Structural Transformation in Ecuador

Article · May 2010

2 authors, including:

Ricardo Hausmann
Harvard University
255 PUBLICATIONS   **17,015** CITATIONS

STRUCTURAL TRANSFORMATION IN ECUADOR

Ricardo Hausmann
Bailey Klinger

STRUCTURAL TRANSFORMATION IN ECUADOR

Ricardo Hausmann
Bailey Klinger

IDB

Inter-American Development Bank

2010

 E-Mail: ricardo_hausmann@harvard.edu (Hausmann), bailey_klinger@hks.harvard.edu (Klinger)

Structural Transformation in Ecuador

Ricardo Hausmann[*]
Center for International Development and Kennedy School of Government
Harvard University

Bailey Klinger[†]
Center for International Development, Harvard University

Abstract

This paper applies new techniques and metrics to analyze Ecuador's past record of and future opportunities for structural transformation. Ecuador's export dynamics and the emergence of new export activities have been the historical drivers of the country's growth, but recently Ecuador's export basket has undergone little structural transformation. The same broad sectors continue to dominate, and the overall sophistication of the export basket has actually declined in recent years. In order to consider why movement to new, more sophisticated export activities has lagged in Ecuador, we examine export connectedness and find that the country is concentrated in a peripheral part of the product space. We quantitatively scan Ecuador's efficient frontier and identify new, high-potential export activities that are nearby in the product space. This sector evaluation provides valuable information for the government to prioritize dialogue and interventions, but it is not meant to be a conclusive identification of 'winners'. Rather, we provide policy guidelines to facilitate the emergence of these and other new export activities, dealing with the sector-specificity of much of what the government must provide to the private sector to succeed while at the same time avoiding the well-known perils of traditional industrial policies.

---

[*] Director of the Center for International Development and Professor of the Practice of Economic Development at the Kennedy School of Government. E-mail: ricardo_hausmann@harvard.edu
[†] Fellow at Harvard's Center for International Development and Director of the Center's International Finance Lab. E-mail: bailey_klinger@hks.harvard.edu

1. Introduction

The purpose of this paper is to apply new techniques and metrics to analyze Ecuador's record of opportunities for structural transformation. Ecuador's export dynamics and the emergence of new export activities have been the key drivers of the country's cycles of economic growth during the past 70 years (Cueva, Albornoz and Avellan 2007). But we find that recently Ecuador's export basket has undergone little structural transformation over the past decade. The same broad sectors continue to dominate, and the overall sophistication of the export basket has actually declined in recent years. This is worrying, because we also show that Ecuador's existing export sectors have little room for growth through quality upgrading, and are typical of much poorer countries.

In order to consider why movement to new, more sophisticated export activities has lagged in Ecuador, the next section examines export connectedness and finds that the country is concentrated in a peripheral part of the product space. This section also reveals greater opportunities for the future than suggested by its current low level of export sophistication.

The final section uses these metrics of sophistication and density to scan Ecuador's efficient frontier and identify new, high-potential export activities. Those same metrics are used to evaluate the government's emerging list of priority sectors. This sector evaluation provides valuable information for the government to prioritize dialogue and interventions, but it is not meant to be a conclusive identification of 'winners'. Rather, policy guidelines are provided to facilitate the emergence of these and other activities, dealing with the sector-specificity of much of what the government must provide to the private sector to succeed while at the same time avoiding the well-known perils of traditional industrial policies that have been laid out. These guidelines offer a potential way forward that would allow Ecuador to accelerate its recently lagging structural transformation and accelerate economic growth and poverty reduction in the country

2. Ecuador's Export Basket

A first pass at analyzing the changes in Ecuador's productive structure is simply to look at the sectoral composition of the export basket. The figure below shows the composition of exports by Leamer commodity group in 2000 and 2007.

Ecuador's exports are dominated by oil, whose share has risen during the past seven years and as of 2007 represented almost 60 percent of export earnings. The other major export sectors are of tropical agriculture and animal (including seafood) products. These two sectors together represent nearly the other third of Ecuador's export earnings. Between 2000 and 2007, these sectors each grew by 20 percent in absolute terms, but fell as a percentage of total exports due to the even faster growth in oil exports.

