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Export Discoveries, Diversification and Barriers to Entry

Bailey Klinger
Daniel Lederman

The World Bank
Latin America and the Caribbean Region
Office of the Chief Economist
&
Development Research Group
Trade and Integration Team
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Abstract

The literature on the relationship between economic diversification and development has grown rapidly in recent years, partly due to the surprising finding that diversification rises with gross domestic product per capita up to a certain point. Export diversification along the extensive margin is inextricable from the introduction of new export products. The authors test the hypothesis that the threat of imitation inhibits the introduction of new exports—export discoveries—under the assumption that the intensive and extensive margins of exports are correlated within broad country-industry groups. Econometric evidence from panel-data techniques that are appropriate for count data (the number of discoveries) suggests that discoveries within countries and industries rise with the growth of exports along the intensive margin (relative to the growth of non-export gross domestic product) but the magnitude of this partial correlation increases with domestic barriers to entry and with customs delays in exporting. However, the magnification effect of barriers to entry appears to be less significant as a determinant of total within-country export discoveries. This is consistent with inter-industry and within-country spillovers related to export discoveries, implying that barriers to entry enhance the effect of export growth on discoveries within country-industries but total discoveries might be unaffected by barriers to entry.

This paper—a product of the Office of the Chief Economist, Latin America and the Caribbean Region; and the Trade and Integration Team, Development Research Group—is part of a larger effort in both departments to assess the role of the structure of trade in development. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at dlederman@worldbank.org.

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1. Introduction

Research by Imbs and Wacziarg (2003) showed that economic development is associated with increasing diversification across industries rather than specialization in lower- and middle-income countries, using both international employment and production data. More recent research established that export diversification across products also appears to increase with the level of development up to a certain point (Klinger and Lederman 2004; Cadot, Carrere and Strauss-Kahn 2010). This article studies one aspect of economic diversification, namely the introduction of new export products during the process of development. Indeed, the probability of introducing a new export product also appears to fall with the level of development, following a similar pattern as export diversification during the early stages of development (Klinger and Lederman 2004).

In light of this descriptive evidence, export diversification might be related to the self-discovery market failure hypothesis of Hausmann and Rodrik (2003a), which suggests that discovering that a product can be profitably produced and exported by a particular country creates knowledge spillovers. Firms that imitate the first mover derive benefits from such discoveries, learning about production costs and foreign demand, yet they pay nothing for it. The prospect of imitation therefore might raise the social returns relative to the private returns of export discoveries. While imitation is clearly desirable from a social viewpoint, the market-failure hypothesis implies that the first mover cannot necessarily appropriate all the value created by their investments in discovery when entry by imitators either reduce the price of the new export or raise its unit costs (when prices are determined in global markets but some inputs are non tradable), hence they might under-invest in the experimentation necessary to discover new exports, and consequently the process of productive diversification might be hampered by this market failure.

However, the market failure hypothesis has not been tested. And it is entirely plausible that both the intensive and extensive margins of trade are hampered by barriers to entry by firms or by barriers to exports. In fact, we know little about the relationship between the emergence of new export products and economic development in general. This paper attempts to fill this void by focusing mostly on testing the market failure hypothesis.

We develop an identification strategy for the existence of market failures affecting export discoveries, using disaggregated product-level export data available for a large sample of countries. In addition, we develop a metric of export discovery activity and establish empirical regularities that serve to deepen our understanding of the discovery process and its relationship with diversification and economic development. The evidence provides some support for the market failure hypothesis: barriers to entry and exporting (which are expected to delay the entrance of imitators) appear to enhance the effect of the growth of the intensive margin of exports (relative to non-export economic activities) on the number of export discoveries within countries and industries. However, this magnification effect of barriers to entry on export discovery counts is less significant when the dependent variable is the total number of export discoveries at the country level. This evidence might be consistent with the existence of inter-industry, within-country knowledge spillovers affecting export discoveries.

The rest of the paper is organized as follows. Section 2 discusses the data and the methodology for identifying episodes of export discoveries. Section 3 proceeds in stages.

First, we explore the relationship between the level of development and export concentration within countries. In turn, we examine the relationship between export discoveries and development by contrasting it with the relationship between patent counts and development. In addition, we test whether structural change in factor endowments associated with development might be responsible for the estimated relationship between the number of export discoveries and the level of development.

As the evidence implies that structural change cannot explain the distribution of export discoveries across and within countries, the second set of results tests the validity of the market-failure hypothesis. The intuition behind our empirical strategy is straightforward: if the threat of imitation reduces private investments in export discoveries, then we should observe that barriers to entry magnify the positive effect of the profitability of exports on export discoveries.

Section 4 concludes by summarizing the main findings and discussing the benefits of imitation and low barriers to entry, as well as other policy implications.

2. Data and Methodology

The first step is to develop a metric of export discoveries. A problem with using export data seems obvious: a product emerging as a new export may have been produced domestically for some time, and therefore would not represent a genuine discovery. However, exporting a particular good for the first time, even if it was already produced domestically, is itself an entrepreneurial act that requires discovery and can be imitated (Ibeh 2003). In other words, the act of exporting is itself a discovery worth investigating, especially in light of the fast growing literature on product variety and the extensive margin of trade (e.g., Hummels and Klenow 2003).

Worldwide export data are drawn from the United Nations COMTRADE database under the Harmonized Commodity Description and Coding System (HS), available beginning in the early 1990s for most countries at the 6-digit level of disaggregation (approximately 5000 products). These data have been used widely to analyze export dynamism and growth, as well as geographic patterns in export growth, but until Klinger and Lederman (2004) had not been used to study the emergence of new exports.

