labor, however, while Yeaple models worker heterogeneity in terms of efficiency units and shows that firms engaged in international activities endogenously employ more sophisticated technologies and more productive workers.

Our empirical analysis focuses on relationships between offshoring and labor demand at the firm level, rather than at the industry level. Few earlier papers exploit firm or plant specific evidence and, to the best of our knowledge, none specifically relates a broad measure of offshoring to the structure of the work force. Gorg and Hanley (2004) examine the effect on total labor demand for a sample of Irish plants by estimating a dynamic employment equation where offshoring (measured by imported intermediates) is introduced as a demand shifter. They find that offshoring has a negative effect on short term plant-level labor demand. Head and Ries (2002) and Hansson (2005) consider more directly the effects on the skill composition of the labor force, for Japan and Sweden respectively. These studies are based on the activities of multinational firms, and find that the skill intensity of home activities increases with the share of foreign activities carried out in labor intensive countries.

[2] In other models heterogeneity in the access into the export market is not driven by fixed costs. Bernard, Eaton Jensen and Kortum (2002) obtain heterogeneity in the decision to export by assuming a model of Bertrand competition and Melitz and Ottaviano (2005) by using linear demand systems across a continuum of varieties.

[3] Other theoretical contributions analyze the link between offshoring and the demand for skills in representative-firm settings. See Jones and Kierzkowsky (1990) and Jones (2005). Egger and Egger (2003) also examine whether the effect is different under a competitive or a unionized labour market for unskilled workers. Markusen (2006) also studies how standard theories of international trade and FDI can explain the effects of the off-shoring of high skilled services.

As regards the link between offshoring and employment of migrant workers, the relevant literature has mostly focused on whether migrant flows and FDI are substitute or complements for a given location (country, province, region etc.) or pair of locations: firm-level evidence is not abundant, but Murat and Paba (2004) document that offshoring is less prevalent (and immigrant employment more prevalent) at small firms in Italy. If the share of unskilled workers is larger among immigrants than among natives, as is realistic in Italy and in other advanced countries, the possibility to employ foreigners locally affects the costs and benefits of offshoring low-skill activities.

2. Data and descriptive statistics

We analyze the Capitalia-Unicredit survey of 4289 Italian manufacturing firms, carried out in 2004 with current and retrospective yearly information for 2001-2003.[4] Like the earlier waves of a long-running series of similar surveys, the dataset includes all Italian firms with more than 500 employees as well as a representative sample of smaller firms, stratified on geographical area, industry, and size. Besides standard firm specific variables, including balance sheet entries, the data also report detailed information on international activities. As regards the relationship between internationalization and firm characteristics, the data appear to conform to similar datasets from other countries. Benfratello and Razzolini (2007), for example, find that larger and more productive firms are more likely to export some of their production and to produce abroad in order to serve foreign markets. Crucially for our purposes, the survey features additional detail as to the size and purpose of each firm's foreign operations, including information as to whether foreign operations are meant to supply intermediate parts, and data on the composition of domestic employment include the percentage of foreign workers.

Table 1 reports descriptive statistics for the main variables used in the empirical analysis. The distributions of sales, valued added, and employment is heavily skewed, and the ratios of sales and value added to total employment are very heterogeneous across firms. Skill levels are

[4] In the empirical analysis we excluded form the sample firms with incomplete information or with extreme observations for the variables of interest. The Data Appendix outlines the sample selection procedure in detail.

poorly measured in the data, which only distinguish blue and white collar workers, but what evidence is available also indicates high heterogeneity across firms: the interquartile range of blue-collar employees as a ratio of total employment is in the order of 20 percentage points.[5] Finally, and very importantly for our purposes, we see, still in Table 1, that foreign workers are a rather small fraction of total employment (3.8% on average) and of total blue-collar employment (5.7% on average) but are highly dispersed across firms. While more than 50% of surveyed firms report no foreign employees, we see that 25% of the observations report at least 4.3% foreign employment (and 10% of the firms report a share higher than 10 percent).

We will be interested in exploring the relationship of these dimensions of heterogeneity to each other, and to firm-specific indicators of activity offshoring and labor force composition. Roughly 7.5% of the firms report that some of the production included in sales occurs in other countries; among these, 38% state that offshored production accounts for less than 10% of sales, 43% that it accounts for between 10 and 50%, and 19% that it accounts for over half of sales. The distribution of the proportion of sales produced abroad is very similar to that of immigrant employment share and both have sizeable mass at zero. There is little theoretical reason to use a discrete specification for immigrant employment. Conversely, offshoring of production is an intrinsically discrete choice, and the fact that discreteness is only partially found in the data may reflect within-firm aggregation of task-specific offshoring decisions.

Not all offshoring is alike. Using input-output information, Daveri and Jona-Lasinio (2007) detect sizable differences in the association with productivity of offshoring of intermediates rather than services. The survey we analyze elicits information as to the motivation and destination of international production activities. Among firms that do offshore some activities, 72% state that lower labor costs as one of the two main reasons for doing so, and another 35% cite the need to avoid being priced out of the output market; only 22% view offshoring as a way to reduce costs of foreign market penetration. Romania is the destination country for 31% of the offshoring firms, China is the next most frequent at 21.5%, and virtually

[5] Another survey question refers to the number of specialized (plant managers and technicians) blue-collar employees. These are rather often reported to be absent or to coincide with total blue-collar workers, which may spuriously reflect survey respondents' inability or unwillingness to provide more precise information. Indicators based on this variable proved uninformative when used alongside or in place of the standard white/blue collar distinction in regressions such as those reported below.

all countries mentioned in the survey as offshoring destinations are at much lower levels of development than Italy.

We define a dummy taking the value one when some offshoring activity is observed, and refer to such observations as 'offshoring firms.' Among such firms, we single out those that indicate both that the portion of their sales that is produced abroad includes intermediates (thus excluding those that offshore only production of finished products, and may be motivated by market proximity considerations rather than by production cost savings) and that some of their offshoring activities are re-imported. We refer to these as the 'restricted sample' of offshoring firms. As we shall see, these are slightly more different from non-offshoring firms in ways consistent with the modeling perspective we propose below.

Table 2 displays the main descriptive statistics separately for non-offshoring firms and for offshoring firms. On average, relative to other firms, offshoring firms are about three times larger in terms of sales and less than three times larger in terms of employment. Sales per employee are some 15% higher. This is to a large extent an obvious reflection of the fact that sales include production performed by the employees of foreign plants, on which we have no information. More interestingly, the value added per employee of offshoring firms is some 2% higher than that of non-offshoring firms, and the former employ a much smaller share of blue collar workers.[6] Offshoring firms also employ fewer extra-EU workers. All such differences are larger if the comparison focuses on a "restricted sample" of firms that offshore only a portion of their manufacturing process and therefore perform in their domestic plants at least some variable-cost production activities.