Figure 1

Ecuador's Exports by Leamer Group
(Percentage)
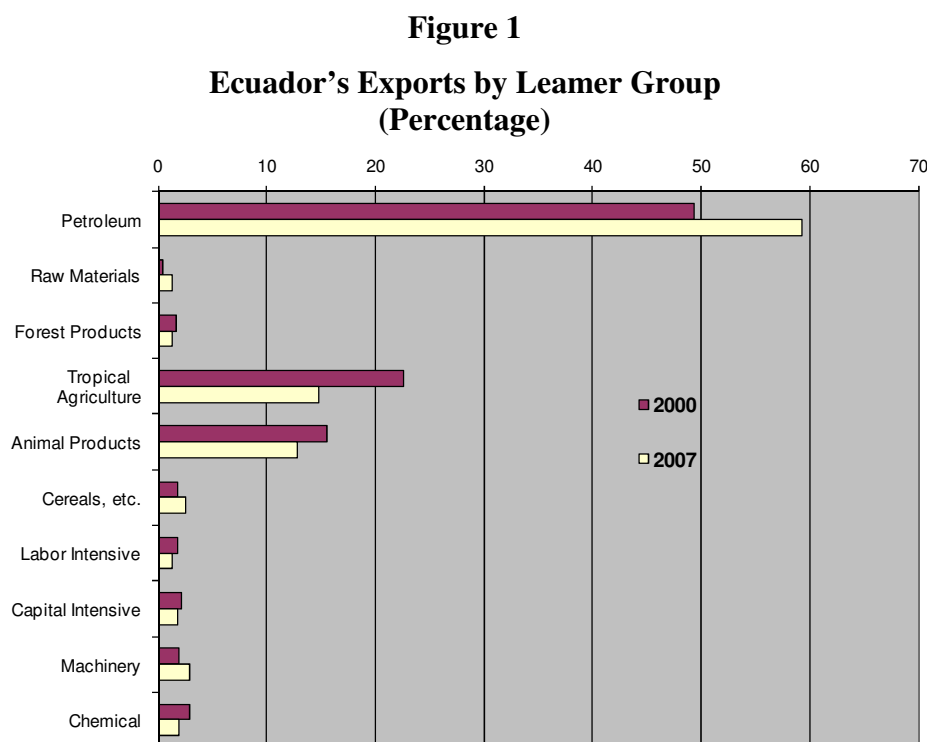
Source: Authors' calculations using UN COMTRADE.

Oftentimes, looking at export composition in dollar or percentage terms can be misleading, as changes in world export patterns can be confounded with country-level changes. In order to get a sense of how Ecuador's comparative advantage has evolved over the past decade, we can consider Revealed Comparative Advantage (RCA), which adjusts for the share of each sector in world exports. We use the Balassa (1986) definition, where *xval* is the export value of sector *i* in country *c* in year *t*:

$$RCA_{c,i,t} = \frac{xval_{c,i,t} \Big/ \sum_i xval_{c,i,t}}{\sum_c xval_{c,i,t} \Big/ \sum_i \sum_c xval_{c,i,t}} \quad (1)$$

This is the ratio of the percentage of the sector in a country's export basket to the percentage of that sector's total share in world exports, or alternatively, the percentage of the country's market share in that sector to the country's overall market share in exports. When this value is above 1, the country is said to have comparative advantage.

Figure 2

Revealed Comparative Advantage by Leamer Group (Index)
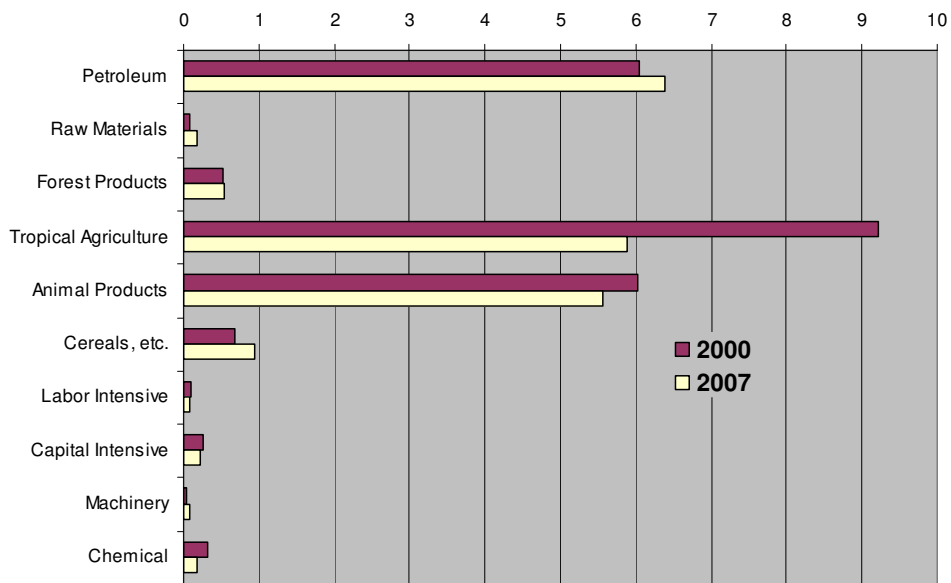
Source: Author's calculations using UN COMTRADE.