To identify a discovery, we require three periods: an initial period used to confirm that the good was never before exported (1994-1996) and to differentiate a discovery from a potentially sporadic export product; a window during which time the discovery can emerge (1997-2002); and then a final period when the discovery is confirmed to be an established export as opposed to sending of product samples in preparation for exporting (exported for at least $10,000 dollars in both 2002 and 2003). After eliminating microstates and countries missing more than two consecutive years of export data during the window, we are left with a sample of 73 countries representing all regions and levels of development (see Appendix for sample composition). In Klinger and Lederman (2004) we discussed how the number of export discoveries (obviously) changes with the criteria used to identify an export discovery. But it turns out that the basic relationship between the frequency of export discoveries and GDP per capita, changes to the filtering criteria in terms of the trade classification that is used, the levels of and number of years of exports required to be classified as a discovery do not affect the results.

Within these data, there is a potential problem of reclassification, because the international Harmonized System of classifying traded products underwent various revisions during this time period, including in 1996 and 2000. Reclassification of exported products occurs when, in a particular year, a country's customs body begins to report goods separately that were previously aggregated in a 'not elsewhere specified' (n.e.s.) group. This is particularly problematic from the point of view of identifying export discoveries, as any filter would falsely identify the newly disaggregated products as discoveries, even though in reality they are not new to the country's export basket. In order to systematically identify cases of customs disaggregation, we apply a outlier-detection methodology based on the divergence from each country's temporal trend during the time window used to count export discoveries by industries and countries. We identify 19 significant outliers that are likely cases of reclassification[1], and eliminate these country/years from our sample, leaving a sample without of discovery activity by industry and country potentially influential outliers.

3. Results

Our filter identifies 3089 cases of discovery during 1997-2002. These are listed by country and by Leamer's (1984) commodity groups in the Appendix.[2] As mentioned, the empirical analyses proceed in stages, beginning with a brief exploration of the relationship between export diversification, export discoveries and the level of

[1] See Appendix for a description of the filter and the identified cases of reclassification. It is noteworthy that many such episodes occurred around 1996-97 and 2000, when customs agencies were implementing the changes in nomenclature.

[2] This metric of discovery is a revision of that developed in Klinger and Lederman (2004). It uses a more explicit definition of discovery (exports starting from 0 rather than from below a threshold), extends the length of the first period for a more stringent test of novelty of the export, and uses the reclassification filter discussed in the text.

development. Below we also discuss the necessary control variables for our test of the market failure hypothesis.

Export Discovery and Diversification

Imbs and Wacziarg (2003) analyze how productive diversification behaves across income levels, and found that although there are theoretical arguments supporting both a positive and a negative monotonic relationship between diversification and growth, the evidence shows that neither view is correct. There is, in fact, a robust pattern whereby as countries develop, production is diversified until reaching a relatively high level of GDP per capita, between $13,000 and $14,600 1996 US dollars, after which point economies become increasingly specialized.

Although Imbs and Wacziarg (2003) used domestic production and labor data in their analysis of the stages of diversification, the same result can be found in export data. We construct a Herfindahl index (*H*) of exports for each country in every year with reported exports between 1992 and 2003, and estimate the following equation using a fixed-effects estimator:[3]

(1) $$H = \beta_0 + \beta_1 (GDPpercapita) + \beta_2 (GDPpercapita)^2 .$$

The results, summarized in Table 1, indicate that, similar to the pattern in domestic production data uncovered by Imbs and Wacziarg (2003), a country's export basket becomes more diversified as income rises until a relatively high level, at which

[3] H was calculated as $H = \sum_{i=1}^{J} \left(\frac{x_i}{\sum_{i=1}^{J} x_i} \right)^2$ where each *i* is an individual product and *J* is the total number of products.

point the process reverses itself and specialization occurs. It is worth noting that these estimates are within countries; the estimations rely on panel data covering 11 years of data for each country and include country-specific effects. This happens in the export basket at a higher transition point than that found by Imbs and Wacziarg with domestic production data ($22,500 in 2000 US dollars, PPP adjusted, compared to $14,600 in 1996 US dollars), but these results support the view that the pattern of economic diversification is in fact related to patterns of international trade.

<Insert Table 1 here>

This robust pattern in both domestic production and export data suggests a particular relationship between discovery and levels of development, given the relationship between diversification and new products.[4] We expect countries at relatively low levels of development to have more export discoveries, as they are in the process of diversifying their economies. As income rises, the frequency of these events declines, particularly at high levels of development when economies experience rising specialization.

To examine these two effects in our data, we estimate the relationships between both export discoveries and patent counts from Lederman and Saenz (2005), on the one hand, and the level of development on the other hand. Table 2 shows the results from Negative Binomial estimators, which are appropriate for count data afflicted by over dispersion.[5] As expected, the frequency of discovery falls as countries develop, after peaking at the lower-middle income level. Although low among the world's poorest

[4] The connections between Imbs and Wacziarg (2003) and the process of discovery were first suggested by Hausmann and Rodrik (2003b).
[5] The null of no over-dispersion was rejected with a probability value of 0 for both models. The same is true for all models discussed in the rest of this paper.

countries, the number of export discoveries rises quickly, reaching a maximum somewhere in the neighborhood of GDP per capita of $4000 USD as countries undergo productive diversification. As the level of development continues to rise, the frequency of export discoveries falls but the number of patents rises exponentially with GDP per capita.

<Insert Table 2 here>

Other Controls

Export discoveries may be concentrated in certain industries and thus episodes of discovery could be driven by changes in factor endowments associated with the process of development, such as increases in the amount of capital per worker. For example, discoveries in poor countries could be concentrated in labor-intensive goods, and as growth occurs and factor endowments change, discoveries would be concentrated in capital intensive goods. In this context, discovery would be a byproduct of structural transformation and unrelated to market failures.

The structural transformation hypothesis can be tested. Table 3 shows little evidence to support this view. Discovery activity in some commodity groups, such as labor intensive goods, does peak at a slightly lower income level than in others, such as chemicals. But nearly all commodities reach their maximum discovery frequency in the $3600 to $4900 GDP per capita range and then decline, with no commodity group peaking beyond $7000 per capita. This evidence suggests that although discovery might be part and parcel of the process of diversification, it does not seem to be a byproduct of shifting comparative advantage.

