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Openness and Innovation: Firm Level Evidence from India

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Abstract: This paper uses firm level data for India to examine the determinants of innovation activity, focusing on variables related to economic openness. Firms that export and those that import are found to be significantly more likely to engage in innovation, defined sequentially as the introduction of new products, new processes, new systems, or devotion of financial resources or time to research and development. Concretely, exporters are 22% more likely to introduce a new product than non-exporters, while the corresponding figure is 66% for importers. Openness to trade is therefore a key determinant of firm-level innovation, which is a key component of economic growth.

Keywords: Trade; Innovation; Firm-Level Data.

JEL Codes: F13; F14; O24; O30.

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1 INTRODUCTION

Global and regional value chains (GVCs) are ubiquitous in the Asia-Pacific region, although some countries are much more involved in them than others. Under this model of production, tasks are shared across a number of countries: components are manufactured and shipped to the next stage in the chain, with multiple processes taking place simultaneously before everything is brought together for final assembly in another location, and the product is shipped to the end consumer in a different part of the region or the world. GVCs have become very common in the region in sectors such as consumer electronics—think of Apple's products, such as the iPhone—and transport equipment. The key firm level processes at the root of GVCs are exporting, importing, and foreign direct investment (FDI): typically, they occur in combination at the level of individual businesses, with a lead firm coordinating all activities at the network level.

The rise of the GVC production model has set out the perspective of a new trade and development paradigm. Outward orientation remains key to development prospects, as the recent experiences of countries in East and Southeast Asia have demonstrated. But instead of needing to build up a complete domestic industry to serve as the basis for exporting, such as clothing and apparel, or car manufacturing, countries can now specialize in one task that forms part of that industry, such as production of particular components. Imports of intermediate goods are thus increasing in importance, and can have a variety of economic benefits at micro- and macro-levels.

As economies evolve and accumulate physical capital, and people accumulate human capital, there is the prospect to move from one task to another in different value chains. From a development standpoint, the early stage in GVC participation typically involves labor intensive operations, such as product assembly. They are relatively low in value addition. At higher levels of development, however, there is the possibility to specialize in higher value added tasks, such as component manufacture, and

then research and design. Higher value added tasks can be beneficial for an economy, as they are often accompanied by positive spillovers in terms of technology and productivity and skills upgrading, as well as endogenous technology creation and adaptation. The new trade and development paradigm therefore focuses on joining GVCs, and—crucially—on "moving up" into higher value added processes. Identifying the policies needed to support moving up is a matter of critical importance for the region. (See Brach and Kappel, 2009, for a general discussion of the issues in a development context.)

Among economists, there is a consensus that, under the right circumstances, outward orientation including through participation in GVCs is still a viable development paradigm, even following the Global Financial Crisis, and in an environment where more and more countries are looking to adopt such policies, if they have not already done so (see e.g., Haddad and Shepherd, 2011). There is skepticism in some quarters, however, as to the extent to which the GVC model indeed allows for moving up—the fear is that a country might join a GVC at a low value added point, such as final assembly, and become stuck there, experiencing stagnating productivity and income growth in a new version of the middle income trap. This paper feeds into the debate on whether or not such concerns are justified. Concretely, it examines the potential that GVC participation—as proxied by a number of firm-level indicators—has to promote innovation, a key determinant of a country's ability to unchain endogenous growth processes and use them to move to increasingly higher levels of per capita income over the medium to long term.

The key insight in this paper is in relation to openness to trade in intermediate goods, as well as exports of final products, and innovation in terms of the introduction of new products, new processes, new systems, and allocation of resources to research and development. Results sit well with the existing literature. Goldberg et al. (2010) and Seker and Rodriguez-Delgado (2012) have recently used Indian

data to show that access to imported intermediate goods is associated with increased product scope for domestic firms. Seker (2012) has shown that the same result holds in 43 developing countries in Eastern Europe and Central Asia, as well as Latin America and the Caribbean. Concretely, Goldberg et al. (2010) estimate that about one-third of the observed rise in product scope in their data can be explained by access to foreign intermediate inputs. This mechanism is potentially an important one for developing countries looking to maximize their gains from trade in the context of endogenous growth.