Ecuador has comparative advantage in its three main export sectors: petroleum products, tropical agriculture, and animal products. But some interesting differences can be noted between figures 1 and 2. First of all, although oil export earnings grew significantly in dollar and percentage terms, the RCA index for oil exports did not grow significantly, likely due to the contribution of oil price increases to the growth in earnings, which were similarly enjoyed by other oil-exporting countries. Second, compared to other countries in the world, animal products

3

and tropical agriculture are very significant sectors in Ecuador's export basket, more so than suggested by export shares alone, although they have been falling. Finally, although exports of cereals are small in value terms ($350 million in 2007), Ecuador very nearly has a comparative advantage in this sector as well (RCA index of .95). Forestry products also emerge as an important sector when considering the RCA index rather than export earnings only.

This picture shows that Ecuador's structure of production is concentrated in oil and agriculture. In the past seven years, this structure has not undergone any significant changes. It has shifted somewhat to the oil sector, which has not been growing faster than in other oil exporting countries. Meanwhile, the other dominant sectors of tropical agriculture and animal products have not quite kept pace with other major exporters, while cereals have enjoyed moderate growth.

But these composition changes are difficult to interpret. The Leamer commodity group are highly aggregated, and within each of them there are sophisticated activities paying higher wages as well as simple commodities. How is the process of structural transformation proceeding in Ecuador? Does the relative decline of the non-oil sectors imply that the country is not successfully moving from simple low-wage sectors to more sophisticated high-wage sectors? Do these broad categories mask structural transformation at the more disaggregated product level? To consider these questions and gain a richer understanding, we must apply new methodologies to analyze the process of structural transformation.

3. Exploring 'Quality': Unit Value Gaps

One dimension in which we can examine Ecuador's export package is quality. Recent research finds that when a country exports a new product, it tends to enter the market at a lower quality. But this quality, as measured by unit prices, converges to the global frontier at a rate of 5 to 6 percent per annum *unconditionally* (Hwang 2007). That is, once a country begins to successfully export a particular product, its quality increases to the global frontier unconditionally at a relatively rapid pace. The implication of this finding is that countries that are currently farther away from the global frontier in products already exported have access to a relatively rapid, and seemingly unconditional, channel of growth.

To determine if this channel of growth is open to Ecuador, taking the gap in logs between a country's unit price for each (Rauch-differentiated) export sector and the world's frontier price,

and the weighting of each sector by its share of the country's total export basket, we can calculate country-level quality gaps.