<Insert Table 3 here>

One relationship that would seem important to control for in our test of the market failure hypothesis is scale. It is possible that with a larger population, there would be a larger pool of entrepreneurs, leading to more experiments and a higher number of export discoveries. It is also possible that a larger pool of imitators, although increasing the social value of discovery, would reduce incentives for individual entrepreneurs to experiment, resulting in a lower frequency of discovery. Scale variables such as total population, working-age population, and number of person-years of education in the country were not found to be statistically significant in any estimation of the model, which is discussed in the following paragraphs. [6]

Testing the Market-Failure Hypothesis

As a measure of barriers to entry, we use a set of objective indicators rather than subjective surveys. These indicators are drawn from the World Bank's *Doing Business* database (World Bank 2004). Although only available for 2003, these are the best measures available, and it is unlikely that the regulatory regime changed significantly during the sample period. Rather than arbitrarily selecting a single indicator, we construct an index based on five of them, encompassing costs and delays in starting a new business, enforcing contracts, and hiring employees. The indicators for registering a new business would be most appropriate if discovery is undertaken by new entrepreneurs, whereas the measures of labor-market rigidities would be most appropriate if discovery is the work of existing firms. It is not clear which is the case, which could also vary by country and by industry. Moreover, all these regulatory measures are highly collinear. A composite index of these variables is consequently the most appropriate measure, which

[6] Nor were measures of financial system development, initial exports, institutional quality, or infrastructure.

we construct using principal components analysis. Nevertheless, the quality of the data corresponding to the variable on the costs of starting a new business across countries is notoriously weak. Consequently we test the robustness of our results reported below to the exclusion of that factor in the composite index.[7]

In addition, we also use the number of days that it takes for exports to clear customs. This indicator is also available from the World Bank's *Doing Business* database. This variable allows us to test whether export-specific barriers affect the magnitude of the effect of export growth along the intensive margin on export-discovery counts. It has been used in recent research on the effect of trade costs and trade flows (Djankov, Freund and Pham 2010).

Our measure of exogenous potential returns to export discoveries ($\overline{\pi}$) is the annual growth of exports along the intensive margin within Leamer-commodity export baskets relative to the realized growth rate of non-export economic activities. That is, we use the growth of exports excluding export goods identified as discoveries, minus the annual growth rate of non-export GDP. The growth of non-export GDP is netted out of our measure so that it directly captures the returns to exporting compared to producing for domestic consumption or producing services, which are not captured in the merchandise trade data used to identify export discoveries. This seems to be an important adjustment, especially when firms can choose goods and services to sell to foreign or domestic markets, depending on the relative profitability of the different activities.

More formally, the exogenous returns to export in country *c* and commodity group $i, \overline{\pi}_{i,c}$ was calculated as:

[7] We thank Caroline Freund for pointing this out.

(2) $$\overline{\pi_{i,c}} = \left(\frac{X_{i,c,T}}{X_{i,c,T_0}}\right)^{\frac{1}{T-T_0}} - \left[\left(\frac{(y_{c,T} - x_{i,c,T})}{(y_{c,T_0} - x_{i,c,T_0})}\right)^{\frac{1}{T-T_0}}\right],$$

where subscript T_0 is the initial year in the time window in which the discoveries were counted and T is the final year of the period. X represents the real value of exports excluding the contribution of the export discoveries at time T, and lower-case x and y are merchandise exports and GDP per capita. This measure of intensive-margin export returns was calculated separately for each of the ten Leamer commodity categories. Our analysis conducted at the country/Leamer commodity group level examines the relationship between the number of discoveries in a particular country/commodity group and intensive-margin export growth in that country/commodity group, as well as how that relationship changes with barriers to entry across countries.[8]

A note of caution concerning our measure of export profitability and its exogeneity with respect to the frequency of country/commodity-group export discoveries is warranted. This variable is exogenous only to the extent that it measures export growth that is not directly due to the contribution of new exports during the period of analysis. However, it might be economically correlated with the extent that the introduction of new exports in a given country/commodity-group causes an increase in the value of exports that were already in the country/commodity-group export mix. Moreover, even if there is no reverse causality, there might be a process of export growth whereby the introduction of new export products and the expansion of existing products within a

[8] In the sample used in the regression analysis only Malaysia had exports that exceeded the value of GDP at the end of the period in 2003, which yielded a very high positive number for this proxy of export profitability, as shown in the table with descriptive statistics in the Appendix. The regression results discussed below, however, were qualitatively similar when this country's observations were excluded from the sample, but the results regarding the presence of market failures were stronger than those reported below.

country/commodity-group face common shocks, thus implying that new exports and export expansion are simultaneous processes. If these concerns were valid, then the interpretation of our econometric results would be slightly different. In terms of the existing literature (e.g., Hummels and Klenow 2003) the coefficient on the variable that captures the interaction between export profitability and regulatory barriers to entry would need to be interpreted as evidence that regulations affect the relationship between the "intensive" and "extensive" margin of trade, rather than affecting the relationship between export profitability and the introduction of new export products.

In addition to these variables of interest, there are some necessary controls. As discussed earlier, the process of discovery is closely linked to stages of diversification. We therefore control for this relationship by including GDP per capita and GDP per capita squared. We also allow for the possibility that discovery is driven in part by factor endowments by controlling for comparative advantage in each industry measured by pre-sample net exports per capita in that particular commodity group (Leamer 1984). In addition, to control for differences across commodity groups and the different number of products composing each commodity cluster, we include dummy variables for each Leamer commodity group.

Finally, we control for historical discoveries by country/commodity group. This is accomplished using export data at a higher level of aggregation[9], which is available for a longer time period but only identifies broad, sector-level export discoveries rather than disaggregated product-level discoveries. This measure of historical pre-sample discoveries controls for time-invariant and unobserved characteristics driving discoveries

[9] SITC Revision 1 at the 3 digit level. See Appendix for data and filter description.

at the country/commodity group level, as in other count-data applications (Blundell et al. 2002), thereby providing a fixed effects regression framework.