Availability of both immigrant employment and offshoring information offers a rare opportunity to assess empirically the relationship between the two phenomena. Our analysis will be focused on firm-level information. Market-level interactions will be controlled by provincial dummies, and technological heterogeneity by industry dummies. Residual heterogeneity in

[6] The skill composition of the domestic labor force of offshoring firms may well be a reason why offshoring of manufacturing activities is associated with higher overall labor productivity in general, but not when offshoring regards service activities (Daveri and Jona-Lasinio, 2007). Services are likely performed by high value-added white-collar workers within manufacturing firms. The measured productivity of (not quality adjusted) labor in domestic plants will tend to be higher when production tasks are offshored, lower when service activities are.

productivity and offshoring costs drives offshoring, and its consequences for employment, in the theoretical and empirical models of the next two sections.

3. Production offshoring by heterogeneous firms

The descriptive evidence of Table 2 is consistent with a data-generating mechanism that associates higher efficiency and stronger skill intensity to firm-level offshoring decision. In this section we formulate a model of firm-level decisions that delivers this implication on the basis of sensible assumptions. First, we show that sorting of highly productive firms into offshoring can be explained if the reorganization of production needed to take advantage of lower marginal costs in foreign locations entails fixed costs. Second, we show that different skill composition across the domestic activities of offshoring and non-offshoring firms is a natural consequence of heterogeneous skill requirements of activities that may or may not be relocated by firms that do choose to offshore some of their production. In the next section we will proceed to discuss how this may bear on the evidence, especially as regards employment of immigrant workers.

3.1 Firm–level heterogeneity and offshoring

As pointed out by Melitz (2003), a firm's intrinsic efficiency bears on its choice across production and sales modes with different fixed and marginal cost and benefits. In Melitz's original contribution, more efficient firms are better able to take advantage of market access, and more inclined to bear the fixed cost of equipping themselves to export. In this paper's context offshoring is more attractive for stronger firms if, at the same time as it makes it possible to tap into cheaper labor pool and decrease marginal costs, it entails higher fixed costs. Substantial fixed costs may in fact be entailed not only by foreign direct investment in wholly owned plants, but also by the negotiations and know-how required by arms-length outsourcing relationships. We disregard the distinction between "insourcing" or "outsourcing" arrangements for production relocation, but allow their costs to be heterogeneous across firms, reflecting organizational rather than technological features. This implies that, among heterogeneous firms within an industry, the more productive ones will select themselves into offshoring.

To focus on international factor cost differences as the driving force of the offshoring decisions we wish to characterize, we suppose that a firm's inverse demand function is

$p(y) = by^{-\frac{1}{\sigma}}$, where $\sigma > 1$ is the elasticity of demand, b is an index of demand strength, and y denotes the firm's total production independently of where its plants are located. The demand-strength parameter b differs across firms but, for a given firm, it is independent of the production process and location: thus, offshoring decisions are not based on product market considerations, such as foreign market penetration, because output is sold on an integrated world market or is transported back to the firm's specific national market.

Production costs (net of transport costs) may instead be affected by offshoring if factor prices or technologies are heterogeneous across locations. We suppose that marginal cost and average variable cost are independent of scale, for notational simplicity and to clarify the role of heterogeneous productivity and offshoring choices in the model.[7] The cost of producing an additional unit of output at firm i is denoted $k(o_i)/p_i$: it is smaller if the firm-specific productivity indicator p_i is larger, and also depends on whether firm i offshores part of its production activities (indicated by o_i=1) or performs all of it domestically (o_i=0).

To choose the location and level of production, a profit-maximizing firm with revenue function $yp(y) = ay^{1-\frac{1}{\sigma}}$ needs to take into account that marginal and fixed costs depend on whether production is wholly domestic or is partly offshored.[8] For each o_i, maximization of profits

$$\Pi(y_i, o_i) = b_i y_i^{1-\frac{1}{\sigma}} - [f(o_i, m_i) + \frac{k(o_i)}{p_i} y_i]$$

implies that price $a_i y_i^{-\frac{1}{\sigma}}$ equals marginal cost $c(o_i)/p_i$ times the mark up factor $\sigma/(\sigma-1)$, and output is

$$y_i^* = \left(\frac{\sigma}{\sigma-1}\frac{k(o_i)}{p_i b_i}\right)^{-\sigma} \tag{1}$$

[7] It would be straightforward to allow for non-constant returns to scale under constant elasticity, as the parameter indexing the elasticity of costs to scale would have the same implications as a larger demand elasticity.

[8] This functional specification represents monopolistically competitive firms producing differentiated goods, but can also be reinterpreted in terms of decreasing returns to production at the level of the firm.

To decide whether to offshore, the firm compares maximized profit levels

$$\Pi(y_i^*, o_i) = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \frac{1}{\sigma}(b_i)^{\sigma}(p_i)^{\sigma-1} c(o_i)^{1-\sigma} - f(o_i, m_i)$$

across the wholly domestic (o_i=0) and partly offshored (o_i=1) configurations of its production process, where the firm's fixed cost of production $f(o_i, m_i)$ depends on the offshoring vs. domestic production choice, as well as on other firm-specific factors indexed by m_i.[9]

Offshoring is optimal for a given firm if the unit cost difference implies a large enough operating profit difference to cover the fixed cost difference, i.e. if

$$(b_i)^{\sigma}(p_i)^{\sigma-1}\left(k(1)^{1-\sigma} - k(0)^{1-\sigma}\right) > \sigma^{\sigma}(\sigma-1)^{1-\sigma}(f(1,m_i) - f(0,m_i))$$

where $a_i \equiv (b_i)^{\sigma}(p_i)^{\sigma-1}$ is a summary index of firm-specific demand and productivity conditions. This index captures heterogeneity due to firm-level characteristics that matter for variable costs, in the same way whether activities are offshored or not (which of course also matters for variable as well as fixed costs, as discussed next). We will discuss below whether, and to what extent, such heterogeneity can be observably recovered by total-factor-productivity.

Among firms with similar cost structures but heterogeneous competitiveness, only those whose a_i index is sufficiently large as to let additional profits from lower marginal cost cover the fixed cost difference offshore. The critical level,

$$\underline{a} = \exp\left[\left[\ln\left(\sigma^{\sigma}(\sigma-1)^{1-\sigma}(f(1,m_i) - f(0,m_i))\right) - \ln\left((k(1))^{1-\sigma} - k(0)^{1-\sigma}\right)\right] / \sigma\right], \tag{2}$$

depends intuitively on offshoring's impact on variable as well as fixed costs. Variable costs differ across firms according to the productivity indicator p_i, and also according to whether production takes place abroad.