Figure 3

Unit Value Gaps, 1998-2000 Average (Percentage)
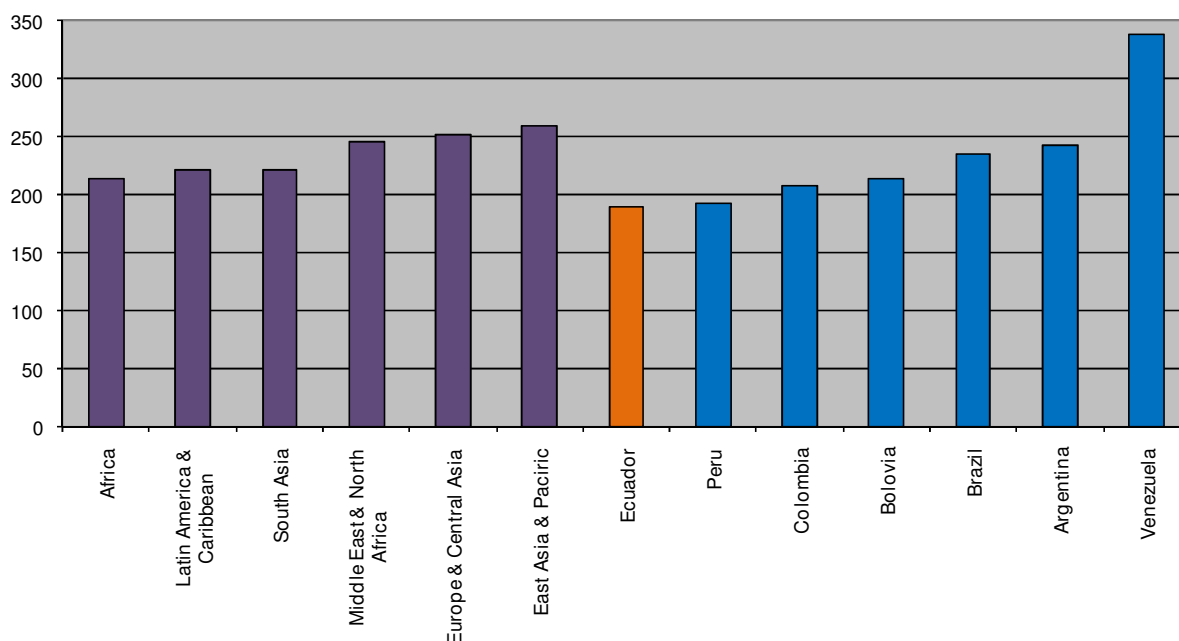
Source: Author's calculations using Hwang (2006), for only Rauch-differentiated goods. Gaps for the six regions are median values.

This figure shows that as of the end of the 1990s, Ecuador had the lowest export-weighted unit value gap among regional comparators. In fact, the space to upgrade quality within existing export activities was even lower than the median value in Sub-Saharan Africa, which is the region with the lowest unit value gaps in the world. This means that Ecuador's non-oil exports fetch a price per unit comparable to the highest unit prices in the world in those goods, which suggests that the dimension of export growth through improving quality in existing sectors does not hold much promise.

Instead, new activities will likely have to emerge. The following section examines Ecuador's record of transforming its structure of production towards newer, more sophisticated sectors.

4. Exploring Composition: Export 'Sophistication'

Recent research by Hausmann, Hwang, and Rodrik (2007) shows that the composition of a country's export basket has important implications for economic growth. Countries that have a more 'sophisticated' export basket enjoy accelerated growth, while those that remain in less sophisticated export sectors lag behind.

The authors measure this sophistication indirectly by examining the wages of countries who are intensive exporters of each product. First, they measure the sophistication of each product, which they call *PRODY*, which is the revealed comparative advantage (RCA)-weighted GDP per capita of each country that exports the good:

$$PRODY_{i,t} = \sum_c \frac{\left(xval_{i,c,t} / X_c\right)}{\sum_j \left(xval_{i,c,t} / X_c\right)} Y_c \quad (2)$$

where $xval_{i,c,t}$ equals exports of good i by country c in year t, X_c equals total exports by country c, and Y_c equals GDP per capita of country c. This is a measure of the GDP per capita of the 'typical' country that exports product i. Richer-country goods are more sophisticated and are associated with higher wages.

This product-level measure of sophistication is then used to measure the sophistication of a country's export basket as a whole. The authors call this measure *EXPY*. *EXPY* is simply the *PRODY* of each good (i) that country c exports, weighted by that good's share in the country's export basket (X_c). It represents the income level associated with a country's overall export package.

$$EXPY_{c,t} = \sum_i \left(\frac{xval_{c,i,t}}{X_{c,t}} \right) PRODY_{i,t} \quad (3)$$

Not surprisingly, the level of income implied by a country's export basket (*EXPY*) is correlated with actual income. That is, rich countries produce rich-country goods, and poor countries export poor-country goods. However, there is significant variance in this relationship. Some countries have managed to discover products that are associated with a level of income

much higher than their own, such as China, India, Indonesia, and Ireland. Moreover, Hausmann, Hwang, and Rodrik show that this variance has important consequences: countries converge to the relative income level implied by their export basket. In essence, countries become what they export. This means that if a country has managed to begin exporting a sophisticated export basket relative to its income level, subsequent growth is higher.

How does Ecuador's level of export sophistication compare to that of its neighbors? The figure below shows the evolution of *EXPY* since 1985 for Ecuador, as well as Argentina, Brazil, Bolivia, Colombia, Peru, and Venezuela.