As mentioned, because our dependent variable is the number of discoveries (a positive integer) with a substantial number of zeros, we estimate the following model with an exponential functional form using a negative binomial estimator: [10]

(3) $$D_{i,c} = \exp\left(\overline{\pi}_{i,c}^{\beta_1}\left(\overline{\pi}_{i,c} \times \alpha_c\right)^{\beta_2} \alpha_c^{\beta_3} X_{i,c}{}^{\gamma} + \lambda D_i\right)\eta_{i,c}\ .$$

Subscripts *i* and *c* correspond to Leamer's commodity groups and countries, respectively. $\eta_{i,c}$ is the aforementioned commodity-group and country fixed effect, which is unobserved and captured by the pre-sample number of export discoveries. α_c is the index of barriers to entry measured at the country level. However, the product of α_c and π measured at the industry level also varies across countries and industries. *X* is the vector of the other control variables discussed above, and D_i is a dummy variable for each Leamer commodity group. The latter controls for unobserved sector-specific effects but also captures the number of product lines in each category, which affects the maximum number of potential export discoveries across commodity groups.

As is commonplace in count-data models, the explanatory variables were transformed into their natural logarithms or were included in growth rates (in case of the exogenous export growth variable), which then allows for the estimation of elasticities. The exceptions were the commodity-group dummies, the indicator of comparative advantage of each country in each of the commodity groups (proxied by net exports per

[10] We began with a Poisson estimator, but the likelihood-ratio test indicated that the data are over dispersed. The results with the Poisson estimator are in fact much weaker, possibly due to the expected biased caused by over dispersion or possibly due to the fact that the expected number of export discoveries falls the level of development and thus the Poisson estimator puts more weight on poor-country observations that may be less accurate than those from rich countries. We gratefully acknowledge a referee's comments on this econometric issue.

capita), and the barriers index. The latter was calculated as the first principal component of the five regulatory indicators discussed above, after they were normalized to have means equal to zero and standard deviations equal to one. The export-delays variables, however, was used in logarithms.

The sign and significance of β_2 in (6) encompass our test of the market failure hypothesis. A positive and significant coefficient would provide evidence in support of this hypothesis.

Table 4 shows the basic estimation results under the first column, and the remaining columns show the results of additional regressions that test their robustness. The second column shows the basic specification but using the barriers index that excludes the costs of starting a new business, which was based on questionable data. Column 3 contains estimates based on the same composite index of barriers, but also includes the interaction between barriers and (log) GDP per capita, which is a rather strong robustness test of whether the key estimated effect of the interaction between barriers and export profitability is not due to an interaction with the level of development. Column 4 shows the estimated coefficients after controlling for unobserved regional characteristics. The interpretation of the corresponding regional dummy variables needs to be done with care, since the model already controls for the pre-sample discovery counts by country/commodity groups. They reflect any additional impact emanating from time invariant regional characteristics. Column 5 shows the results after adding interactive variables between the regional dummies and the barriers index to help us ascertain that the interaction that matters is the one with export profitability rather than some other regional factor. Finally, Column 6 presents results from the same specification as 5, but the barriers variable is the number of days it takes for exports to clear customs.

<Insert Table 4 here>

The expected inverted-U relationship between discoveries and GDP per capita persists and is highly significant across all specifications. In addition, historical discoveries enter as positive and significant, signaling that we are effectively correcting for fixed country/commodity effects leading to discovery. As suggested by the similarity in maximum points across Leamer categories shown in Table 3, factor endowments are not significant, a result that persists without controlling for historical discoveries (not reported).

The growth of the intensive margin of exports, measured as the growth rate of the Leamer commodity cluster minus non-export GDP growth, enters as positive and jointly significant with the interaction with barriers to entry in all specifications, as predicted by the market-failure hypothesis. Given that we tested a variety of additional control variables that were mentioned above, these results suggest that the predictions of the market-failure hypothesis are robustly supported by the data, under the assumption that the intensive margin of trade within country/commodity-groups is correlated with export discoveries. This export growth is positively and significantly associated with the number of export discoveries, but the magnitude of this partial correlation seems to rise with barriers to entry, suggesting that when first movers can internalize more of the benefits of discovering a new export activity, the frequency of discovery rises.

The direct effect of barriers to entry on discovery frequency is largely insignificant and not robust. This result <u>does not</u> imply that barriers to entry do not have an impact on discovery through its negative effect on export growth, given their offsetting stimulus to discovery through increased appropriability and drag on discovery through higher costs for the first mover. Furthermore, the results suggest that barriers to entry raise the magnitude of the effect of export profitability on discovery counts, but this comes at the cost of reducing the social gains from diffusion through imitation.

It is noteworthy that the model under column 6 has a positive and significant coefficient on the variable of interest related to the market failure hypothesis, which in this case is the product of the number of days it takes to clear customs for exports and the relative growth rate of the intensive margin of trade. This suggests that our estimations might be in fact capturing the temporary protection from competition offered by barriers to entry in exports.

Regarding the magnitude of the coefficients presented in Table 4, the results and data characteristics suggest that the influence of barriers to entry on the effect of export profitability on the discoveries is significant. For example, consider the results reported in column 2, which were based on the index of barriers that excludes the questionable data on costs of starting a new business, as well as the descriptive statistics of the relevant sample, which are shown in the Appendix. In this specification, the results imply that a one standard deviation shock in the relative growth of exports along the intensive margin (equal to a growth rate of almost 500 percent over the whole period) is associated with a 2.5 percent increase in the number of export discoveries when the index of barriers to entry is equal to zero. This is the product of the coefficient of π (0.5) and its standard deviation in the sample reported in the Appendix. The magnitude of this effect rises with barriers to entry, and a one standard deviation increase in this index (which equals 0.88) increases the effect of export profitability by 0.66 percent (which equals the product of the reported coefficient of the interactive variable and the one-standard-deviation increase in the barriers index). That is, a one standard deviation shock in the barriers index raises the effect of a one-standard-deviation shock of the export profitability shock by more than 26 percent (0.66 divided by 2.5).