The present paper undertakes a similar analysis using recent firm-level data for India, but with the difference that a wider variety of innovation activities are covered. Although product innovation is important, innovative activity in lower income countries frequently focuses on processes—a subject this paper addresses, but the previous literature does not. This paper also examines mechanisms by looking at two indicators of research and development activity: allocation of funds, and allowing employees time to experiment with various types of innovation.

The paper proceeds as follows. The next section presents the dataset and empirical model. Section 3 then discusses results, and shows that they are robust to a variety of specifications. The final section concludes by discussing the policy implications of these results.

2 Data and Preliminary Analysis

2.1 Data

The World Bank's Enterprise Surveys dataset currently has data on over 120,000 firms in 125 mostly developing and transition economies. This paper uses the most recent survey of Indian firms (2014). After limiting the sample to manufacturing firms only—as data for services firms appear less reliable, particularly in relation to trade—the sample consists of 7,161 firms in 19 sectors. Table 1 shows the

sectoral distribution of firms in the sample. The survey covers a single year of activity, although some questions contain a temporal dimension (e.g., by comparing the current year with three years prior).

The process for undertaking Enterprise Surveys is highly standardized. The World Bank works with local partners to develop a sampling frame based on the business register, or similar resource. Survey companies are then engaged to contact firms using stratified random sampling. Interviews are conducted face to face, typically with a senior manager. Topics covered include basic financial and performance information, business constraints, international integration, and relations with government. The breadth of the Enterprise Surveys makes them an incomparable resource for conducting policy relevant firm-level empirical work in developing countries.

This paper uses a selection of data points from the 2014 Indian Enterprise Survey. The reason for choosing a single survey is that the current version of the questionnaire—which provides important new details on innovation—has not yet been incorporated into the standardized multi-country dataset. The interest of exploiting new data on innovation is strong, and justifies limiting the sample to a single survey—indeed, a large one, with some thousands of firms in the sample. Table 2 sets out the variables taken from the survey for the empirical analysis, and provides detailed definitions. Table 3 shows descriptive statistics.

Many of the variables used in this analysis are standard in the firm-level trade literature, and so are not discussed further. However, it is important to describe the five variables used to capture innovation activity at the firm-level, as they represent a departure from the previous literature in terms of their richness. A first feature of these new data is that it is possible to distinguish three sorts of innovation: product, process, and systems. The first refers to the introduction of a new product, the most well-known type of innovation. The second captures innovative changes to production systems—a particularly important type of innovation in the developing country context. The third covers

innovation in management and organizational systems, again a source of incremental technical change. These three indicators are used sequentially in the empirical analysis to show the linkages between international engagement and innovation at the firm-level, keeping the coverage as wide as possible.

The last two innovation indicators focus on research and development, which is one important mechanism by which innovation can take place, and an important link to policy due to the incentives that exist in many countries. The first variable is an indicator of R&D spending by the firm, either in-house or through external contracts. It captures the most traditional type of research and development, but needs to be supplemented in the developing country context because firms are frequently resource constrained, and find it difficult to spend directly on R&D. That does not mean, however, that they do not engage in innovation. The second indicator is broader, and captures the allocation of time to employees to engage in incremental innovation activities. Again, this mechanism is likely to be of particular important in a developing country like India, and highlights the broad scope that even resource constrained firms have to be innovative.

2.2 Preliminary Analysis

As an initial check on the data, Figures 1 and 2 use kernel density plots to compare the productivity levels of internationally engaged firms and those that deal with the domestic market only. The first figure looks at importers, and the second focuses on exporters. In both cases, there is clear evidence that international engagement—the fruit of policies that favor openness—is associated with higher productivity at the firm level. This result is well established in the literature, so this confirmation of a known regularity indicates that the Indian Enterprise Survey data line up well with other firm-level sources examined in previous work.

The key hypothesis of this paper is that international engagement through importing and exporting is associated with an increase in innovation activity, in particular through the mechanism of increased

attention to research and development, either through direct spending or in-kind allocation of time. Table 4 breaks down the data by cross-tabulating innovation activity with firm type, focusing on internationally engaged firms versus those that deal with the domestic market only. It is immediately apparent that importers and exporters are more likely to engage in innovation of all types, with the difference being especially stark in the case of process innovation. In addition, there is clear evidence that importers and exporters are more likely to engage in research and development activity, as a means to innovating. Again, the difference with firms that are not internationally engaged is strongest in the case of time allocation for research and development.

