Teaching locals new tricks: foreign experts as a channel of knowledge transfers

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Abstract

Gains from productivity and knowledge transmission arising from the presence of foreign firms have received a good deal of empirical attention, but theoretical micro-foundations for this mechanism are limited. Here we develop a model in which foreign experts may train domestic workers who work with them. Hypotheses are generated under the assumptions that workers learn from experts (the effect of using an expert is not strictly temporary) and that this learning is embodied in the workers rather than in the firm. We use fixed effects and nearest neighbour matching estimators on a panel of plant-level data for Colombia that identifies the use of foreign experts, to show that these experts have substantial and persistent positive effects (though not always immediate) on the wages of domestic workers and on the value added per worker.

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1. Introduction

There now exists a well-developed empirical literature on the transmission of technical/managerial knowledge and productivity "spillovers" between countries and whether trade or investment is a more important channel of transmission (Keller 1998, 2002, Haskel and Slaughter 2002, Gong and Keller 2003, Javorcik and Spatareanu 2003 and Javorcik 2004).

Several different ideas for the micro-foundations of the transmission mechanism have been proposed or modelled. Theoretical models have looked at linkages as a source of productivity spillovers, so that upstream and/or downstream firms benefit from the arrival of multinationals (Markusen and Venables, 1999). This has generally been in the form of variety effects from supporting an increased number of intermediate or final goods. Rodriguez-Clare (1996), for example, develops a model of how the multinationals can improve welfare by generating more linkages compared to the linkages that would be generated by the domestic firms they displace from the labor market. The second stream of theoretical analysis looks at workers or local firms learning from watching or working for foreign firms with a resulting increase in their productivity (Ethier and Markusen 1996, Fosfuri, Motta, and Rønde 2001, Markusen 2001, Glass and Saggi 2002). Empirical work in search of spillovers to local firms include Haddad and Harrison (1993), Aiken and Harrison and Lipsey (1996), Blomström and Kokko (1998), Blomström and Sjöholm (1999), Aitken and Harrison (1999), Blalock (2002), Javorcik and Spatareanu (2003), Javorcik (2004), Görg and Strobl (2005), and Girma and Görg (2007). Other empirical literature has documented that local firms and their managers often get their start as employees of multinational firms (Katz 1987, Hobday 1995, Hall and Khan 2003).

Very little in this literature is directed at modelling the precise micro-mechanism of how foreign skilled workers impart those skills to domestic workers. To close this gap is the purpose

of our paper. We focus on direct imports of the services of foreign experts as a method of both providing an important good or service and for training domestic workers faster and/or cheaper than they can learn on their own. We depart from the tradition of comparative steady-state analysis used in new growth theory, since we want to explicitly consider timing issues rather than merely steady-state levels and growth rates. For this reason, we use a very simple competitive constant-returns model with no spillovers, externalities, or other bells-and-whistles.

We use a two-period model: a "during" period in which ex-ante identical entering firms may or may not choose to use foreign experts and an "after" period. Firms that use foreign experts are denoted type-f and those that use only domestic workers are type-d. There is free entry into firm type and they hire ex ante identical workers. We show that if (a) workers learn from foreign experts (the advantages of using foreigners is not merely temporary) *and* (b) this learning is embodied in the workers themselves, then type-f firm workers should receive a lower during-expert wage and a higher after-expert wage. However, if (a) foreign experts confer a strictly temporary effect on worker productivity *or* (b) lasting effects on productivity are embodied in the firm (a type-f firm can hire type-d workers in the second period who then have the same productivity as continuing type-f workers), then generally no differences in wages should be observed.

Our empirical section uses Colombian Manufacturing Surveys (1977-1991), where the use of foreign experts is identified in each period (if any) for each plant. The surveys contain a sample of 304 plants for which we observe three distinct stages – before employing any foreign experts, while foreign experts remain with the plant, and after they leave – and this information allows us to evaluate contemporaneous and posterior impact of the experts on the wages of skilled and unskilled workers and labor productivity. We find the impact to be large and positive

(although not always immediate). However, the longer the plant postpones the decision to hire foreign experts, the smaller is the experts' contribution to the increased wages or productivity.

Perhaps the most important challenge to our analysis is that the decision to hire a foreign expert is non-random, and the factors that enter into this decision are likely to have an element of personal choice on behalf of the plant's manager and are not directly observable. Plant fixed-effects and nearest neighbor matching estimators are used to overcome this problem. In the former we include plant fixed effects to remove the impact of any time-invariant characteristics and find that the use of foreign experts increases the wages of skilled workers and value added per worker by about 11 percent in the post-expert period. In the latter we use a number of observable plant characteristics to pair the plants employing foreign experts with similar plants who don't and find that the use of foreign experts raises wages of unskilled and skilled workers by 5 and 6 percent respectively in the post-expert period. The impact on the value added per worker is approximately 8 percent and is present in both contemporaneous and post-expert periods.

Our results on the post-expert period wages and during and post-expert value added support the theoretical hypothesis outlined above. However, coefficients on the during-expert wage are weakly positive and statistically insignificant. Thus no negative during-expert wage effect is observed, although the weakly positive effect is much less than that on value added, which is qualitatively consistent with the central hypothesis (the wage premium should fall below the value-added premium in the during-expert period). Various institutional factors might account for the fact that wages are not lower in the during-expert period, but this puzzle is left for future work.

2. Theoretical Model

We have tried to formulate a model which relates closely to the actual empirical exercise that follows. In particular, we want a model that allows for the simultaneous existence of ex-ante identical firms some of which choose to use foreign experts and some of which do not. We assume ex ante identical workers as well, since our data do not include any observations on individual workers, and certainly do not want a model that hinges on unobserved worker heterogeneity (which is certainly not to say that this isn't *empirically* important). We want the model to be "testable", in the sense of having falsifiable predictions.

(1) There are two time periods, (t = 1,2). These will correspond to during-expert and after-expert time periods in our empirical analysis. Discounting between periods does not affect any of the results and so is ignored.

(2) At t = 1, firms in the X sector can choose to be one of two "types": they can choose not to employ foreign experts at t = 1, type d (for domestic), or to use foreign experts, type f.

(3) There are many potential firms and there is free entry and exit into or out of firm types so all firms earn zero profits over the two-period time horizon. All firms pay the same fixed entry cost at t = 1.