Another potential weakness of the empirical model is that it assumes a linear relationship between the marginal effect of export returns on the frequency of discovery and barriers to entry. There could be a threshold below which barriers to entry have no effect on deterring discovery, but after which there is an effect.

To test for such a relationship, we ranked countries from low barriers to high barriers based on their composite-barriers index, and then apply rolling regressions with a window of 20 countries, sequentially adding the country with the next-highest barriers to entry and dropping the one with the lowest barriers. We estimated equation 3 without including barriers to entry or the interaction term and observed how the coefficient on export returns changes as the sample window moves from low to high-barrier countries.

The result is illustrated in Figure 1, which suggests a threshold effect. For low-barrier countries, the marginal effect on discovery of an increase in returns is negligible. For mid- to high-barrier countries the estimated effect becomes larger and statistically significant in spite of the low degrees of freedom due to the small window and large number of control variables. This relationship is quite robust, persisting across different ranges of the moving window and different specifications of the model, and offers further support to the market failure hypothesis. [11]

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[11] A changing relationship between returns and discovery could manifest itself through changes in the other coefficients or the constant, but estimates of all other coefficients were stable across the moving window.

<Insert Figure 1 Here>

Thus far the estimations have focused on the effect of barriers to entry on the magnitude of the partial correlation coefficient between the number of export discoveries and the growth of exports along the intensive margin within country-industry pairs. In the presence of inter-industry knowledge spillovers, it is possible that export discoveries in one industry can affect the number of export discoveries in another industry in the same country. But this spillover could be thwarted by barriers to entry. In other words, it is possible to observe that barriers to entry protect first movers within industries, thus raising the number of export discoveries (for a given export growth rate along the intensive margin) in that industry, but at the same time reducing the entry of first-movers in another industry. To approach this possibility, Table 5 presents results of similar specifications as that in Table 4, but with the dependent variable being the number of export discoveries by country instead of by country-industry pair. The corresponding Negative Binomial estimations were allowed to have regression errors clustered by country, thus approximating within country model that is also comparable to the estimations in Table 4. If the results concerning the sign and significance of the estimated coefficient that tests the validity of market-failure hypothesis are different from those in Table 4, we might be able to make inferences about the nature of the knowledge spillovers.

The relevant parameter, namely the estimated coefficient on the product of the profitability of exports (along the intensive margin relative to non-export activities) times the various barriers-to-entry proxies appear positive but not significant in the first three columns. It is positive and significant, albeit only at the 10 percent level, only in models

4 and 5. In 4, the estimated coefficient corresponds to the excluded region, which is South Asia. Upon closer inspection of the other regional dummy variables times the barrier index, only the one for Africa is significant and negative. The same is true for the model under column 5, which corresponds to the specification where the proxy for barriers to entry is the number of days to clear customs. This implies that for most regions, there is weaker evidence in favor of the market-failure hypothesis when the dependent variable is the total number of export discoveries at the national level, as the relevant estimated coefficient tends to be smaller and less significant than in the models that estimate this relationship within country-industry pairs. Hence we are tempted to conclude that there might be inter-industry spillovers in export discoveries and thus barriers to entry tend to decrease the number of discoveries by country compared to the counter-factual of only within country-industry spillovers.

4. Conclusions and Policy Implications

Recent research has highlighted the importance of diversification for developing countries: a process that may be hindered by spillovers in the discovery of new products for export. After extending this finding from domestic production data to export data, we use disaggregated export data to identify export discoveries by countries and by country-industry pairs, and characterize its relationship with patent counts, export diversification, and development. We then use this discovery metric to test the market-failure hypothesis.

According to the data, in countries where first movers expect fewer of the benefits of their discoveries due to the threat of imitation, the rate of discovery of new export sectors is lower. Even after controlling for the quadratic relationship with GDP per capita, the amount of discoveries in past years, factor endowments, plus a plethora of additional explanatory variables, discovery has a larger response to increased export growth along the intensive margin in countries with higher barriers to entry. While Hausmann and Rodrik (2003a) attribute this imitation specifically to the learning of production costs which are not predictable *ex ante*, our test makes no determination as to the importance of this particular channel. The spillover may not come from learning production costs, but instead from learning the characteristics of foreign demand (Vettas 2002), free-riding on investments to cultivate foreign demand (Bhagwati 1968, Mayer 1984), learning the redesigns needed to meet foreign safety standards (Granslandt and Markusen 2000), or some other unidentified channel. And entry of imitators can either reduce export prices of new exports or increase the costs of non-tradable inputs if export prices are determined only by global demand.

Regardless of the particular channel, this finding suggests that there are indeed spillovers from demonstrating the viability of a new product for export. While this indicates that public support for experimentation in new sectors and activities may be warranted, it is important to note that it does not mean that increasing barriers to entry is an advisable way to increase discovery. Indeed, imitation is desirable as this is the channel through which the returns from export discoveries are socialized. Moreover, such barriers are directly attributed to lower levels of private sector development (World Bank 2005), and according to Hausmann and Rodrik's (2003a) model, would lead to under-specialization of the economy, as widespread imitation leads to the efficient focusing of resources in the most profitable sectors. Furthermore, the evidence does suggest that inter-industry spillovers are thwarted by barriers to entry, a conclusion that can be inferred from the comparison of the relevant estimated coefficient in models within country-industry pairs and models within countries.

Furthermore, supporting new exports with barriers to entry protects beneficiaries from market discipline, which would be repeating the errors of import-substituting industrialization policies by not allowing the market to eventually 'pick the winners'. Support mechanisms that do not erect barriers insulating firms from competition, and instead balance government and market failures, represent a more productive way forward[12]. Furthermore, such policies are not themselves completely new. From Lesotho's Pioneer Industries Bill of 1967 to China's National New Product Program of 1988, various mechanisms focused specifically on new products have already been deployed. Evaluating the results of such programs would provide an even better test of the market failure hypothesis, and represents a promising avenue for future research.