To model the relationship between the firm's offshoring choices and costs we suppose that production involves two distinct stages, dubbed 'components' and 'assembly' in what follows. While production of a unit of final output requires components and assembly activities in fixed proportions, each of the two stages of production may use different types of labor in flexible proportions. For illustration purposes, suppose two types of labor may be used in production, dubbed S and U (these indices may be read to mean "skilled" and "unskilled" but, as

[9] If demand and productivity are so weak as to imply negative profits for both offshoring choices, then the firm should shut down.

discussed below, need not correspond directly to observable characteristics of individual workers). And consider a Cobb-Douglas functional specification and let x units of S labor and z units of U labor produce the components of $Gx^{\gamma}z^{1-\gamma}$ units of output.

If a unit of skilled labor costs s and a unit of unskilled labor costs u, a cost-minimizing firm uses $x_{\gamma} = \frac{1}{G}\left(\frac{1-\gamma}{\gamma}\frac{s}{u}\right)^{\gamma-1}$ skilled workers and $z_{\gamma} = \frac{1}{G}\left(\frac{1-\gamma}{\gamma}\frac{s}{u}\right)^{\gamma}$ unskilled workers to produce the components of a unit of output, at total cost

$$\frac{1}{G}\left(\frac{1-\gamma}{\gamma}\frac{s}{u}\right)^{\gamma-1}s + \frac{1}{G}\left(\frac{1-\gamma}{\gamma}\frac{s}{u}\right)^{\gamma}u = \left(\frac{1}{\widetilde{G}}\right)(s)^{\gamma}(u)^{1-\gamma}, \text{ where } \left(\frac{1}{\widetilde{G}}\right) \equiv \left(\frac{1}{G}(1-\gamma)^{\gamma-1}\gamma^{-\gamma}\right). \qquad (3)$$

We similarly suppose that the production function $Ax^{\alpha}z^{1-\alpha}$ implies employment of $x_{\alpha} = \frac{1}{A}\left(\frac{1-\alpha}{\alpha}\frac{s}{u}\right)^{\alpha-1}$ skilled workers and $z_{\alpha} = \frac{1}{A}\left(\frac{1-\alpha}{\alpha}\frac{s}{u}\right)^{\alpha}$ unskilled workers to assemble a unit of output. The marginal cost of assembly activities is therefore given, as a function of wages, by an expression similar to that of equation (3), in terms of A and α rather than G and γ.

The S and U types of labor in this simple model may in the data correspond to different observable skill levels, or to different national origins. In general, the skills of migrants differ from the skills of local workers along more detailed dimensions than that of the rough indicators (white and blue collars) available in standard data. Indeed, recent works on the US show that even among low skilled workers, specific tasks require different sets of skills and that immigrant workers tend to specialize in manual tasks rather than in interactive and language intensive ones (Peri and Sparber, 2007). Empirically, offshoring is related to employment of immigrants, over and beyond the variation accounted for by firm-level employment blue vs white employment shares.

For the purpose of analyzing and interpreting the evidence introduced above, the essential modeling ingredient is a role for immigrant employment in determining how offshoring affects variable costs. The model suggests that offshoring is related to immigrant employment in that the U workers who are not employed domestically when some production are relocated are more likely than others workers to be immigrant. The mix of skills across the pools of migrant and domestic workers is different in ways that are not captured by available rough measures of the skill composition of the work force. Recalling that other firm-specific characteristics, denoted m, are allowed to influence the impact of offshoring on fixed costs, our empirical work will also need to identify empirical variables that influence the largely organizational costs of offshoring, but do not matter for the aspects that bring immigrant employment into play.

3.2 Observable implications

Some of the model's empirical implications are obvious, and consistent by construction with the descriptive evidence that motivates our analysis. Other aspects, especially those pertaining to the interplay of employment composition and offshoring, are more interesting. They deserve to be illustrated in some detail, and assessed econometrically below.

At a given firm, the effect of offshoring on domestic employment is ambiguous. Relocation of "assembly" lowers the local labor input requirement of each unit of final output, but also decreases the marginal cost of production and increases the output level in equation (1): thus, employment may well increase in the "components" activity that remains domestic. The overall size of domestic employment is increased by a scale effect, similar to that induced by productivity-enhancing fragmentation in Grossman and Rossi-Hansberg (2006), and decreased by a substitution effect.

Figure 1 illustrates firm-level relationships between 'competitiveness', employment, and offshoring. The plots report (as dashed and dotted lines) theoretical relationships conditional on whether production is offshored or not. The circles refer to a sample of firms drawn from a lognormal distribution of competitiveness a (measured on the horizontal axis of panels A and C in the figure; to improve legibility, a small amount of unrelated noise is added to the variables implied by each draw of a). The firms that offshore production are those whose a draw is larger than the threshold defined in equation (2). Since offshoring entails a fixed cost and the parameters satisfy condition (4), offshoring firms have lower marginal costs and, as shown in panel A of Figure 1, are unambiguously larger in terms of production and sales: the selection into offshoring of exogenously more competitive firms reinforces the positive association between offshoring and production levels induced by the lower marginal cost of offshored production.

Panel C illustrates the implications of offshoring outcomes for firms' domestic employment levels. Since the lower marginal cost of an offshoring firm increases production at the same time as it decreases its domestic labor requirements, offshoring is in general ambiguously related to domestic employment. For the parameters used in plotting the Figure, we see in panel C that at a given level of exogenous competitiveness a offshoring reduces the size of firms in terms of employment: it increases their size in terms of sales in panel A, but not by enough to offset the lower domestic labor requirement of offshored production. But even after the parameters have pinned down a negative impact of offshoring for a given firm's size, the model yields an interestingly ambiguous cross-sectional association between employment levels and the actual, endogenous offshoring choices of heterogeneous firms. Since more competitive (and likely larger) firms selected into offshoring by fixed costs, in panel C the more competitive non-offshoring firms are larger in terms of employment than the least competitive offshoring firms.

As to the observable implications of firm heterogeneity and offshoring choices, we see in panel B of Figure 1 that offshoring firms are larger in terms of sales, but not necessarily in terms of domestic employment, and quite intuitively display higher sales/worker ratios. In reality as in the model, only some of the firms that operate in a given labor and product market offshore production. The model interprets these outcomes in terms of heterogeneous firm-level efficiency or 'competitiveness,' and predicts that firms that offshore a portion of their production activities should be larger in terms of output and sales but may or may not be larger in terms of local employment.

The model's implications for the *composition of employment* are unambiguous if, as is realistic, the "assembly" production activities that may be performed offshore use more intensely the U type of labor ($\alpha < \gamma$). Figure 2 illustrates the implications of our model for the relationship between offshoring, firm size, and employment composition. Its panel A again illustrates the basic mechanism whereby the structure of fixed cost and marginal costs implies that offshoring firms produce and sell more than non-offshoring ones (the implications of different fixed offshoring costs are similarly intuitive, and are not shown). The other three panels of Figure 2 illustrate the implications of the model's explicit treatment not only of the cost, but also of the structure of employment.