Of course, these observations are based on simple sample splitting. They do not control for other factors that may be at work. To do that, a full econometric model is necessary. The next section turns to that question.

3 Empirical Model and Results

3.1 Empirical Model

Building on the initial insights gleaned from the preliminary analysis in the previous section, this paper's empirical model is postulated to take the following form:

$$\Pr(Innovation_{fs} = 1) = \sum_{s} d_s + b_0 Importer_{fs} + b_1 Exporter_{fs} + \sum_{i} b_i Controls_{fcst} + e_{fs}$$

where f indexes firms and s indexes sectors. The key variables of interest are dummy variables to indicate firms that directly import some of their intermediate inputs, and those that export part of their final production. The d term indicates a full set of fixed effects by sector, and e is a standard error term. Controls refers to a fixed set of firm-level control variables: firm productivity, size, capital intensity, foreign ownership, capacity utilization, and management experience.

The independent variable is sequentially set equal to the five indicators of innovation activity and mechanisms. All of the independent variables are dummies, so estimation is by fixed effects logit; full notation is suppressed above for clarity in terms of the relationships among the variables.

3.2 Discussion of Results

Table 5 contains estimation results. The model performs largely in line with expectations in terms of the control variables: larger and more capital intensive firms are more likely to engage in innovation, as are those that have a higher level of capacity utilization and greater management experience. The most robust relationship is for firm size, which has a positive and statistically significant coefficient in all five regressions. Capital intensity and management experience have appropriately signed and statistically significant coefficients in two cases, and capacity utilization in one. It is somewhat surprising that the dummy variable for majority foreign ownership does not have a statistically significant coefficient. One possible explanation is that India has had a difficult relationship with foreign investment. As a result, the dominant form of investment in the country is either market seeking or looking for a low wage production base, rather than a place from which to conduct innovative activity.

The two variables of main interest are the exporter and importer dummies. Exporting is positively and statistically significantly associated with the probability of engaging in innovation in all five regressions. Importing displays the same result in four of the five regressions. There are noticeable differences between the coefficients on these two variables in a number of the regressions. For product innovation, for example, the importer dummy has a much larger coefficient than the exporter dummy. This finding is in line with a mechanism in which access to superior foreign inputs makes it possible to produce new products, as was found by Goldberg et al. (2010). By contrast, being an exporter makes it significantly more likely that a firm will undertake research and development spending, whereas being

an importer increases the probability of allocating employee time for R&D activities. These last two findings suggest that research and development is a key mechanism through which international engagement promotes innovation.

The overall finding to emerge from Table 5 is that the preliminary analysis in Section 4 is borne out by more detailed econometric work. Internationally engaged firms are indeed more likely to engage in innovation than comparable firms that only deal with the domestic market, even after controlling for other observable and unobservable factors. Converting the coefficients in Table 5 to odds ratios makes it possible to get an idea of the quantitative importance of these effects. For product innovation, exporters are 22% more likely to introduce a new product than non-exporters, while the corresponding figure is 66% for importers. For process innovation, the additional probabilities are 53% and 49%. Clearly, the effects uncovered here are of major economic significance in the Indian data: international engagement, which is supported by open trade policies, makes it significantly more likely that firms will innovate. In terms of the mechanics of that innovation, odds ratios based on Table 5 show that exporting is associated with a 63% increase in the probability of spending on R&D, and a 19% increase in the probability of allocating time to research and development. The comparable numbers for importing are 32% and 42%. Again, these figures are highly economically significant, and suggest that there are clear mechanisms by which exposure to international markets can support innovation in the developing country context.

4 Conclusion and Policy Implications

This paper has shown that firms that import intermediate goods or export part of their final production tend to be more innovative than firms that deal only with the domestic market. Its findings can be interpreted as an extension of Goldberg et al. (2010), using a range of indicators for innovation activity, covering products, processes, and systems. In addition, it provides some first evidence on

mechanisms, focusing on R&D spending and in-kind time allocation. The effect of international engagement through exporting and importing is both economically and statistically significant. Given the importance of product innovation in endogenous growth models, this paper suggests that trade in intermediate inputs, as well as exporting, can be an important vector of growth in the developing world.