An important remaining issue concerns the interpretation of our rather robust results if export growth along the intensive margin is endogenously or simultaneously determined with the number of export discoveries. If they are correlated in the sense of two-way causality, then our results suggest that regulatory barriers to entry affect the relationship between the extensive and intensive margins of trade. This is nevertheless a contribution to the existing literature, but the policy implications would need to be reassessed, at least until further research can more precisely identify the causal relationship between overall export growth and the introduction of new export products.

[12] For a more detailed discussion, see Rodrik (2004).

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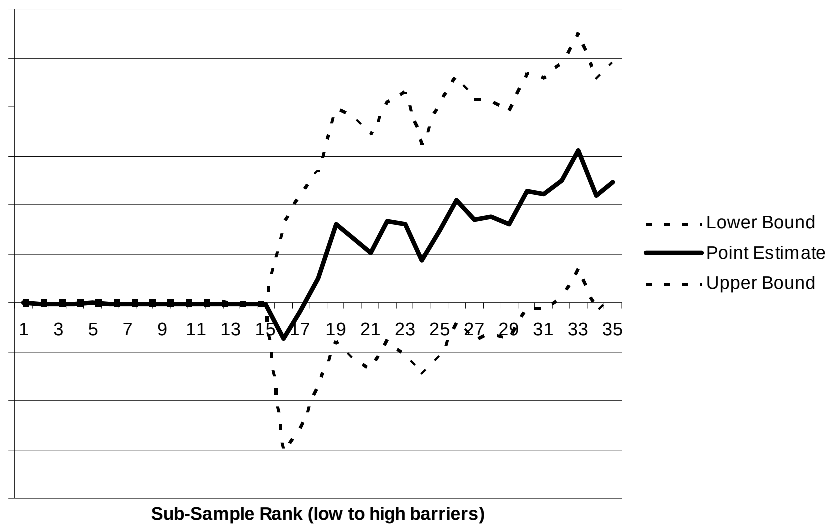
Figures & Tables

Figure 1
Effects of Returns on Discovery: Non-Linear Effect of Barriers



Source: Author's Calculations. Dashed lines indicate 90% confidence interval

Table 1: Stages of Export Diversification

(Country FEs estimation; data from 1992-2003)

	Herfindahl Index
GDP per capita	-.0000117
	(2.41)**
GDP per capita^2	2.60e-10
	(2.46)**
Diversification/Specialization Transition Point	$22,500
Observations	1140
Number of Countries	130

Absolute value of t statistics in parentheses
** significant at 5%

Table 2: Export Discoveries, Patents and the Level of Development

	Export Discoveries: counts	Patents: counts
ln(GDP per capita)	8.667	-16.237
	(6.53)***	(2.96)***
ln(GDP per capita)^2	-0.514	1.059
	(6.67)***	(3.43)***
Constant	-32.289	65.872
	(5.71)***	(2.74)***
Observations	73	68

Absolute value of z statistics in parentheses
*** significant at 1%

Table 3: Export Discoveries and GDP per Capita by Leamer (1984) Commodity Groups

Leamer Commodity Group	Number of Discoveries[N1]	Discovery Curve Maximum Point (GDP per capita)
Petroleum	1.17	2052**
Raw Materials	0.85	4901***
Forest Products	0.73	4416***
Tropical Agriculture	0.49	4486***
Animal Products	0.73	4109***
Cereals, etc.	0.72	4055***
Labor Intensitve	0.38	3626***
Capital Intensive	0.56	4546***
Machinery	0.61	4578***
Chemical	0.78	6838***

N1: normalized by the number of lines in the HS 1989/1992 nomenclature composing that category. ** significant at 5%; *** at 1%. Country fixed effects are included, but not reported. Source: Author's Calculations.

Table 4: Negative-Binomial Estimation Results:
Determinants of Export Discovery Counts during 1994-2003 by Industry

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP per capita)	8.436	8.245	8.310	6.657	13.927	2.382
	(9.09)***	(8.83)***	(8.14)***	(3.76)***	(3.88)***	(0.55)
Ln(GDP per capita)^2	-0.507	-0.495	-0.498	-0.404	-0.812	-0.231
	(9.24)***	(8.91)***	(8.32)***	(3.90)***	(4.04)***	(1.32)
Ln(historical discoveries)	0.305	0.305	0.304	0.249	0.257	0.160
	(3.39)***	(3.39)***	(3.37)***	(2.87)***	(2.88)***	(1.74)*
Factor Endowments	0.349	0.354	0.355	0.397	0.383	0.376
	(0.98)	(0.99)	(1.00)	(1.08)	(0.98)	(0.97)
π	0.368	0.501	0.493	0.434	0.523	-8.146
	(1.71)*	(2.08)**	(2.04)**	(1.75)*	(2.06)***	(3.90)***
$\pi \times barriers$	0.674	0.748	0.736	0.652	0.774	2.711
	(1.77)*	(2.13)**	(2.09)**	(1.80)*	(2.09)**	(3.88)***
Barriers	-0.003	0.026	0.237	0.583	4.733	-2.752
	(0.04)	(0.25)	(0.28)	(0.56)	(1.82)*	(0.68)
$\pi \times \ln(GDPpc)$			-0.022	-0.050	-0.476	0.437
			(0.24)	(0.45)	(1.72)*	(0.84)
Leamer-industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Barriers index excludes costs of entry	No	Yes	Yes	Yes	Yes	Days to clear customs for exports only (log)
Regional dummies	No	No	No	Yes	Yes	Yes
Regional dummies times barriers				No	Yes	Yes
Observations	510	510	510	510	510	510

Notes: Absolute value of robust z-statistics reported within parentheses. Significant at 1%***, 5%**, 10%*. Note: See text and Appendix for definitions of variables. The excluded regional dummy variable in models 4-6 corresponds to South Asia, which in this sample is India. The other significant interactions between regional dummies and the barriers indexes are Africa (which is negative and significant at 1% level) and Eastern Europe and Central Asia (ECA, which is negative and significant at the 10% level). The excluded Leamer commodity group in all specifications is mining and petroleum.