For the parameters used in plotting the figures, the 'assembly' activities candidates for offshoring are much more U-labor intensive than the 'components' activities that are always performed in the firm's domestic plant. Thus, in panel C the heterogeneous 'competitiveness' indicator a is related to U-type employment (indicated by circles) in very different ways across offshoring and non-offshoring firms: for given a offshoring implies much lower U employment, but it actually implies a *higher* level of S employment (indicated by crosses), because components production is sufficiently more S intensive than assembly that the offshoring-related increase of a firm's sales (in panel A) more than offset the loss of domestic S labor entailed by delocation of assembly.

Panels B and D of Figure 2 relate the level of sales (on their and panel A's vertical axis) to S and U employment levels, respectively. In panel D, the ratio of (higher) sales to (lower) U employment levels is much larger for offshoring firms. In panel C, the ratio of sales to units of S-type domestic labor is actually smaller when production is offshored, and is not very different across offshoring and non-offshoring firms: as both of these perform domestically the activities that employ most of their skilled workers, the relationship between sales and skilled employment is very similar regardless of whether less skill-intensive activities are performed domestically or abroad.[10]

4. Empirical evidence

The structure of our theoretical offshoring model is inspired by the descriptive statistics of Section 2, as well as by recent advances in modeling of related phenomena, and is therefore by construction compatible with some key empirical features. In the data, offshoring firms are larger, have larger sales/employment and value added/employment ratios, and employ a larger share of skilled workers in their domestic operations, especially when offshored production includes intermediate products to be re-imported and assembled, rather than finished products only. Discreteness of offshoring choices is explained in this and related models by the fixed character of cost differentials, which also rationalizes the size differentials across offshoring and non-offshoring firms in terms of the role of heterogeneous firm-level competitiveness in determining how easily marginal cost savings may offset the fixed cost of organizing foreign production.

In the model laid out in Section 3, offshoring of low-skill activities is motivated by cost savings rather than output market proximity. It may increase or decrease domestic employment, but certainly alters its skill intensity. In what follows, we assess the statistical significance of

[10] This paper's model focuses on marginal labor costs and disregards the labor content of fixed costs, which is likely to consist predominantly of native workers with characteristics more similar to those of S workers than to those of U workers employed in variable activities. The implications of offshoring for the composition of domestic 'headquarters' employment would be qualitatively similar to those we analyze explicitly.

these patterns, and attempt to provide more structural evidence of the model's fit, by specifying and estimating formal models that make it possible to control for observable heterogeneity across sectors and geographical location.

To characterize the relationship between offshoring and migration, we estimate a system of two equations. The first one relates the (endogenous) offshoring outcome to other observable firm-level characteristics, including some that are not expected to be directly relevant to employment skill composition. The second relates (instrumented) offshoring information to the structure of firms' employment.

4.1 Determinants of offshoring decisions

For our main purpose of detecting linkages between internationalization of production and domestic employment, we adopt the semi-structural approach of instrumenting the offshoring dummy with variables that plausibly drive offshoring but, for given offshoring, do not directly influence the composition of employment.

In reality sales, employment, and offshoring depend on many more firm characteristics than just intrinsic efficiency. While the theoretical illustrations in Figures 1 and 2 kept those constant across firms, they are likely to vary across sectors and local labor markets in the data. To some extent this heterogeneity may be controlled by industry and geographical dummies. Moreover, it is possible to use the survey's information to try and control for additional dimensions heterogeneity that may select firms into the offshoring mode of operation.

In the theoretical model, a chief determinant of a firm's decision to offshore is its intrinsic 'competitiveness', indexed by the firm-specific a_i variable in the model. Its relevance reflects the presence of offshoring fixed costs, which may in turn depend on firm-specific organizational features. As Figures 1 and 2 make clear, this variable jointly determines the volume of sales, the size and composition of employment, and offshoring decisions. In practice, 'competitiveness' is not directly observable. In principle it could be estimated by standard production function methods. These are particularly problematic if, as our theoretical perspective makes clear, the factor intensity of production in domestic plants is naturally different across offshoring and non-offshoring firms. To account for endogenous production function heterogeneity across offshoring and non-offshoring firms, observable variables relevant to that choice could be used to endogenize selection of firms into different technologies, and improve estimation of production function parameters and TFP residuals. Estimating structural production functions would remain problematic on cross-sectional data, however, since simultaneity and unobserved heterogeneity would still be worrisome sources of bias for the resulting productivity indicators. In light of these problems, we choose to report results based on an admittedly simple minded approach to TFP estimation, controlling only for capital intensity on all data pooled in cross-section. We compute an empirical counterpart to the theoretical factors captured by the model's a index as the residual from the cross-sectional estimation of a two-factor Cobb-Douglas augmented with province and (2-digit NACE) industry dummies, to control for production-function and wage-driven relationships between firms' production and sales.

At the firm level, for given competitiveness and given market conditions, the choice between offshored and domestic immigrant-intensive production may also be driven by heterogeneity of the fixed costs of offshoring (as indexed by m_i in the model of Section 3). Some of the relevant variation may be observable, at least in principle: firms located near airports, or firms whose managers' previous career includes overseas postings, might well find it easier to set up and control offshore production facilities. These and other organizational features, however, can hardly be viewed as completely exogenous, since a firm that finds the offshoring option attractive for unobservable reasons might well choose its location or managers so as to make that convenient. Moreover, our data do not include location information beyond the provincial dummies that we include in our specifications to control for a myriad of phenomena, nor do the data offer information about the previous career or linguistic skills of managers. The data do include survey questions meant to single out family firms: we know whether members of the owner's family are senior managers, and whether firms employ managers who are not members of the family. This information can arguably provide instruments for the purpose of detecting the implications of offshoring decisions. It is hard to see how exploiting international production opportunities could have causal effects on the aspects of manager selection that reflect family histories and demographic developments (in our data, non-family managers are significantly and increasingly likely to be employed by older firms). But the presence of family and non-family managers arguably can affect a firm's propensity to offshore production, because less diversified family owners may well be more reluctant to risk and innovate than the managers of public firms,[11] and will affect offshoring costs if external managers are more likely than the entrepreneurs' offspring to have relevant skills. The substantive implications are similar whether family matters for the differential impact of offshoring on variable or fixed costs.

Like all instrumental variables, the ones we propose may fail to be appropriate. Specifically, IV regressions may detect relationships that are spuriously driven by technological differences across firms within an industry, rather than by the impact of firm productivity and management on their propensity to offshore. For example, family firms may be less innovative, hence employ lower-skill (and more likely immigrant) workers when not offshoring. Indeed family firms in our sample are found to have lower productivity levels and a lower propensity to innovate. Attitudes towards immigrants as such (rather than towards offshoring as a cost-saving strategy) may also differ systematically across family-managed and other firms. As discussed below, we will seek support for our results' robustness in the comparison of results obtained from specifications that are arguably more or less strongly affected by spurious unobservable heterogeneity: comfortingly, the results are very similar when either instrument set is used, when immigrant employment is measured as a share of total or blue-collar employment, and when technologically advanced sectors are included in or excluded from the sample.