Openness to international trade and investment flows is a crucial policy priority for fostering this kind of innovative activity. Appropriately liberal trade and investment policy settings—backed with stability and certainty in their administration—can encourage the free movement of goods that make it possible for firms to innovate. They also strengthen market disciplines, which provides an incentive for firms to innovate as a way of maintaining competitiveness.

It is important to stress the value of openness in order to counteract the view the industrial policy considerations would operate in favor of protection of "new" value chain activities that represent the potential for higher value added retention. Infant industry arguments, although theoretically plausible under certain circumstances, have proved in practice to be difficult to administer effectively—it is hard to make infants "grow up" and become globally competitive. Instead, the approach suggested in this paper is in line with an incentive neutral trade and investment policy that allows goods and capital—including those with embodied technology—to flow freely across borders and be put to their optimal use.

A final factor developing countries need to pay special attention to—all the more so as we move into the era of sustainable and inclusive growth—is the development of human capital. An important mechanism for innovation in a developing country like India is the allocation of time to employees to undertake research and development, without necessarily engaging in formal spending. This kind of innovation focuses on incremental improvements, which are the most common form of technical

change in developing countries. For the mechanism to work, employees need to have appropriate skills and background. Developing countries need to redouble their efforts to develop their human capital stocks, in appropriate ways depending on their level of per capita income. Physical technology and human capital are strong complements, so it is important to move forward on both fronts simultaneously. GVCs frequently cite an educated workforce as a strong factor in their location decisions, so developing county governments need to be responsive to that fact.

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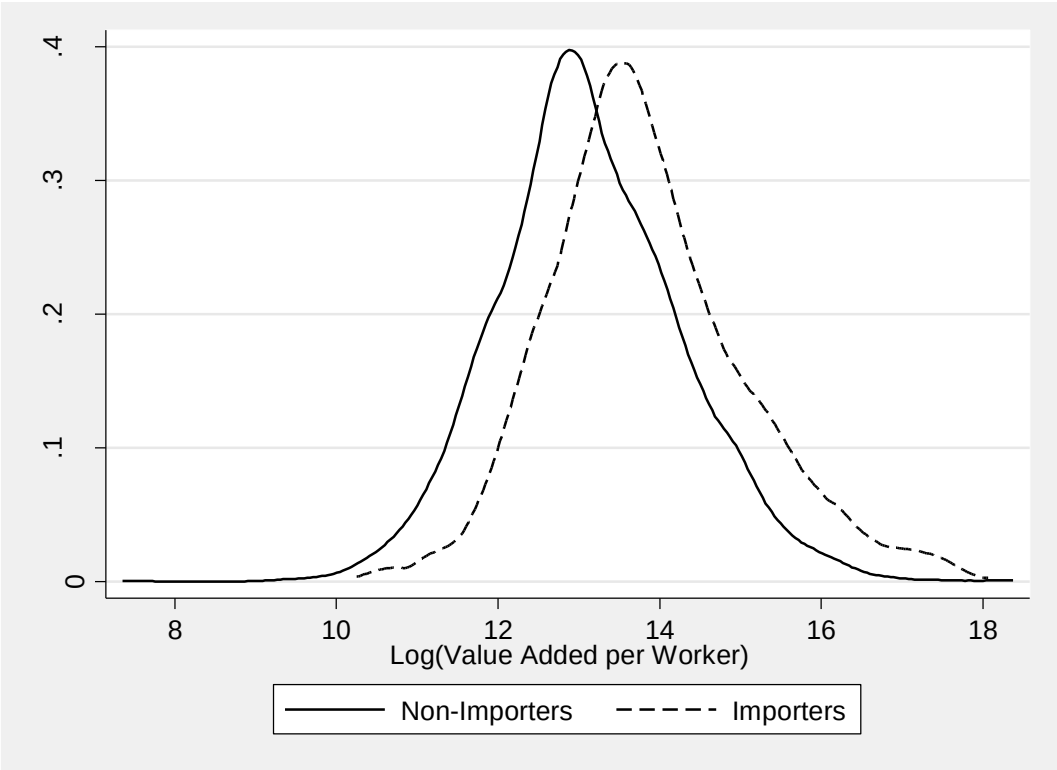
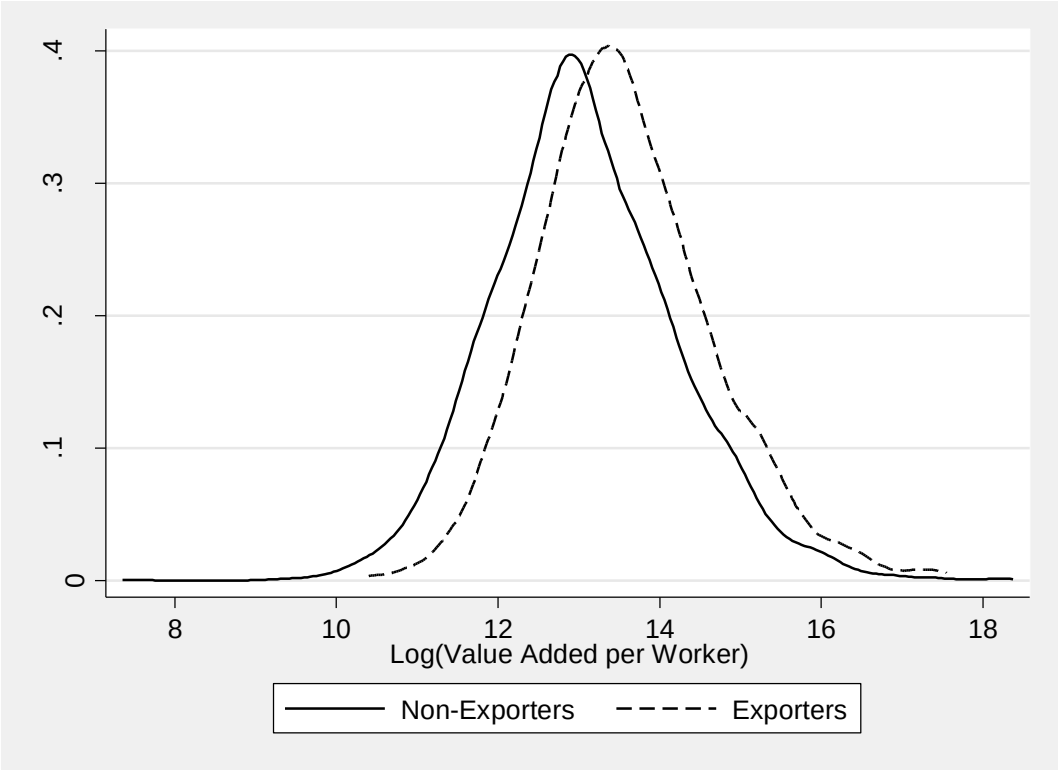
FIGURES