(4) No firms use foreign experts at t = 2 and no entry or exit occurs at t = 2 (and indeed no firm could make a profit doing so).

(5) Firms produce goods that are symmetric but imperfect substitutes, a standard Dixit-Stiglitz monopolistic-competition demand structure.

(6) The model is partial-equilibrium. Firms in the X sector can hire unlimited numbers of workers at a fixed two-period wage equal to some outside option. Total expenditure on X sector varieties is fixed in each time period (no intertemporal substitution).

(7) Generally, we assume that a worker's productivity is enhanced by working with a foreign expert, but this may be permanent (i.e., carry over to period 2) or strictly temporary depending on choices of parameters.

(8) Learning by workers may be strictly specific to type-f firms, or they may be able to transfer their skills to type-d firms in the second period depending on choices of parameters.

(9) Similarly, the knowledge transfer from foreign experts may be firm-specific rather than worker specific and, if so, workers from type-d firms have higher productivity if they

transfer to a type-f firm in the second period.

π_{ij}'s will denote exogenous worker productivity parameters in units of X. The first subscript i = d,f is firm type and the second subscript j = 1,2 is time period. π_{f2} and π_{d2} are the second-period productivities of workers who do not switch firm types. Productivity of workers (if any) who switch from a type-f to a type-d firm in the second period is denoted π_{fd2} and similarly a worker who switches from a type-d to a type-f firm is denoted π_{df2}.

p_{ij} is the endogenous price of a representative good produced by firm type-i in period j. $\sigma > 1$ denoted the elasticity of substitution among all varieties regardless of firm type (there is no distinction between goods produced using foreign experts or not, differences are only on the cost side). M_i denotes the total fixed expenditure on X goods in period i (no substitution over time).

Similarly, w_{ij} is the wage of a worker in a type-i firm in period j. No additional notation is needed for transiting workers: in equilibrium, a worker moving firm types is just indifferent to staying, and so earns the same wage as if the worker stayed with his or her first-period firm type. L_{ij} is the number of workers employed by a representative type-i firm in period j. If j=2, these are none-transiting workers. The workers who move from a representative type-f firm to a type-d firm are denoted L_{fd2} and those who move from a type-d to a representative type-f firm are L_{df2}.

p_e denotes the price of a foreign expert, used only in period 1. In order to prevent "bang-bang" solutions in which either all or zero firms use foreign experts, we assume a positively sloped supply curve of foreign experts where β is the inverse slope parameter (this is an alternative to more satisfactory general-equilibrium assumptions). For type-f firms, we assume fixed coefficients between domestic and foreign experts, and α will be a parameter giving the number of domestic workers who work with one foreign expert. Higher values of α that imply foreign experts are more valuable.

The first six equations are marginal-cost, marginal-revenue inequalities with associated employment quantities as complementary variables: if the inequality is strict in equilibrium, the associated complementary variable is zero. The result that the optimal markup is 1/σ in large-group monopolistic-competition is well known and thus will not be re-derived here.

	Inequality	Complementary variable
(1)	$w_{d1}/\pi_{d1} \geq p_{d1}(1-1/\sigma)$	L_{d1}
(2)	$w_{f1}/\pi_{f1} + p_e/(\alpha\pi_{f1}) \geq p_{f1}(1-1/\sigma)$	L_{f1}
(3)	$w_{d2}/\pi_{d2} \geq p_{d2}(1-1/\sigma)$	L_{d2}
(4)	$w_{f2}/\pi_{f2} \geq p_{f2}(1-1/\sigma)$	L_{f2}
(5)	$w_{f2}/\pi_{fd2} \geq p_{d2}(1-1/\sigma)$	L_{fd2}
(6)	$w_{d2}/\pi_{df2} \geq p_{f2}(1-1/\sigma)$	L_{df2}

Next we have four supply-demand market-clearing inequalities, giving the demand for a representative good of firm type-i in period j. Prices are complementary variables. Note that $\pi_{ij}L_{ij}$ is the amount of the representative good of firm type-i produced in period j.

(7)	$\pi_{d1}L_{d1} \geq p_{d1}^{-\sigma}(n_d p_{d1}^{1-\sigma} + n_f p_{f1}^{1-\sigma})^{-1}M_1$	p_{d1}
(8)	$\pi_{f1}L_{f1} \geq p_{f1}^{-\sigma}(n_d p_{d1}^{1-\sigma} + n_f p_{f1}^{1-\sigma})^{-1}M_1$	p_{f1}
(9)	$\pi_{d2}L_{d2} + \pi_{fd2}L_{fd2} \geq p_{d2}^{-\sigma}(n_d p_{d2}^{1-\sigma} + n_f p_{f2}^{1-\sigma})^{-1}M_2$	p_{d2}
(10)	$\pi_{f2}L_{f2} + \pi_{df2}L_{df2} \geq p_{f2}^{-\sigma}(n_d p_{d2}^{1-\sigma} + n_f p_{f2}^{1-\sigma})^{-1}M_1$	p_{d1}

There are two free-entry or zero-profit conditions for firm types d and f, with the number

of firms active in equilibrium as the complementary variables. We will just write these as fixed costs (F) equal markup revenues as is standard in the monopolistic-competition literature.

(11) $F \geq (p_{d1}/\sigma)\pi_{d1}L_{d1} + (p_{d2}/\sigma)(\pi_{d2}L_{d2} + \pi_{fd2}L_{fd2})$ $\qquad n_d$

(12) $F \geq (p_{f1}/\sigma)\pi_{f1}L_{f1} + (p_{f2}/\sigma)(\pi_{f2}L_{f2} + \pi_{df2}L_{df2})$ $\qquad n_f$

Three equations relate to labor market arbitrage and clearing. The first of these is the participation constraint that workers earn their outside option of w = 1 in each time period, or 2 over the two time periods. This need not imply enforceable contracts: we assume that a worker from a type-f firm can work for any type-f in the second period in a spot labor market. Similarly for transitioning workers. The next equation (14) is an arbitrage condition, which states that workers in the two firm types must be paid the same total wage over the two time periods, in which case (13) hold for type-f firm workers as well. Equation (15) ensures that the number of first-period type-d workers are employed either by type-d firms or transit to type-f firms at t = 2. Equation (15) is a similar condition for workers initially employed in type-f firms.