Formally, let the offshoring $OS_i = 1$ outcome be observed if a latent variable $OS_i^* \geq 0$, while $OS_i = 0$ otherwise. We consider specifications for the latent variable in the form

$$OS_i^* \quad = \quad \alpha g(X_i) + \varepsilon_i \ , \tag{4}$$

where $g(X_i)$ is a suitable function of a set of firm-level variables.

The first and third columns of Table 3 report the results of the estimation of reduced form probit models for offshoring outcomes that specify $g(Y_i)$ as a linear function of the TFP proxy for productivity. These regressions indicate that offshoring is rather tightly related to productivity proxies in our data. The other two columns of Table 3 specify $g(X_i)$ as a linear function of the arguably relevant determinants of offshoring decisions introduced above, namely the presence of family members and of others in the firms' top management. The explanatory power of these organizational indicators is also very high: the significantly negative coefficient of the FF dummy indicates that the presence of a family member reduces the management's

[11] Tucci, Barba Navaretti and Faini (2006) discuss how risk aversion in family firms may increase the perceived cost of carrying out risky foreign operations.

propensity to offshore production, while the presence of external managers has the opposite effect. The two indicators are imperfectly correlated in our data: about a fifth of firms report employment of a single manager (and about one out of eight reports zero managers), but while the number and the share of external managers is positively related to the size of the firm, firms of all sizes may or may not employ non-family managers: among the firms that employ a single manager, for example, about a fifth report that the person is not a member of the owner's family (or the owner herself).

4.2 Offshoring and immigrant employment

This evidence reported in the previous subsection is consistent with our theoretical model's focus on offshoring decisions driven by firm-level competitiveness and/or by determinants of offshoring costs. In the model, offshoring in turn affects the skill composition of employment, in that the activities which remain in the domestic country have higher skill requirements than those that may be performed abroad.

To assess the extent to which offshoring and the resulting skill intensity of domestic activities account for the national origin of each firm's employees, we estimate regressions relating the share of migrant workers on total workers to off-shoring. To assess the realism of this implication we run regression in the form

$$\left(\frac{L_j}{L}\right)_i = \beta OS_i + v_i \qquad \textbf{(5)}$$

where the dependent variable is the ratio of foreign employees to total or blue collar employment in the domestic operations of surveyed firms. On the right hand side, the coefficient β measures the relevance of offshoring in those respects.

If a single exogenous 'competitiveness' characteristic determined all aspects of firm heterogeneity, the offshoring indicator OS_i would be uniquely determined by firm-level efficiency. As mentioned, however, more than one dimension of relevant heterogeneity determines offshoring and employment in reality. The parameter of interest β can be estimated consistently by OLS only if the unobservable determinants relegated to the error terms of (4) and (5) are not correlated, $E(\varepsilon_i v_i) = 0$. This however rules out the plausible possibility that unobserved firm characteristics may jointly affect the skill structure and nationality of the workforce and management's inclination to offshore. If, for example, entrepreneurs who discriminate against immigrant workers also like to internationalize their activities, then $E(\varepsilon_i v_i) < 0$ and the OLS estimates of β will be biased downwards. More generally, the bias will depend on the correlation between the unobservables in (4) and (5).

To try and disentangle structural mechanisms from such spurious relationships, we estimate (5) by instrumental variables (IV), using the predicted propensity to offshore OS_i^* from the reduced-form relationship (4) to instrument the observed offshoring outcome.[12] Table 4 reports the results of OLS and IV regressions of the share of immigrants on total workers on observed offshoring (OLS) and on instrumented offshoring (IV), using province and two-digit industry dummies to control for the effects of technological differences in the skill intensity of production activities and of locally determined wages.[13]

As predicted by the model the estimated coefficient of the offshoring prediction is negative in all specifications, and the effect is stronger when estimated on the 'restricted' sample of firms that we expect to conform more closely to our theoretical perspective. The coefficients are larger in absolute value when estimated by IV. This may reflect attenuation bias, or it may indicate that the unobservable (and unrelated to TFP and organizational instruments) component of what determines decisions to offshoring choices is positively related, at the firm level, to the unpredictable inclination to hire immigrants: entrepreneurs who for some reason prefer to outsource their activities abroad also, for unexplained reasons, prefer to hire foreign workers. As mentioned above, neither estimated TFP productivity and family-management indicators are beyond suspicion in the role of instrumental variables. Since all IV models are exactly identified, we do not offer evidence on the validity of the assumed orthogonality conditions. Since the instruments may be problematic for different reasons, however, it is therefore comforting to find that IV results are broadly similar when either set is used. Standard errors are smaller when our binary proxies for "family firm" are used as regressors in the reduced form for offshoring. Also,

[12] While the data do not deny the relevance of our productivity-based explanation to individual firms' offshoring decisions, it is of course impossible to rule out uncontrolled endogeneity bias. Egger and Egger (2003) use a formally similar approach to industry-level data, and model heterogeneity in terms of offshoring costs and incentives proxied by variables excluded from the determinants of employment's skill intensity.

[13] We report results of linear regressions. Specifications that account for the limited range of the dependent variable yield essentially identical results.

these instruments are stronger, as documented by the weak instrument test statistics reported in the table.

In Table 5 and 6 we perform two important robustness checks. In particular, Table 5 summarizes the regression results obtained by restricting the sample only to those firms which operate in low-tech industries. This is important to control for the possibility that some of our findings may be spuriously driven by the fact that family firms are less likely to innovate within a given industry, and do not adopt new technologies that affect both the skill composition of the work force and offshoring costs. This element of the data generating process, which would invalidate use of family firm dummies as instruments, is likely to important (relatively to cost-saving-oriented decisions to produce abroad) in sectors with smaller opportunities for process innovation. Comfortingly, all our results are virtually unaltered if the sample is restricted to low.-tech industries: if anything, we even find a stronger, albeit less precisely estimated, negative relationship.

The negative coefficient estimates reported in Table 4 might reflect another omitted variable problem. The share of migrants on total workers might depend on additional firm technological characteristics that are not fully captured by the set of two digit industry dummies, for instance the share of blue-collar workers on total workers. This would bias not only the OLS estimates, since blue-collar worker intensity is likely to be correlated with both the share of migrants on total workers and the offshoring decision, but also bias the IV estimates if the share of blue-collar workers on total workers is not orthogonal to our set of instruments: the skill composition of a firm's labor force may well be empirically related to its productivity, and it is also possible (as just mentioned) that family firms are less inclined to adopt skill-intensive technologies. Under the reasonable, albeit untestable, assumption the all migrant workers in our sample are blue-collar, this problem can be circumvented using the share of migrants on total blue-collar workers as dependent variable. As shown in Table 6, all our previous findings are confirmed in this specification.[14]

[14] Alternatively we could include the blue collar workers to total workers ratio directly in the specifications reported in Table 4. Unreported regression results show that the inclusion of this additional variable does not alter any of our findings. This approach of course is not robust to the plausible endogeneity of skill intensity.