Table 5. Negative-Binomial Estimation Results: Determinants of Export Discovery Counts during 1994-2003 by Country

	(1)	(2)	(3)	(4)	(5)
Ln(GDP per capita)	8.635*** (5.70)	8.319*** (5.21)	8.321*** (3.14)	15.452** (2.79)	7.183 (0.78)
Ln(GDP per capita)^2	-0.519*** (5.51)	-0.500*** (4.98)	-0.507*** (3.18)	-0.904*** (2.85)	-0.441 (1.13)
Ln(Historical discoveries)	0.342** (2.09)	0.341** (2.08)	0.268** (2.49)	0.258** (2.42)	0.229* (1.87)
Factor endowments	0.100 (1.10)	0.102 (1.11)	0.097 (1.44)	0.098 (1.32)	0.024 (0.29)
π	0.189 (0.72)	0.266 (0.94)	0.282 (1.36)	0.350 (1.55)	-5.611* (1.93)
$\pi \times barriers$	0.356 (0.77)	0.405 (0.98)	0.437 (1.43)	0.522* (1.63)	1.865* (1.93)
Barriers	-0.083 (0.42)	-0.044 (0.18)	-0.022 (0.09)	5.349 (1.38)	0.793 (0.10)
$\pi \times \ln(GDPpc)$				-0.497 (1.17)	0.035 (0.03)
Leamer-industry Dummies	Yes	Yes	Yes	Yes	Yes
Barriers index excludes costs of entry	No	Yes	Yes	Yes	Days to clear customs for exports only (log)
Regional Dummies	No	No	Yes	Yes	Yes
Regional Dummies times Barriers	No	No	No	Yes	Yes

Notes: Absolute value of robust z-statistics reported within parentheses. Significant at 1%***, 5%**, 10%*. The dependent variable is the count of export discoveries by country during 1994-2002. They correspond to estimations with clustered errors around countries. Factor endowments are proxied by the average of net exports of each Leamer industry during 1989-1993. π is the profitability of exports for each Leamer industry proxied by export growth of each industry (without the contribution of export discoveries) minus non export GDP per capita growth. The barriers index under columns 2-4 excludes the data on costs of starting a business. The excluded industry is mining and petroleum and the excluded Region is South Asia in the specification with industry and regional dummies. In models 4 and 5, the only other significant interaction is the one between Africa and the barriers index, which is negative. See text and appendix tables for further details.

Appendix

Composition of Sample

We take all countries that report exports in COMTRADE during at least two years during the 1994-1996 pre-window period, as well as in the 2002-2003 post-window period, eliminate those missing at least two consecutive years of data during the 1997-2002 window (necessary for purposes of identifying reclassifications), and dropping microstates (countries with a 1995 population less than 500,000 according to the World Bank WDI), we the cross-section of 73 countries in our sample listed in Table A.III below.

Identifying Cases of Reclassification

As discussed in the text, the discovery filter would misidentify cases of commodity reclassification (when a country begins to report a particular group of goods separately that were previously aggregated in a 'not elsewhere specified' product line) as discoveries. While it is not possible to identify each case of reclassification directly, we have developed a systematic and objective filter by recording discoveries by year between 1997 and 2002 (based on the year the export good first emerges) and identifying extreme outliers.

We would not necessarily expect the same number of discoveries in each year from 1997 to 2002, because with each passing year the test for novelty becomes more stringent and the incubation period between when the export first emerges and the years 2002/2003 when it must be established (exported for more than $10,000 in both years) is shorter. Therefore, after recording country discoveries for each year from 1997-2002, we regress the pooled observations on year dummies as well as total country discoveries. The regression results are shown below in Table A.I. Based on this regression, we have for a given overall level of discovery activity the expected temporal profile of discovery for each of the six years in the window.

Table A.I: Estimation Results for Reclassification Filter

	Discoveries in Country-Year
year1997_dummy	1.457
	(12.36)**
year1998_dummy	0.944
	(7.83)**
year1999_dummy	0.334
	(2.66)**
year2000_dummy	0.146
	(1.15)
year2001_dummy	-0.073
	(0.56)
ln(totalcountrydiscoveries)	1.005
	(25.24)**
Constant	-2.450
	(13.47)**

Observations	438

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%
Source: Author's Calculations

When a customs agency begins to report a group of products previously grouped in a n.e.s line, there will be an uncharacteristic jump in registered discoveries in one particular year. As such, we flag country/years when the standard errors of these estimates are greater than one standard deviation (as calculated with the pooled data). This identifies outliers, but is biased towards large-discovery countries. Therefore, we also flag country/years when the standard errors of the estimates, normalized by total country discoveries, are greater than one standard deviation of the pooled normalized standard errors. These estimates are biased towards low discovery-activity countries. Therefore, the common set is restricted to extreme outliers, given a country's total discovery activity and temporal effects.

Using this filter, we identify 19 cases when there is a hugely uncharacteristic jump in new exports given the year and overall discovery activity. We treat all identified discoveries during these country/years as reclassifications and drop them from the total country discovery counts. Table A.II shows the country/years discarded.

Table A.II: Country-Years Discarded as Reclassifications

Country	Year
Costa Rica	1997
Estonia	1997
Israel	1997
Netherlands	1997
El Salvador	1997
Slovak Republic	1997
Switzerland	1998
Peru	1998
Paraguay	1998
Sweden	1998
Indonesia	1999
Jordan	1999
Madagascar	2000
Oman	2000
Paraguay	2000
Egypt, Arab Rep.	2001
United Kingdom	2001
Denmark	2002
Egypt, Arab Rep.	2002

Source: Author's Calculations

In addition to reclassifications within countries, we also check the data for reclassifications within products. While the consistent use of the 1988/92 revision should prevent the data from including reclassifications through the addition of a product line to the nomenclature that pre-existed, there is one significant outlier in the data: product

271000 (Oils petroleum, bituminous, distillates, except crude). This particular product was a ‘discovery’ in 14 countries in 2002, almost double the instances of the next most frequent discovery in all years of the window combined. This obvious product/year outlier was therefore dropped from the dataset.