(13) $w_{d1} + w_{d2} \geq 2$ $\qquad w_{d1}$

(14) $w_{f1} + w_{f2} \geq w_{d1} + w_{d2}$ $\qquad w_{f1}$

(15) $L_{d1} \geq L_{d2} + L_{df2}$ $\qquad w_{d2}$

(16) $L_{f1} \geq L_{f2} + L_{fd2}$ $\qquad w_{d2}$

(17) $p_f \geq (\beta/\alpha)n_f L_{f1}$ $\qquad p_f$

This last equation is the supply price of foreign experts on the left, and the right-hand side is β times the number of domestic type-f workers in period 1 adjusted by foreign productivity α (by virtue of fixed coefficients between domestic workers and foreign experts).

Analytical results are desirable, and we tried hard to find a simple model that was analytically solvable yet had the properties discussed at the beginning of the previous section. We abandon this after a lot of work, with the need for an interior solution over a range of parameter values being a big stumbling block in particular. We solve the model numerically as a non-linear complementarity problem using GAMS. Indeed, some results depend on parameter values as we shall see while others do not seem to (although we have no general proof of the latter) and so an analytical model would leave lots of indeterminacies in any event. We will consider six case of the productivity parameters.

Case 1: $\pi_{d1} = 1$, $\pi_{f1} = 1.2$, $\pi_{d2} = 1$, $\pi_{f2} = 1.4$, $\pi_{fd2} = 1$, $\pi_{df2} = 1$

Working with foreign experts not only increases productivity in period 1, this is real learning that carries over to period 2. Learning is specific to worker and firm type so type-f workers cannot carry that knowledge to type-d firms and type-d workers cannot transit to type-f firms and be more productive.

Case 2: $\pi_{d1} = 1$, $\pi_{f1} = 1.2$, $\pi_{d2} = 1.4$, $\pi_{f2} = 1.4$, $\pi_{fd2} = 1$, $\pi_{df2} = 1$

Now the advantage of working with foreign experts is only temporary. Productivity in type-d firms catches up in the second period. We could also interpret this as a perfect spillover, in which type-d firms can observe all of the learning in the type-f firms.

Case 3: $\pi_{d1} = 1$, $\pi_{f1} = 1.2$, $\pi_{d2} = 1$, $\pi_{f2} = 1.4$, $\pi_{fd2} = 1.4$, $\pi_{df2} = 1$

We return to case 1, except now the learning is fully embodied in type-f workers, and they can take their full second-period type-f firm productivity with them when they transit to type-d firms.

Case 4: $\pi_{d1} = 1$, $\pi_{f1} = 1.2$, $\pi_{d2} = 1.4$, $\pi_{f2} = 1.4$, $\pi_{fd2} = 1.4$, $\pi_{df2} = 1$

This is a combination of cases 2 and 3, in that type-d firms catch up in the second period and type-f workers can take their learning with them when they transit.

Case 5: $\pi_{d1} = 1$, $\pi_{f1} = 1.2$, $\pi_{d2} = 1$, $\pi_{f2} = 1.4$, $\pi_{fd2} = 1$, $\pi_{df2} = 1.4$

This returns to case 1, except that the learning is purely firm specific and not worker specific. First-period type-f workers cannot take their productivity with them when transiting, but conversely type-d workers can move to type-f firms in the second period and have the same productivity as continuing workers in type-f firms.

Case 6: $\pi_{d1} = 1$, $\pi_{f1} = 1$, $\pi_{d2} = 1.4$, $\pi_{f2} = 1.4$, $\pi_{fd2} = 1$, $\pi_{df2} = 1$

Foreign experts have no productivity effects on firms or workers. They simply relieve a labor shortage at time t = 1 while workers in both type-f and type-d firms are learning by doing.

We have run many simulations with this model for different values of other parameters and have a feel for which results tend to be robust and which are not. Table 1 gives a flavor of this by reporting results for three different values of α, the foreign-expert productivity parameter. Cases 1, 3, and 5 tend to have robust results, while cases 2, 4, and 6 do not.

In case 1, we always get the result that type-f firms offer a lower first period wage and a higher second-period wage. Thus when we regress wages on a foreign-expert-use dummy later on, we should expect that the coefficient on the "during" dummy variable (= 1 in a time period in which a foreign expert is used) should have a negative sign and an "after"dummy variable (=1 in a time period after a firm has used an expert) should have a positive sign.

In case 3 we get the same qualitative result. When the knowledge is fully internalized by individual workers such that they can transfer it to type-d firms, wages have this same pattern. It is important to note that the average wage in period 2 in a type-d firm will be a combination of lower wages for continuing workers (w_{d2}) and transiting type-f workers (w_{f2}), but this average wage must still be less than the average wage in a type-f firm.

Case 5 is the one in which the learning is purely firm-specific, so workers leaving type-f

firms cannot take their productivity with them while workers hired from type-d firms at t = 2 enjoy the same productivity in type-f firms as continuing workers. As intuition would suggest, this results in wages in a given period being the same for workers in both firm types. The empirical prediction is no "during" or "after" effect.

Cases 2, 4, and 6 are "it depends" cases. In case 2, where type-d workers catch up in period 2, implies the same result on wages as in cases 1 and 3 for low values of α, but is *reversed* for high values of α (type-f workers get *more* in the first period and *less* in the second period). This is basically a firm-size effect. When α is large, is it optimal to hire many domestic workers at t = 1 relative to type-d firms since their complementary factor is cheap and type-f productivity is high. But then there are more workers for the second period, the firm's price is low, and the marginal revenue product in type-f firms is less than that in type-d firms.

Case 4 does not reverse the result of cases 1 and 3, but rather converges to equal wages across firm types in each period as α becomes large. Workers transiting from type-f to type-d firms leads to a convergence in firm size as α gets large, so second-period workers get the same wage in each firm type which by the arbitrage condition implies that they get the same wage in the first period.

Similarly, case 6 (foreign workers don't affect productivity, they just relieve a labor shortage) begins with the result of cases 1 and 2. This is again a firm size effect. Type-f firms go into period 2 with a smaller work force, and so the marginal-revenue product of workers is higher than in type-d firms even though the physical productivity of workers is the same in both firm types in period 2. As α gets large, this effect disappears, firms converge in size and so second-period marginal-revenue products are the same across firm types.