5 Concluding comments

This paper has explored the relationship between offshoring of production and employment of local, possibly immigrant workers. Aiming to characterize how firm-level mechanisms may induce positive or negative covariation between the two phenomena, we have focused on heterogeneous firms' profit-maximizing discrete choice of whether to offshore production. Our theoretical framework, inspired by recently developed modeling approaches, delivers intuitive implications for the amount and composition of domestic employment. In a large sample of Italian firms we estimate economically sizable and statistically significant relationships between offshoring decisions, which in turn bear on their propensity to employ foreign-born workers, and such firms' characteristics as indicators of productivity and of managerial structure: firms that are less productive and/or are managed by the owner family's members are less likely to offshore production, and more likely to demand immigrant labor.

These results are interesting in the context of more general issues facing manufacturing industries in Italy and other high-wage countries. In our theoretical framework, firms choose whether to outsource production to countries where labor is cheaper, or hire similar immigrant workers locally. Both choices preserve (to some extent) the country's manufacturing competitiveness. Immigration can provide a suitable local supply of labor, and fragmentation of production and relocation to cheap labor countries can give firms sufficient competitive leeway to maintain part of their local activities. The implications of offshoring for factor-income distribution and for efficiency are similar to those of other forms of economic integration driven by wage and factor endowment heterogeneity. Offshoring depresses domestic employment opportunities for some types of workers but, as suggested by Grossman and Rossi-Hansberg (2006), it can however foster overall employment creation through its productivity-enhancing effects. Allowing easier immigration can reduce incentives to offshore production to cheap labor countries, while immigration pressure can be increased by policy actions meant to reduce the incidence of offshoring. Less intuitively, policies that improve domestic firms' competitiveness can increase the incidence of offshoring, since a stronger market position makes it easier for firms to overcome fixed organizational costs and exploit foreign locations' lower marginal costs.

In order to flesh out these and other policy implications, further research should proceed to bring our theoretical and empirical results to bear on market-level evidence. Embedding our firm-level theoretical relationships in structural models of local labor markets, focusing in particular on a fuller analysis of relationships between the skill level and national origin of workers, will make it possible to assess how heterogeneity not only across firms, but also across provinces and sectors may bear on the extent to which immigration may bid down the wages of substitutable native workers with equivalent skills, and affect incentives to offshore production.

Data Appendix

Sample selection

The 2004 release of the Capitalia-Unicredit survey includes information on a sample of 4289 Italian manufacturing firms. All firms with more than 500 employees are included whereas firms with less than 500 employees are selected with a stratified sampling method. We removed from the sample firms with missing or non-manufacturing activity codes. Furthermore, we removed those with missing values on balance sheet data, on work force composition (question B1.1) and on offshoring activities (question D3.1). Finally, we also excluded firms with TFP below the 0.5 or above the 99.5 percentiles of the overall distribution. Our final sample is made up of 3281 observations. Table A.1 reports the distribution of firms by size-classes before and after our cleaning procedures.

Table A.1. Employment distribution before and after the cleaning, %

	Before	After
11-20	22.15	21.80
21-50	29.54	31.31
51-250	36.93	38.90
251-499	5.27	4.63
≥500	6.11	3.35

Variable Definitions

Offshoring Dummy (*OS*)**: i**n the questionnaire (question D3.1) each firm is asked to answer whether it currently performs a portion of its manufacturing activities in another country. Our dummy is set equal to 1 is the answer is yes and 0 otherwise.
Number of employees (L)**:** average number of employees (question B1.1.6) over the three year period.
Sales, value added, fixed capital (Q, Y, K)**:** three-year average of balance sheet entries.
Share of blue collar workers (L_B/L): ratio of blue collar employees (B1.1.5.1+B1.1.5.2) to total employment (B1.1.6).
Share of extra-EU workers (L_E/L)**:** ratio of extra-EU workers (B1.1.6.4) to total employment (B1.1.6).
Share of extra-EU workers on blue collar workers (L_E/ L_B)**:** ratio of extra-EU workers (B1.1.6.4) to blue collar employees (B1.1.5.1+B1.1.5.2).
Industry Dummies: these take the value 1 (zero otherwise) for firms whose main production activity is in each of 21 NACE two-digit industries (15+16 - food, beverages and tobacco; 17 - textiles; 18 - clothing; 19 - leather; 20 - wood; 21 - paper products; 22 - printing and publishing; 23 - oil refining; 24 - chemicals; 25 - rubber and plastics; 26 - non-metal minerals; 27 - metals; 28 - metal products; 29 - non-electric machinery; 30 - office equipment and computers; 31 - electric machinery; 32 - electronic material, measuring and communication tools, TV and radio; 33 - medical apparels and instruments; 34 - vehicles; 35 - other transportation; 36 - furniture).

HT Dummy: takes the value of 1 if the firm operates in a High-Tech industry and 0 otherwise. The following NACE two-digit industries are classified as HT: 24 - chemicals; 29 - non-electric machinery; 30 - office equipment and computers; 31 - electric machinery; 32 - electronic material, measuring and communication tools, TV and radio; 33 - medical apparels and instruments; 34 - vehicles; 35 - other transportation.
Provincial Dummies: these take the value 1 (zero otherwise) if the administrative headquarters of the firm is located in each of the 103 provinces of Italy in the 2001-03 period.
EM dummy: takes the value 1 if the firm has external senior managers (35.3% in the full sample), zero otherwise.
FF dummy: takes the value 1 if the owner or a member of her family has a senior management position in the firm (70.5% in the full sample), zero otherwise.

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Table 1: Descriptive Statistics, all firms

	Mean	Std.dev.	1stQ	Median	3rdQ
Sales (Q)	24.8	78.6	4.4	9.5	19.8
Value added (Y)	6.1	18.1	1.0	2.3	4.8
Employees (L)	106.5	258.5	23.0	46.6	96.0
Sales/Employees (Q/L)	0.244	0.225	0.125	0.185	0.289
Value added/Employees (Y/L)	0.052	0.026	0.036	0.047	0.061
Share of blue collar workers (L_B/L)	0.671	0.184	0.593	0.711	0.795
Share of extra-EU workers on total workers (L_E/L)	0.038	0.080	0.000	0.000	0.043
Share of extra-EU workers on blue collar workers (L_E/L_B)	0.057	0.119	0.000	0.000	0.065

Note: All statistics are computed for 2001-03 unweighted average data on the full sample of 3281 firms with the exclusion of (L_E/L_B) which is computed on 3232 firms since 49 firms declare not to employ blue collar workers. Sales, value added and their ratios are in million Euros.