Figure 1: Productivity differential between firms that only use domestic inputs and those that use imported inputs.



Source: World Bank Enterprise Surveys; author's calculations. Use of foreign inputs is defined as any share greater than zero.

Figure 2: Productivity differential between firms that only serve the domestic market and those that export.



Source: World Bank Enterprise Surveys; author's calculations. Exporting is defined as any share greater than zero.

TABLES

Table 1: Sectoral distribution of firms.

Sector	Number of Firms	Percent of Total
Machinery and equipment	721	10.07%
Plastics & rubber	696	9.72%
Basic metals	656	9.16%
Fabricated metal products	651	9.09%
Textiles	622	8.69%
Chemicals	599	8.36%
Electronics	586	8.18%
Transport machines	561	7.83%
Food	540	7.54%
Non-metallic mineral products	532	7.43%
Garments	210	2.93%
Paper	166	2.32%
Wood	140	1.96%
Publishing, Printing, and Recorded Media	135	1.89%
Tobacco	112	1.56%
Leather	97	1.35%
Furniture	79	1.10%
Refined petroleum product	33	0.46%
Precision instruments	25	0.35%

Table 2: Variables, definitions, and sources.

Variable	Definition	Source
Exporter	Dummy variable equal to unity for establishments that export a non-zero percentage of their sales either directly or indirectly (through a distributor)	Enterprise Surveys questions d3b and d3c
Foreign	Dummy variable equal to unity for establishments that are owned more than 50% by the foreign private sector	Enterprise Surveys question b2b
Importer	Dummy variable equal to unity for establishments that import a non-zero percentage of their material inputs and supplies directly	Enterprise Surveys question d13
Log(Capacity Utilization)	Logarithm of the establishment's output produced as a proportion of the maximum output possible using all available resources	Enterprise Surveys question f1
Log(Capital Intensity)	Logarithm of the establishment's net book value of machinery, vehicles, and equipment, and land and buildings per permanent full-time employee	Enterprise Surveys questions l1, n6a, and n6b
Log(Employees)	Logarithm of the establishment's number of permanent full-time employees	Enterprise Surveys question l1
Log(Experience)	Logarithm of the number of years' experience in the sector of the firm's top manager	Enterprise Surveys question b7
Log(Productivity)	Logarithm of total sales less the cost of raw materials and intermediate goods used in production, per permanent full-time employee	Enterprise Surveys questions d2, l1, and n2e
New Process	Dummy variable equal to unity for establishments that have introduced new or significantly improved methods of manufacturing products or offering services in the last three years	Enterprise Surveys question h3
New Product	Dummy variable equal to unity for establishments that have introduced new or significantly improved products or services in the last three years	Enterprise Surveys question h1
New Systems	Dummy variable equal to unity for establishments that have introduced new or significantly improved organizational structures or management practices in the last three years	Enterprise Surveys question h5
R&D Spending	Dummy variable equal to unity for establishments that spent on formal research and development activities, either in-house or contracted with other companies, during the last three years	Enterprise Surveys question h7

R&D Time	Dummy variable equal to unity for establishments that gave employees some time to develop or try out a new approach or new idea about products or services, business process, firm management, or marketing, during the last three years	Enterprise Surveys question h8

Table 3: Descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Exporter	7,161	0.183	0.387	0	1
Foreign	7,161	0.003	0.053	0	1
Importer	5,101	0.107	0.309	0	1
Log(Capacity Utilization)	7,118	4.352	0.280	0.693	4.605
Log(Capital Intensity)	4,818	12.802	1.620	-3.324	18.611
Log(Employees)	7,159	3.697	1.245	1.099	8.987
Log(Experience)	7,144	2.415	0.738	0	4.159
Log(Productivity)	6,651	13.161	1.148	7.354	18.368
New Process	7,161	0.458	0.498	0	1
New Product	7,161	0.448	0.497	0	1
New Systems	7,161	0.435	0.496	0	1
R&D Spending	7,161	0.355	0.478	0	1
R&D Time	7,161	0.466	0.499	0	1

Table 4: Innovation activity by type of firm.

	% of Exporters	% of Non-Exporters	% of Importers	% of Non-Importers
New Product	58%	42%	65%	42%
New Process	63%	42%	65%	42%
New Systems	54%	41%	55%	41%
R&D Spending	56%	31%	59%	33%
R&D Time	61%	43%	67%	44%

Source: World Bank Enterprise Surveys; author's calculations.

Table 5: Regression results.

	(1) Product	(2) Process	(3) Systems	(4) R&D Spending	(5) R&D Time
Exporter	0.198**	0.427***	0.192*	0.487***	0.177*
	(0.013)	(0.000)	(0.061)	(0.000)	(0.087)
Importer	0.506***	0.404**	0.154	0.280**	0.349***
	(0.000)	(0.013)	(0.357)	(0.050)	(0.004)
Log(Productivity)	0.028	0.026	-0.078*	0.072	-0.020
	(0.481)	(0.513)	(0.060)	(0.112)	(0.585)
Log(Size)	0.140***	0.174***	0.166***	0.294***	0.250***
	(0.005)	(0.002)	(0.003)	(0.000)	(0.000)
Log(Capital Intensity)	0.037	0.062	0.087***	-0.019	0.069**
	(0.290)	(0.125)	(0.009)	(0.612)	(0.025)
Foreign	-0.507	-0.605	-0.263	0.155	0.443
	(0.548)	(0.404)	(0.737)	(0.863)	(0.612)
Log(Capacity Utilization)	0.725***	-0.249*	0.134	-0.182	0.030
	(0.002)	(0.079)	(0.408)	(0.224)	(0.859)
Log(Experience)	0.129*	0.230***	0.096	-0.157**	0.116
	(0.090)	(0.003)	(0.134)	(0.046)	(0.139)
Observations	3365	3365	3365	3365	3365
Pseudo-R2	0.026	0.034	0.014	0.046	0.027

Note: Dependent variables are indicated at the top of each column, i.e. dummy variables for each type of innovation. Estimation is by logit with fixed effects by sector. Statistical significance is indicated as follows: * (10%), ** (5%), and *** (1%).