To summarize, alternative parameter assumptions, each of which has a clear economic

interpretation, can generate different outcomes. Many simulations do, however, suggest certain regularities. If the use of foreign experts has a learning effect for workers (the productivity advantage persists in period 2) *and* this is embodied in the workers rather than the firms, then type-f workers will have a lower during (t= 1) wage and a higher after (t = 2) wage. If this is the empirically relevant case, then we should also see both higher during and after-expert productivity, value added per worker, in type-f firms.

These are the basic hypotheses that we will take to the data. But they are clearly falsifiable hypotheses. If the advantage of using foreign experts is purely temporary *or* the after-expert productivity advantage is embodied in firms rather than workers (type-d workers switching get the same higher productivity as continuing type-f workers), then we will not see this type-f firm wage effect. When the after-expert advantage is embodied in firms, we should still see a higher value-added-per-worker in type-f firms however. We should also not see the type-f firm wage and value-added effects if there are perfect spillovers from type-f to type-d firms (an interpretation of case 2).

3. Empirical Analysis

Our theory model is primarily focusses on the *timing* of learning and productivity increases, since firms go to the same productivity values in the long-run regardless of whether or not foreign experts are used. The latter allow the accumulation of skills *cheaper* and especially *earlier*. This is not an easy thing to test empirically, at least with available data that we are aware of. Further, the competitive labor-market assumption means that all workers share in the benefits, not just those who work directly with the foreign experts.

We are able to test the hypothesis that foreign experts visiting local plants share their

knowledge and improve the plant's productivity. As a data source we employ plant level data from the the Annual Manufacturing Survey (1977 – 1991) collected by Colombia's Departamento Administrative Nacional de Estadistica (DANE). AMS data covers all establishments employing ten or more workers and, among other things, reports values of production, domestic and foreign sales, imported and domestically purchased intermediate inputs, wage bills by skill category, capital stocks, ownership, taxes and subsidies. Roberts and Tybout (1996) provide a more comprehensive description of the data. There are several advantages using these data. First, the plants report directly the number of foreign experts employed in a given period. Secondly, the panel nature of the data allows us to discern the within-plant changes in productivity resulting from the assistance from foreign experts. Thirdly, these statistics can be supplemented by the interviews of the plant managers covering the same time frame to provide more detail on the learning process (Morawetz, 1981; Berry and Escandon, 1994).

We start by comparing the profiles of 715 plants who report having employed foreign experts at least once during the period in question with the plants who have never done so. To these means, we run a series of regressions, in which plant characteristics are regressed on the dummy variable indicating whether the plant has employed any foreign experts during at least one period over the 1977-1991 span, plant size and a set of industry, year and region fixed effects. The findings from these regressions are presented in Table 1. The reported coefficients can be interpreted as percentage difference between the two types of plants. Irrespective of whether size is added as an additional covariate, the firms opting for the help from foreign expert are more capital and skilled labor intensive, import a higher share of raw materials, and export a higher share of their output. Their workers are more productive (measured by value added per

worker or sales per worker) and are better paid irrespective of the skill level.

To truly exploit the panel nature of the data, for the rest of the analysis we restrict our sample to 304 plants, which we observe during three distinct stages – before employing any foreign experts, while foreign experts remain with the plant and after they leave.

To discern how foreign experts affect productivity, we estimate variations of the following wage equation:

$$\ln(w)_{ijkt} = \alpha_0 + \alpha_1 During_{ijkt} + \alpha_2 After_{ijkt} + \delta Z_{ijkt} + Ind_j + Time_t + Area_k + \epsilon_{ijkt} \quad (18)$$

The subscripts *i*, *j*, *k*, and *t* denote plant, industry, region and time. Our dependent variable is the natural logarithms of real wages for skilled and unskilled workers. We have selected these variables on the supposition that wages are sufficiently correlated with the workers' marginal productivity. In fact, Verner (1999) finds that wages do not keep pace with productivity gains, a finding that suggests that, if anything, we underestimate the effect of foreign experts on the productivity of local workers. However, we also repeat the analysis using value added per worker as the measure of worker productivity (see Cahuc et al. (2002) for discussion against the use of output per worker).

Our main independent variables are indicators for whether the plant is currently employing foreign experts ("During") or has employed them in the past ("After"). The omitted category is the period prior to the employment of foreign experts. The coefficient on the variable "During" can be potentially interpreted as the immediate impact of experts on productivity, since more than half of the plants report only one period in which they employ a foreign expert.

Drawing on the literature on firm-level determinants of wages, our vector of additional controls, *Z*, includes total labor force, skill intensity, capital intensity, share of imported raw materials (on the assumption that plants investing in imported and better quality raw materials are

also the ones seeking out higher quality workers), and regional wages to reflect opportunity costs. Following the literature on rent sharing and efficiency wages, we also include plant's market share and sales per worker. All specifications include industry, year and region fixed effects. We also experiment with other covariates, such as unemployment rates (to reflect opportunity costs), industry protection measures, industry growth rates, and Herfindahl index of industry concentration (on the assumption that the increasing degree of competition may raise the effort level that the managers must exert to remain viable and will motivate them to turn to outside sources). None of these factors is found to be important in the determination of wages or value added per worker in our sample. Given a relatively small sample size, we choose a more parsimonious specification and do not include these variables. To account for general forms of heteroskedasticity and serial correlation in the error term, we compute robust standard errors clustered by plant.

We gather a general idea of the impact of foreign experts on domestic workers by considering a specification in which we control only for industry, year and region effects. As shown in Table 3, the percentage increase in wages and value added per worker relative to the period prior to the employment of foreign experts is positive and significant. The wages increase by approximately 8 percent. This increase is immediate (as evidenced by the positive coefficient on the variable "During") and is retained after the foreign experts leave. The instantaneous increase in the value added per worker is a walloping 19 percent, which remains at a high 7 percent after the expert leaves the plant.

Apart from the coefficient on the "During" variable in the specifications with wages for skilled workers and value added per worker, the inclusion of additional controls does not change much either the magnitude or the significance level of the impact of foreign experts on

productivity. Table 4 shows that after the foreign expert leaves the plant, workers' wages are 5.3-7.3 percent and value added per worker is 8.5 percent higher than during the period prior to the visit by the foreign expert.

One may wonder whether the "intensity of the treatment" matters, i.e. whether the number of employed foreign experts or the time they spend at the local plant matters for the productivity gains. Unfortunately, there is not much variation in the data to test the first hypothesis: of all non-zero values for the number of foreign experts, 85% report only 1 expert present. Similar problem arises when we look at the number of periods with non-zero values for foreign experts – half of the plants invite a foreign expert for only one period.