Table 2: Descriptive Statistics, non-offshoring vs. offshoring firms

	Non-off. firms	Off. firms Full sample	Off. firms Restr. sample
Observations	3034	247	124
Sales (Q)	21.9	60.5	63.6
Value added (Y)	5.4	15.0	14.6
Employees (L)	94.1	258.4	269.7
Sales/Employees (Q/L)	0.241	0.279	0.319
Value added/Employees (Y/L)	0.052	0.053	0.055
Share of blue collar workers on total workers(L_B/L)	0.675	0.623	0.586
Share of extra-EU workers on total workers (L_E/L)	0.039	0.026	0.016
Share of extra-EU workers on blue collar workers (L_E/L_B)	0.058	0.039	0.026

Note: All statistics are computed for 2001-03 unweighted average data. Sales, value added and their ratios are in million Euros. The restricted sample of offshoring firms excludes firms that declare both to offshore only the production of finished products (question D3.2.1) and not to re-import the offshored production (question D3.2.5).

Table 3: Reduced form probit model for offshoring

Observations	Full sample	Full sample	Restr. sample	Restr. sample
Estimation method	Probit	Probit	Probit	Probit
Dependent variable	OS	OS	OS	OS
TFP	0.131(0.077)		0.179(0.093)	
Family Firm (FF) Dummy		- 0.146(0.082)		- 0.278(0.099)
External Manager (EM) Dummy		0.660(0.080)		0.593(0.098)
Industry dummies	[0.00]	[0.00]	[0.00]	[0.00]
Provincial dummies	[0.12]	[0.12]	[0.36]	[0.27]
Pseudo R^2	0.146	0.192	0.162	0.207
OS = 0 correct predictions	0.996	0.992	0.998	0.996
OS = 1 correct predictions	0.057	0.089	0.048	0.064

Note: Robust standard errors in round brackets. P-values of the null that each set of coefficients is equal to 0 in square brackets. The number of observations used is smaller than original sample sizes since offshoring is predicted perfectly by province dummy in all provinces where all firms have no offshoring activities. TFP is computed as the residual from the cross-sectional estimation of a two-factor Cobb-Douglas augmented with industry and provincial dummies.The FF dummy variable equals 1 if the owner or a member of her family has a senior management position in the firm (70.5% in the full sample) and zero otherwise. The EM dummy variable equals 1 if the firm has external senior managers (35.3% in the full sample) and zero otherwise.

Table 4: Models for the share of extra EU workers on total workers

Full sample			
Observations	3281	2759	2759
Estimation method	OLS	IV (TFP)	IV (FF and EM)
Offshoring (OS)	-0.014(0.004)	-0.080(0.050)	-0.106(0.026)
Industry dummies	[0.00]	[0.00]	[0.00]
Provincial dummies	[0.00]	[0.00]	[0.00]
Weak Identification Test Statistics		17.19	53.02
Restricted sample			
Observations	3158	2475	2475
Estimation method	OLS	IV (TFP)	IV (FF and EM)
Offshoring (OS)	-0.022(0.004)	-0.155(0.068)	-0.150(0.044)
Industry dummies	[0.00]	[0.00]	[0.00]
Provincial dummies	[0.00]	[0.00]	[0.00]
Weak Identification Test Statistics		7.26	19.95

Note: See Table 3. The prediction from the offshoring equations in Table 3 are used as instrument for the offshoring dummy in IV estimates. The reported weak identification test statistic is the Kleibergen-Paap (KP) statistic. This can be considered as the heteroskedasticity robust analog to the more standard Cragg-McDonald (CM) statistic. Critical values for the KP statistic have not been developed yet and the commonly accepted approach is to use with caution the critical values found in Stock and Yogo for the CM statistic (10% maximal IV size is 16.38, 15% is 8.96 and 20% is 6.66).

Table 5: Models for the share of extra EU workers on total workers

Full sample (low-tech industries only)			
Observations	2313	1895	1895
Estimation method	OLS	IV (TFP)	IV (FF and EM)
Offshoring (OS)	-0.020(0.005)	-0.081(0.049)	-0.143(0.039)
Industry dummies	[0.00]	[0.00]	[0.00]
Provincial dummies	[0.00]	[0.00]	[0.00]
Weak Identification Test Statistics		17.62	29.99
Restricted sample (low-tech industries only)			
Observations	2230	1684	1684
Estimation method	OLS	IV (TFP)	IV (FF and EM)
Offshoring (OS)	-0.028(0.005)	-0.149(0.067)	-0.209(0.075)
Industry dummies	[0.00]	[0.01]	[0.01]
Provincial dummies	[0.00]	[0.00]	[0.00]
Weak Identification Test Statistics		7.15	10.72

Note: See Table 3. Predictions from the offshoring equations in Table 3 are used as instrument for the offshoring dummy in IV estimates. The reported weak identification test statistic is the Kleibergen-Paap (KP) statistic. This can be considered as the heteroskedasticity robust analog to the more standard Cragg-McDonald (CM) statistic. Critical values for the KP statistic have not been developed yet and the commonly accepted approach is to use with caution the critical values found in Stock and Yogo for the CM statistic (10% maximal IV size is 16.38, 15% is 8.96 and 20% is 6.66).

Table 6: Models for the share of extra EU workers on blue collar workers

Full sample			
Observations	3232	2715	2715
Estimation method	OLS	IV (TFP)	IV (FF and EM)
Offshoring (OS)	-0.021(0.006)	-0.047(0.067)	-0.121(0.039)
Industry dummies	[0.00]	[0.00]	[0.00]
Provincial dummies	[0.00]	[0.00]	[0.00]
Weak Identification Test Statistics		16.46	51.60
Restricted sample			
Observations	3111	2434	2434
Estimation method	OLS	IV (TFP)	IV (FF and EM)
Offshoring (OS)	-0.030(0.006)	-0.144(0.082)	-0.185(0.065)
Industry dummies	[0.00]	[0.00]	[0.00]
Provincial dummies	[0.00]	[0.00]	[0.00]
Weak Identification Test Statistics		7.01	19.05

Note: See Table 3. Predictions from the offshoring equations in Table 3 are used as instrument for the offshoring dummy in IV estimates. The reported weak identification test statistic is the Kleibergen-Paap (KP) statistic. This can be considered as the heteroskedasticity robust analog to the more standard Cragg-McDonald (CM) statistic. Critical values for the KP statistic have not been developed yet and the commonly accepted approach is to use with caution the critical values found in Stock and Yogo for the CM statistic (10% maximal IV size is 16.38, 15% is 8.96 and 20% is 6.66).