Identified Cases of Inside-The-Frontier Innovation

Table A.III: Discoveries by Country

Algeria	38	Greece	46	Niger	10
Argentina	29	Guatemala	106	Norway	9
Australia	34	Honduras	59	Oman	115
Austria	5	Hong Kong, China	46	Panama	51
Bolivia	88	Hungary	90	Paraguay	37
Brazil	44	India	94	Peru	49
Canada	19	Indonesia	119	Poland	221
Central African Republic	3	Ireland	66	Portugal	27
Chile	42	Israel	78	Romania	114
China	10	Italy	5	Singapore	2
Colombia	73	Japan	11	Slovak Republic	22
Costa Rica	42	Jordan	102	Slovenia	43
Cote d'Ivoire	33	Korea, Rep.	30	Spain	5
Croatia	47	Latvia	68	Sudan	15
Cyprus	26	Macedonia, FYR	42	Sweden	4
Czech Republic	8	Madagascar	19	Switzerland	2
Denmark	30	Malawi	14	Togo	34
Ecuador	57	Malaysia	41	Turkey	30
Egypt, Arab Rep.	32	Mauritius	98	Uganda	17
El Salvador	46	Mexico	13	United Kingdom	31
Estonia	53	Moldova	33	United States	1
Finland	8	Morocco	81	Uruguay	62
France	4	Netherlands	2	Venezuela	38
Gabon	22	New Zealand	20		
Germany	20	Nicaragua	54		

Table A.IV: Discoveries by Leamer Commodity Cluster

Leamer Commodity Group	Number of Discoveries Worldwide
Petroleum	41
Raw Materials	253
Forest Products	147
Tropical Agriculture	129
Animal Products	220
Cereals, etc.	165
Labor Intensitve	360
Capital Intensive	587
Machinery	541
Chemical	646

Data Definitions and Sources

Variable Name	Description	Units	Year(s) Used	Transformation	Source
ln(GDP Per Capita)	Natural log of real GDP per capita (PPP)	2000 PPP Constant Prices	1995 (Table 1 uses all years)	log	World Bank WDI
Population	Population	Count	1995	None	World Bank WDI
$\overline{\pi}$	Growth of non-discovery exports (at the Leamer commodity group level) minus non-export GDP per capita growth	decimal form	1994-2003	None	COMTRADE & World Bank WDI
ln(historical discoveries)	Historical discovery counts*	Total counts between 1984 and 1993	1984-1993	log**	COMTRADE
Factor Endowments	Average value of net exports per capita between 1989 & 1993	Current dollars per capita	1989-1993	Net exports for each year divided by that year's population.	COMTRADE & World Bank WDI
Cost of starting a business	Cost of obtaining legal status to operate a firm.	2000 US dollars (PPP)	2004	Original in % of GDP per-capita. Multiplied by 2003 GDP per capita (PPP) to obtain dollar figure. log**	Cost measure: World Bank (2004). GDP per capita (PPP): World Bank WDI.
Days to start a business	Number of days to obtain legal status to operate a firm	Count	2004	log**	World Bank (2004).
Cost to enforce a contract	Cost to enforce a payment dispute in the courts	Percent of the debt	2004	log**	Cost measure: World Bank (2004).
Days to enforce a contract	Number of days to enforce a payment dispute in the courts	Count		log**	World Bank (2004).
Labor market rigidity index	Index of labor market rigidity	index	2004	log**	World Bank (2004).
Barriers	Index of the above five measures of barriers, calculated using principal component analysis (one factor)	index	2004	none (index of logs)	Author's calculations based on World Bank (2004)
Days to clear customs for exports	Number of days it takes to clear customs	Count	2004	log	World Bank, Doing Business Database
Ln(Patents)	Patents in US and EU (US: patents in EU only, EU: patents in	Sum of Counts	1994-1999	log**	Lederman and Saenz (2005)

	US only)				

*Historical counts are identified using export data from 1970 onwards at the SITCr1 3-digit level. The filter identifies a discovery in the year it first appears as an export greater than 0. The period 1974-1983 is used to create baseline of existing exports, the period 1984-1993 to generate counts of discoveries. The filter drops countries from the sample missing more than 7 years of data in the 1974-1983 period (to ensure at least three years of data exist to identify existing exports) and more than 5 years of data in the 1984-1993 period.

**Before taking logs, 1 added to each to keep observations of 0 in the sample

Descriptive statistics of data used in regressions reported in Table 4 and others discussed in the text.

Variable	Mean	Standard Deviation	Minimum	Maximum
Full Sample (N=510)				
Discoveries by Leamer Commodity Groups	4.42	6.83	0.00	48.00
Log (GDP per capita) in 1995	9.11	0.98	6.33	10.32
Log (historical discoveries by Leamer Groups)	0.29	0.51	0.00	2.64
Factor Endowments [Average net exports per person by Leamer Groups, 1989-1993]	0.00	0.28	-0.90	4.39
$\overline{\pi}$ [Export growth net of non-export GDP]	0.72	4.98	-0.53	35.98
Barriers Index with Cost of Starting a Business	-0.12	0.91	-2.29	1.18
Barriers Index without Cost of Starting a Business	-0.13	0.88	-2.29	1.19
Log (days to clear customs for exports)	2.76	0.59	1.61	3.87
Sample without Malaysia (N=500)				
Discoveries by Leamer Commodity Groups	4.43	6.86	0.00	48.00
Log (GDP per capita) in 1995	9.12	0.99	6.33	10.32
Log (historical discoveries by Leamer Groups)	0.30	0.52	0.00	2.64
Factor Endowments [Average net exports per person by Leamer Groups, 1989-1993]	0.00	0.28	-0.90	4.39
$\overline{\pi}$ [Export growth net of non-export GDP]	0.01	0.13	-0.53	0.78
Barriers Index with Cost of Starting a Business	-0.11	0.92	-2.29	1.18
Barriers Index without Cost of Starting a Business	-0.12	0.88	-2.29	1.19
Log (days to clear customs for exports)	2.76	0.60	1.61	3.87