As an alternative to using the number of periods the expert stays at the plant as a continuous independent variable, in panels A and B of Table 5 we report the findings from the analyses conducted separately for two types of plants: those who invite an expert only once and those keep the experts for a longer time. The plants that invite an expert for only one period experience a 12 percent jump in value added per worker. The wages of unskilled workers increase by 8 percent after the expert leaves. Such pattern appears to be consistent with the situation in which an expert is invited to fix (or set up) equipment or give recommendations regarding product design, rather than for on-going training.

The results reported in Panel B for the subset of the plants welcoming foreign experts on a more consistent basis indicate that the benefits may be cumulative: the productivity starts increasing while the expert is still at the plant (although we can no longer interpret this jump as instantaneous) but the gain is at its highest after the expert leaves. This pattern appears to be consistent with the theory of on-the-job training, which requires a longer interaction period and generates more permanent productivity gains.

Perhaps the most important challenge to our empirical analysis is that the decision to hire a foreign expert is non-random, and the factors that enter into this decision are likely to have an element of personal choice on behalf of the plant's manager and are not directly observable. The same factors may also be affecting the productivity of local workers. Plant fixed-effects and nearest neighbor matching estimators are used to overcome this problem.

In the former we include plant fixed effects to remove the impact of any time-invariant characteristics. Here we rely solely on the within-plant variation to identify the effect of foreign experts on the productivity of various types of workers. The inclusion of the fixed effects in Table 6 dampens the impact of foreign experts on all three measures of productivity. The impact remains statistically significant (and surprisingly unchanged in magnitude) only in the specification for skilled workers. The loss of statistical significance is not surprising given that the fixed effects along with year dummies absorb most of the variation in the data. Limiting the sample to those plants that have employed foreign experts for longer than one period, bounces both the magnitude and the significance of the coefficients up to the levels observed in the OLS specifications. Both value added per worker and the wages of skilled workers increase by approximately 11 percent after the visit by foreign experts. The wages of both skilled and unskilled workers increase by approximately 3-5 percent during the visit by foreign experts, however this increase is not statistically significant. The increase in the value added per worker during the visit by foreign experts is 8 percent and is significant at 5 percent level, which is perfectly consistent with the finding by other authors that wages do not keep pace with labor productivity gains.

To assess the validity of our findings, we also employ propensity score matching and construct a counterfactual for the wages and productivity outcomes that the plant would have

had, had it not hired any foreign experts (see Arnold and Javorcik (2005) for an application of the propensity score matching to the analysis of the knowledge transfer). We do so by paring up each plant with foreign experts with a very similar plant employing only domestic workers based on a number of "pre-treatment" – i.e. "prior to employment of foreign experts" – characteristics. These characteristics include the plant's total employment, capital intensity, profitability (sales per worker), share of imported raw materials, market share, industry, and location. To reduce the dimensionality problem when considering differences on more than one observable characteristic, these characteristics are summarized into a single scalar (propensity score) reflecting the probability of a plant to use foreign experts (the results from the logit estimation are reported in Table 7). A plant without foreign experts but with a similar propensity score as a plant with foreign experts will then be used as the missing counterfactual. The success of the propensity score matching is confirmed in Table 8, where one can see that the matched firms display considerable homogeneity as opposed to the stark differences we observe in the unmatched sample.

In Table 9 we repeat the fixed effects estimation of the effect of foreign experts on the wages of skilled and unskilled workers and the value added per worker on the matched and the unmatched samples. This effect, as in previous analyses, is captured by the contemporaneous dummy "During" and the dummy for the post-treatment period "After." There is a considerable difference in the estimation results for the whole sample and the matched sample. The effects estimated based on the whole sample are almost always larger and more significant than for the matched sample. This illustrates the potential problem that the estimation on the full sample suffers from endogeneity bias which leads to an overstatement of the causal effect of foreign experts on wages and productivity. Taking the estimates in Table 9 at face value, our findings for

the matched sample indicate that foreign experts raise wages of unskilled and skilled workers by 5 and 6 percent respectively in the post-expert period. The impact on the value added per worker by approximately 8 percent and is present in both contemporaneous and post-expert periods. The matching method thus confirms our finding that the use of foreign experts exerts positive effect on the workers' wages and productivity.

As noted earlier, our theory model partly suggests timing issue: obtaining skills earlier in time through the use of foreign experts. This is not easy to test, but we think that we make some progress using the approach shown in Table 10. The sample is again plants that have before, during and after periods for use of foreign experts within the sample period. The dependent variable is the log of post-expert wages or value added minus the log of pre-expert wages or value added. Two new regressors are used instead of the "during" and "after" dummies. The first is the "waiting time", defined as the number of periods the plant waited before hiring an expert (this is time-invariant and so precludes using plant fixed effects). The second is the pre-expert level of the (log) of skilled wages, unskilled wages, or value added per worker corresponding the dependent variable.

Results in Table 10 indicate significant, negative effects of waiting time on changes in wages (effects on values added per worker are economically small and statistically insignificant). This is at least consistent with our theory, which is that workers eventually but slowly learn on their own. Thus the longer the waiting time before using the foreign experts, the less is the their contribution to increased wages. Adding the pre-expert *level* of wages or value as a regressor in the three right-hand regressions of Table 10 cuts the effect of waiting time in half in the two wage regression, but it remain statistically significant at the 10% level. Since we cannot observe the origin/entry date of most firms (sample starts in 1977), the pre-expert level of wages may

itself be a reasonable proxy for experience and learning accumulated up to the beginning of the sample period (industry and region fixed effects are used). To the extent that this interpretation is valid, then the negative effects of the pre-expert wage (or value added) level in all three regressions is again consistent with the model: if the higher initial wage or value added per worker indicates a higher level of earlier skill accumulation, then a negative coefficient is expected. The fact that these coefficients are all less than one indicates that the higher initial wage reduces but does not eliminate the contribution of the foreign experts.