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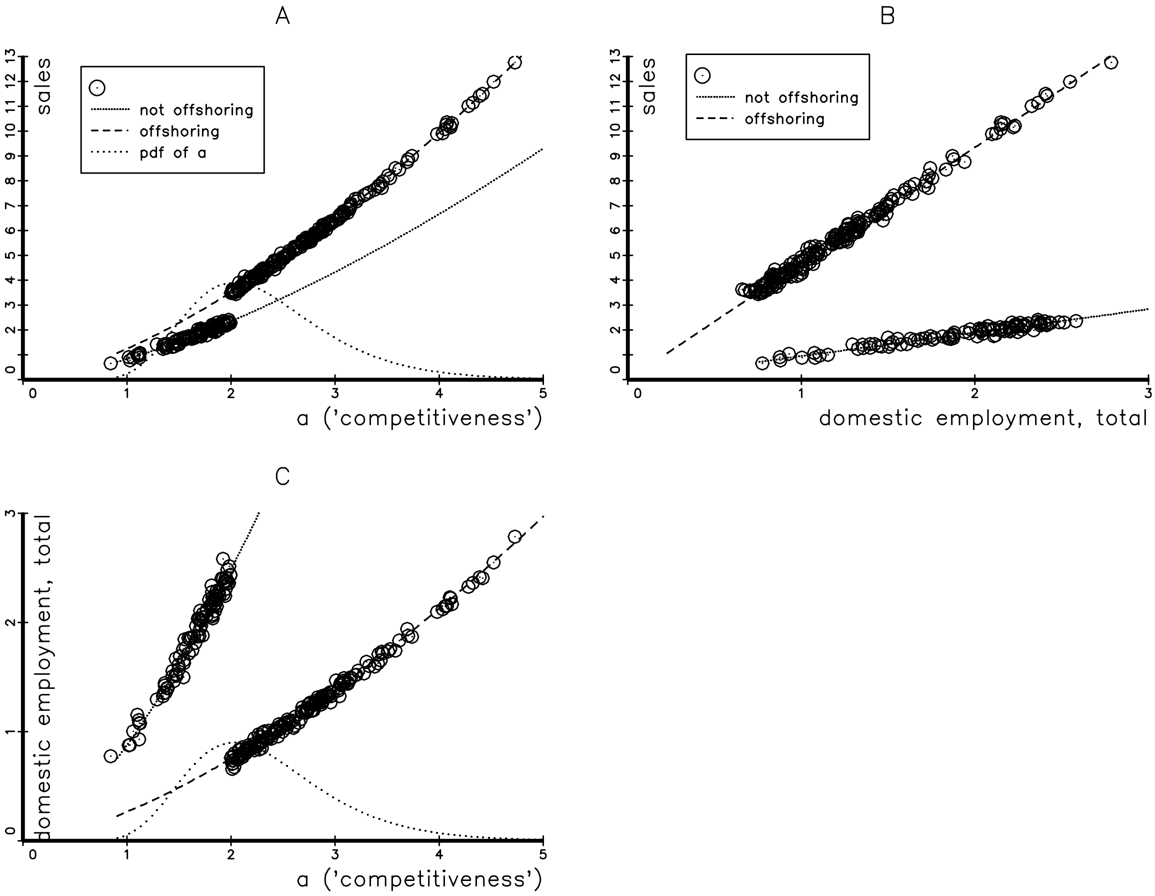

FIGURE 1: Illustration of the model's implications for the joint distribution across firms of exogenous strength (a), sales, domestic employment, and offshoring. The program that plots these figures use the following parameter set: α =0.1, γ =0.66, σ =1.5; G=10, A=1; $f(1)-f(0)=2$; w_{sd} =0.4 , w_{ud} =0.3 w_{sf} =0.5, w_{uf} .=0.1. The firm-level productivity indicators are a sample of 275 independent draws from a lognormal distribution with log mean 0.8 and log standard deviation 0.3, whose density is plotted in panels A and C (for illustrative purposes, not to scale).

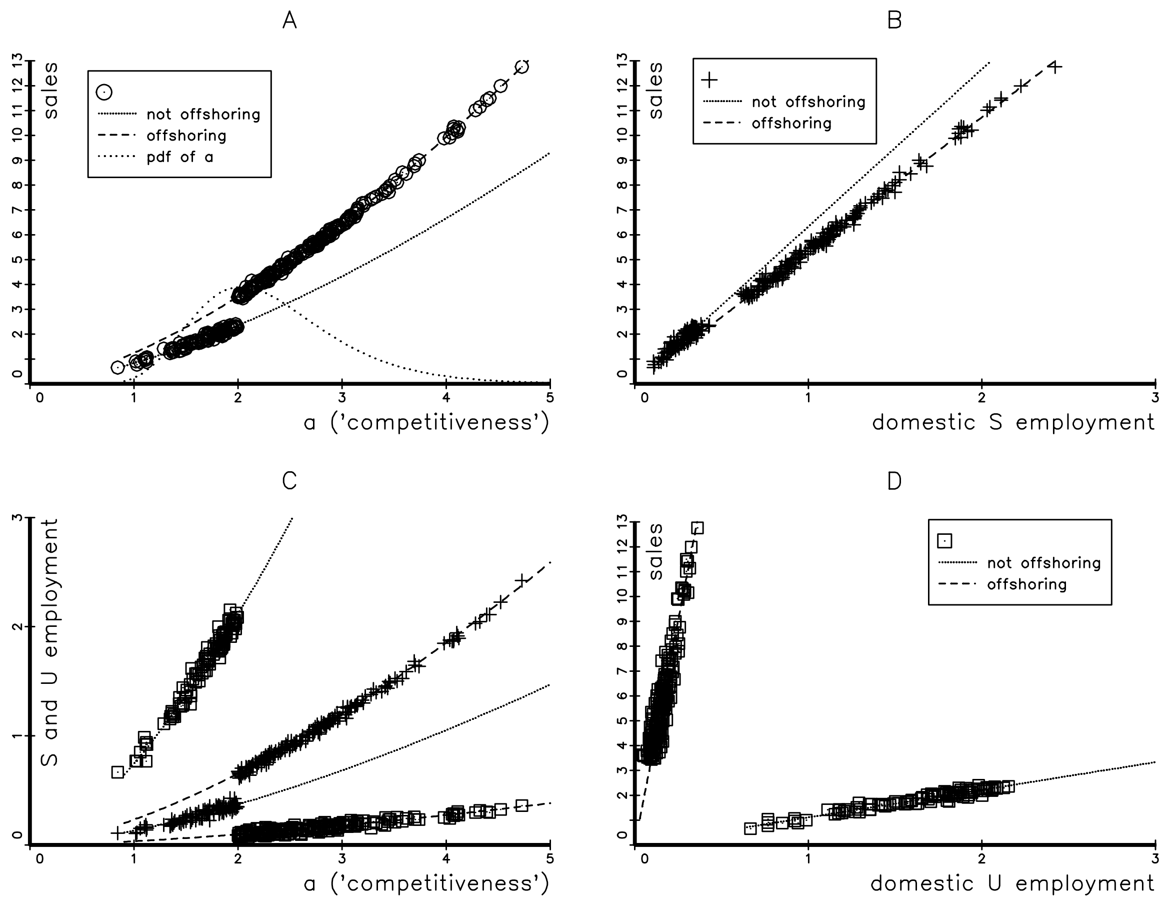

FIGURE 2: Illustration of the model's implications for the joint distribution across firms of exogenous strength (*a*), sales, domestic employment of different types, and offshoring. The parameter values are the same as in Figure 1.