Our analysis supports the general predictions of the theory that we are able to test with the available data. The exception is that we do *not* find a negative effect on the workers' wages during the period(s) in which foreign experts are present at the plant. Recall that domestic workers should be willing to accept temporarily lower wages in exchange for higher ones later, once the training has taken place. It is the case that in the fixed-effects (Table 6) and matching (Table 9) regressions, the during-expert coefficients on wages are statistically insignificant and half the size of the after-expert coefficients on skilled wages. It is also the case that in these regressions, the during-expert point estimates on wages are about half the size of the during-expert coefficient on value added. We thus feel that the estimates do not stray too far from the theoretical predictions. It is plausible to suggest that institutional features such as minimum wage requirements, industry-wide wage setting, imperfect ability to predict future wages as well as trade unions may help explain the lack of empirical evidence for a negative during-expert wage premium.

4. Conclusions

This paper provides theoretical micro-foundations for the mechanism of knowledge transfer, a phenomenon much studied empirically but lacking theoretical underpinnings. It develops a model in which knowledge is transmitted through one specific channel – the foreign experts visiting the local plant and training its workers.

Our model has a number of empirical implications for the wages of skilled and unskilled domestic workers and their productivity, some of which we are able to test with the data from Colombia. Specifically, we use fixed effects and nearest neighbour matching estimators on a panel of plant-level data that identifies the use of foreign experts and show that these experts have substantial, although not always immediate, positive effects on the wages of domestic workers and on the value added per worker. We are also able to shed some light on the timing issue and find that the longer the plant postpones the decision to hire foreign experts, the smaller their contribution to the improved wage and productivity profiles.

The fixed-effects and matching results are largely consistent with the theory. Although the expected negative "during" effect on wages is positive (perhaps due to labor-market institutions), it is insignificant and much smaller than the "after" effect on wages and the "during" effect on value added. Specifically, results are largely consistent with assumptions in the theory model that (a) workers/firms learn from foreign experts rather than capture merely transitory benefits and (b) that learning is embodied in the workers themselves.

Results are *not* consistent with theoretical versions in which the benefits from foreign experts are purely transitory, embodied in the firm, or in the form of pure spillovers to other firms and workers. In the spillover case, there should be no after effect of experts on value added by firm type as well as no effect on wages, but both are strongly positive and significant.

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Table 1: Simulation results for the theoretical model

	Cases 1	2	3	4	5	6
Parameters						
π_{d1}	1.0	1.0	1.0	1.0	1.0	1.0
π_{f1}	1.2	1.2	1.2	1.2	1.2	1.0
π_{d2}	1.0	1.4	1.0	1.4	1.0	1.4
π_{f2}	1.4	1.4	1.4	1.4	1.4	1.4
π_{fd2}	1.0	1.0	1.4	1.4	1.0	1.0
π_{df2}	1.0	1.0	1.0	1.0	1.4	1.0
Results: $\alpha = 2$						
W_{d1}	0.930	0.852	1.078	0.852	0.849	0.889
W_{f1}	0.757	0.842	0.710	0.842	0.849	0.835
W_{d2}	1.070	1.148	0.922	1.148	1.151	1.111
W_{f2}	1.243	1.158	1.290	1.158	1.151	1.165
Results: $\alpha = 5$						
W_{d1}	0.933	0.848	1.165	0.877	0.877	0.889
W_{f1}	0.851	0.904	0.831	0.877	0.877	0.879
W_{d2}	1.067	1.152	0.835	1.123	1.123	1.111
W_{f2}	1.149	1.096	1.169	1.123	1.123	1.121
Results: $\alpha = 40$						
W_{d1}	0.934	0.847	1.185	0.889	0.889	0.889
W_{f1}	0.873	0.919	0.860	0.889	0.889	0.889
W_{d2}	1.066	1.153	0.815	1.111	1.111	1.111
W_{f2}	1.127	1.081	1.140	1.111	1.111	1.111

Case 1: Productivity embodied in workers, advantage persists in period 2 (learning) but f-workers cannot exploit their learning in type-d firms at t = 2

Case 2: Productivity advantage of type-f workers purely temporary (period 1 only) or perfect spillovers to type-d firms

Case 3: Same as case 1, except f-workers can transfer their skills to type-d firms in period 2

Case 4: Combination of cases 2 and 3: f-workers can transfer skills, but perfect spillovers to type-d firms at t = 2 as well

Case 5: Period 2 productivity advantage of type-f firms embodied in the firms. Type-f workers cannot gain by moving, but type-d workers can

Case 6: No productivity effects on workers at all. Foreign experts merely help relieve a labor shortage in period 1

Table 2: Difference in Mean Characteristics Between Plants With Foreign Experts and Those Without

Additional Controls:	3-Digit Industry, Year and Region Fixed Effects				3-Digit Industry, Year and Region Fixed Effects and Plant Size			
Dependent Variable:	Coeff	Robust Std Error		R-squared	Coeff	Robust Std Error		R-squared
log (Capital Per Worker)	0.563	0.015	***	0.15	0.353	0.016	***	0.18
Exports / Total Sales	0.033	0.002	***	0.04	0.012	0.002	***	0.07
Share of Imported Raw Materials	0.086	0.001	***	0.19	0.049	0.001	***	0.24
log (Unskilled Workers Wage)	0.324	0.005	***	0.24	0.134	0.005	***	0.35
log (Skilled Workers Wage)	0.436	0.006	***	0.19	0.137	0.006	***	0.39
log (Local Technicians Wage)	0.450	0.009	***	0.17	0.138	0.009	***	0.37
log (Value Added Per Worker)	0.571	0.009	***	0.24	0.304	0.009	***	0.30
log (Sales Per Worker)	0.501	0.010	***	0.30	0.255	0.010	***	0.34
Skilled Workers / Total Labor	0.049	0.002	***	0.21	0.023	0.002	***	0.23

Results from regressing plant characteristics on the dummy variable indicating whether the plant has employed any foreign experts during the reporting period 1977-1991

Based on 16712 plants (92,642 observations) of which 15,997 plants (85,473 observations) have never employed foreign experts and 715 plants (7,169 observations) employed foreign experts in at least one reporting period.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Percentage Change in Wages and Labor Productivity During the Time an Expert is Visiting the Plant and After He/She Leaves Relative to the Pre-Expert Levels

	log (Unskilled Wage)			**log (Skilled Wage)**			**log (Value Added Per Worker)**		
	Coefficient	Robust Std Error		Coefficient	Robust Std Error		Coefficient	Robust Std Error	
During	0.078	0.021	***	0.080	0.027	***	0.193	0.040	***
After	0.072	0.021	***	0.058	0.027	**	0.078	0.040	**
3-digit Industry Fixed Effects	Yes			Yes			Yes		
Year Fixed Effects	Yes			Yes			Yes		
Region Fixed Effects	Yes			Yes			Yes		
R-squared	0.27			0.22			0.31		
N	2921			2921			2921		

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Percentage Change in Wages and Labor Productivity During the Time an Expert is Visiting the Plant and After He/She Leaves Relative to the Pre-Expert Levels (Controlling for Plant Characteristics)

	log (Unskilled Wage)			**log (Skilled Wage)**			**log (Value Added Per Worker)**		
	Coefficient	Robust Std Error		Coefficient	Robust Std Error		Coefficient	Robust Std Error	
During	0.031	0.019	*	0.022	0.024		0.088	0.028	***
After	0.073	0.018	***	0.053	0.024	**	0.085	0.027	***
Skilled Workers / Total Employment	0.260	0.041	***	0.075	0.054		0.453	0.060	***
log(Total Labor)	0.128	0.007	***	0.196	0.009	***	0.034	0.010	***
log(Capital Per Worker)	0.036	0.006	***	0.047	0.008	***	0.084	0.009	***
log(Sales Per Worker)	0.194	0.010	***	0.185	0.013	***	0.655	0.014	***
Share of Imported Raw Materials	-0.033	0.047		0.114	0.061	*	0.294	0.069	***
Market Share	0.454	0.187	***	0.714	0.243	***	0.716	0.268	***
Regional Wage	0.132	0.027	***	0.140	0.035	***	0.047	0.039	
3-digit Industry Fixed Effects	Yes			Yes			Yes		
Year Fixed Effects	Yes			Yes			Yes		
Region Fixed Effects	Yes			Yes			Yes		
R-squared	0.62			0.59			0.78		
N	2921			2921			2921		

Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: The Impact of the Length of Interaction with Foreign Experts on Domestic Workers' Wages and Productivity

	A. One Period With Foreign Experts						B. Many Periods With Foreign Experts					
	log (Unskilled Wage)		**log (Skilled Wage)**		**log (Value Added Per Worker)**		**log (Unskilled Wage)**		**log (Skilled Wage)**		**log (Value Added Per Worker)**	
During	0.048		0.047		0.121	**	0.037		0.067	**	0.071	**
	[0.034]		[0.042]		[0.053]		[0.026]		[0.034]		[0.035]	
After	0.081	***	0.042		0.056		0.071	***	0.129	***	0.124	***
	[0.024]		[0.030]		[0.039]		[0.029]		[0.039]		[0.040]	
Skilled Workers / Total Employment	0.194	***	0.015		0.457	***	0.347	***	0.078		0.483	***
	[0.058]		[0.074]		[0.089]		[0.062]		[0.084]		[0.083]	
log[Total Labor]	0.125	***	0.183	***	0.050	***	0.123	***	0.154	***	-0.003	
	[0.011]		[0.014]		[0.018]		[0.010]		[0.014]		[0.013]	
log[Capital Per Worker]	0.051	***	0.059	***	0.061	***	0.045	***	0.047	***	0.095	***
	[0.009]		[0.012]		[0.014]		[0.010]		[0.013]		[0.013]	
log[Sales Per Worker]	0.182	***	0.166	***	0.631	***	0.182	***	0.191	***	0.682	***
	[0.014]		[0.017]		[0.021]		[0.015]		[0.021]		[0.021]	
Share of Imported Raw Materials	-0.041		-0.035		0.375	***	0.029	***	0.339	***	0.411	***
	[0.070]		[0.086]		[0.109]		[0.068]		[0.091]		[0.091]	
Market Share	0.888	***	1.760	***	0.319		0.029		0.564		1.243	***
	[0.294]		[0.365]		[0.454]		[0.277]		[0.370]		[0.365]	
Regional Wage	0.207	***	0.216	***	0.043		0.080	***	0.088	***	0.036	***
	[0.065]		[0.080]		[0.100]		[0.030]		[0.040]		[0.039]	
3-digit Industry Fixed Effects	Yes		Yes		Yes		Yes		Yes		Yes	
Year Fixed Effects	Yes		Yes		Yes		Yes		Yes		Yes	
Region Fixed Effects	Yes		Yes		Yes		Yes		Yes		Yes	
R-squared	0.67		0.65		0.78		0.63		0.65		0.82	
N	1431		1431		1431		1490		1490		1490	

Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Impact of Foreign Experts on Domestic Workers' Wages and Poductivity, Fixed Effects Estimation

	All			Employ Foreign Experts for Longer Periods		
	ln(Unskilled Wage)	ln(Skilled Wage)	ln(VA per Worker)	ln(Unskilled Wage)	ln(Skilled Wage)	ln(VA per Worker)
During	0.024	0.003	0.032	0.031	0.049	0.081**
	[0.017]	[0.022]	[0.024]	[0.024]	[0.031]	[0.034]
After	0.028	0.054**	0.009	0.035	0.111***	0.113***
	[0.019]	[0.025]	[0.027]	[0.030]	[0.039]	[0.042]
log(Total Labor)	-0.011	0.073***	0.008	-0.021	0.076***	-0.024
	[0.015]	[0.019]	[0.020]	[0.021]	[0.028]	[0.029]
log(Capital Per Worker)	0.024***	0.029***	0.051***	0.001	0.031**	0.053***
	[0.008]	[0.010]	[0.010]	[0.011]	[0.014]	[0.015]
log(Sales Per Worker)	0.184***	0.195***	0.724***	0.197***	0.189***	0.762***
	[0.014]	[0.018]	[0.019]	[0.020]	[0.027]	[0.028]
Share of Imported Raw Materials	-0.02	0.021	0.08	0.01	0.036	0.091
	[0.059]	[0.075]	[0.081]	[0.090]	[0.119]	[0.127]
Market Share	-0.199	-0.09	1.884***	0.584	0.664	2.710***
	[0.413]	[0.531]	[0.589]	[0.606]	[0.795]	[0.836]
Constant	2.449***	2.398***	0.442***	2.550***	2.499***	0.449*
	[0.117]	[0.154]	[0.159]	[0.182]	[0.241]	[0.253]
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2921	2921	2921	1490	1490	1490
Number of plant	234	232	234	110	110	110
R-squared	0.3	0.18	0.54	0.34	0.18	0.58

Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Determinants of Employment of Foreign Experts (Logit Estimation)

Dependent Variable: Employment of Foreign Experts (0 - no, 1 -yes)

log (Total Labor)$_{t-1}$	0.716	***
	[0.020]	
log (Capital per Worker)$_{t-1}$	0.241	***
	[0.021]	
log (Sales per Worker)$_{t-1}$	0.199	***
	[0.030]	
Share of Imported Raw Materials$_{t-1}$	0.794	***
	[0.147]	
Market Share$_{t-1}$	-1.607	***
	[0.534]	
Industry Fixed Effects		
Region Fixed Effects		
Time Fixed Effects		
Number of obs = 72,091		

Log likelihood = -9216.3935
Pseudo R2 = 0.1519
LR chi2(38) = 3300.99
Prob > chi2 = 0.0000

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Mean Values of Selected Characteristics for Matched and Unmatched Samples

	Full Sample			Matched Sample			
				without foreign experts			
	without foreign experts	with foreign experts	**Diff Full Sample**	unmatched	used as comparison group	with foreign experts	**Diff Matched Sample**
log (Unskilled Worker Wage)	3.604	3.911	**0.307**	3.515	3.803	3.842	**0.040**
log (Skilled Worker Wage)	3.886	4.250	**0.364**	3.766	4.119	4.196	**0.076**
log (Value Added Per Worker)	4.573	5.183	**0.610**	4.431	4.970	5.079	**0.109**
log (Total Labor)	3.588	4.458	**0.869**	3.328	4.435	4.518	**0.082**
Skilled Workers / Total Employment	0.212	0.305	**0.093**	0.203	0.260	0.285	**0.026**
log (Capital per Worker)	3.339	3.972	**0.633**	3.231	3.924	3.947	**0.023**
log (Sales per Worker)	5.294	5.712	**0.417**	5.276	5.852	5.889	**0.036**
Share of Imported Raw Materials	0.077	0.139	**0.062**	0.057	0.139	0.146	**0.007**
Market Share	0.006	0.013	**0.007**	0.003	0.015	0.018	**0.003**

Table 9: The Effect of Foreign Experts on Domestic Workers' Wages and Productivity (Matched and Unmatched Samples)

	Unmatched Sample			Matched Sample		
	log(Unskilled Worker Wage)	log(Skilled Worker Wage)	log (Value Added Per Worker)	log(Unskilled Worker Wage)	log(Skilled Worker Wage)	log (Value Added Per Worker)
During	0.041*	0.047	0.118***	0.006	0.034	0.078**
	[0.024]	[0.035]	[0.036]	[0.023]	[0.034]	[0.035]
After	0.052**	0.053*	0.095***	0.045*	0.062**	0.076**
	[0.022]	[0.027]	[0.033]	[0.023]	[0.032]	[0.035]
log(Total Labor)	0.106***	0.211***	0.081***	0.144***	0.207***	0.074***
	[0.003]	[0.004]	[0.004]	[0.009]	[0.012]	[0.014]
log(Capital per Worker)	0.022***	0.006**	0.037***	0.049***	0.041***	0.088***
	[0.002]	[0.002]	[0.003]	[0.009]	[0.012]	[0.013]
log(Sales per Worker)	0.170***	0.186***	0.605***	0.201***	0.209***	0.629***
	[0.005]	[0.005]	[0.006]	[0.015]	[0.017]	[0.024]
Share of Imported Raw Materials	0.169***	0.220***	0.416***	0.065	0.271***	0.402***
	[0.023]	[0.026]	[0.031]	[0.059]	[0.079]	[0.081]
Market Share	1.906***	1.339***	2.104***	0.642***	0.470	0.781*
	[0.300]	[0.240]	[0.553]	[0.218]	[0.303]	[0.444]
Constant	1.912***	1.797***	0.716***	1.534***	1.600***	0.468***
	[0.023]	[0.024]	[0.029]	[0.074]	[0.089]	[0.106]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87252	77359	81039	4798	4673	4404
R-squared	0.38	0.36	0.69	0.50	0.49	0.71

Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10: The Impact of Postponing the Decision to Hire Foreign Experts

	Unskilled wage	Skilled wage	VA per worker	Unskilled wage	Skilled wage	VA per worker
Waiting Time Before Hiring An Expert	-0.022***	-0.037***	0.003	-0.012*	-0.019**	-0.001
	[0.008]	[0.011]	[0.014]	[0.006]	[0.009]	[0.011]
Pre-Expert Level: Log(x) Pre-Expert				-0.634***	-0.611***	-0.742***
				[0.080]	[0.077]	[0.067]
Skilled workers / Total	-0.117	-0.227	0.065	-0.037	-0.073	0.485***
	[0.128]	[0.152]	[0.191]	[0.095]	[0.140]	[0.150]
Log (Total Labor)	-0.009	-0.013	-0.094**	0.068***	0.113***	0.003
	[0.019]	[0.027]	[0.040]	[0.020]	[0.027]	[0.032]
Log (Capital Per Worker)	0.014	0.02	0.036	0.030**	0.042**	0.075***
	[0.017]	[0.027]	[0.035]	[0.014]	[0.020]	[0.029]
Log(Sales Per Worker)	0.067***	0.060*	0.244***	0.166***	0.140***	0.519***
	[0.022]	[0.031]	[0.047]	[0.026]	[0.033]	[0.051]
Share Imported Raw Mat	-0.272	-0.038	0.510**	-0.188*	0.008	0.366**
	[0.170]	[0.213]	[0.236]	[0.113]	[0.147]	[0.161]
Market Share	0.987***	0.455	-0.334	0.710**	0.658	0.366
	[0.351]	[0.556]	[0.823]	[0.344]	[0.432]	[0.692]
Regional Wage	0.046	-0.028	-0.011	0.093**	0.096*	0.163**
	[0.048]	[0.068]	[0.076]	[0.040]	[0.050]	[0.077]
Industry/year/region fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1236	1236	1236	1236	1236	1236
R-squared	0.19	0.18	0.27	0.44	0.42	0.59

*Dependent Variable: difference in logs of post and pre-expert wages or value added per worker

** "Waiting Time" is the number of periods the plant waited before hiring an expert; time-invariant

* significant at 10%; ** significant at 5%; *** significant at 1%