Figure 4

***EXPY* over Time (Constant 2000 US$ PPP)**
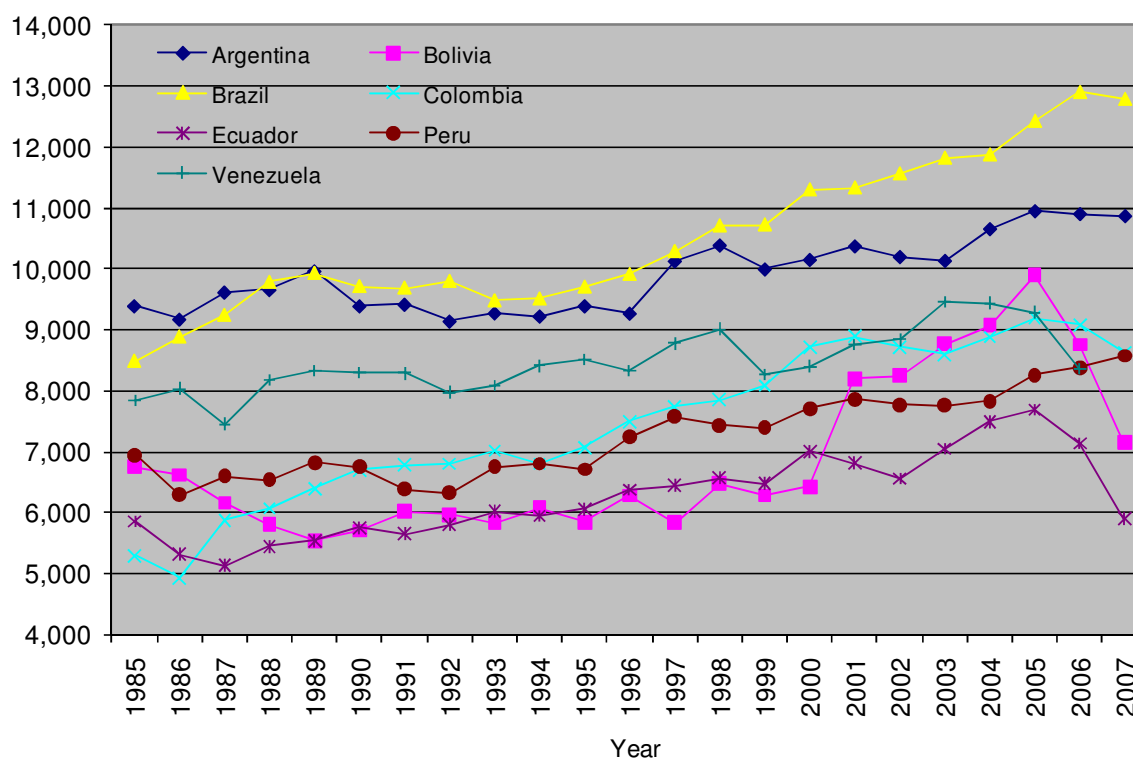
Source:Author's calculations using Feenstra (2005) and UN COMTRADE.

This figure reveals interesting shifts in the composition of exports for the major South American economies. Although Argentina began 1985 with the most sophisticated export basket in the region, Brazil has since overtaken it, with significant shifts towards more sophisticated 'rich-country' type export activities (particularly since the mid-1990s). Colombia, which in 1985

7

had the least sophisticated export basket, also enjoyed rapid structural transformation since the mid-1990s. As of 2007, Colombia had overtaken Ecuador, Bolivia, Venezuela, and Peru, although it has trended downward in the past two years. Similarly, over the past three years, Bolivia and Venezuela have shifted towards export sectors typical of countries with lower levels of income.

The data show that Ecuador's performance over the past two decades was one of sustained but moderate growth in EXPY in the 1990s, followed by two years of decline, another burst of upgrading from 2002 to 2005, and since then a downward track similar to Bolivia and Venezuela. As of 2007, the country has one of the lowest levels of export sophistication in the region.

What are the major products in Ecuador's export basket that are contributing to this low level of export sophistication? The table below shows the 10 sectors that are the largest share of Ecuador's export basket, with *PRODY*<GDP (i.e. the largest export sectors that are typical of poorer countries).

Table 1

Top 10 'Unsophisticated' Products in Ecuador's Export Basket, 2007

Product Name	Exports (US M)	PRODY (PPP)
Bananas, including plantains, fresh or dried	1300	6711
Crustaceans	601	3718
Cut flowers, dried flowers for bouquets, etc,	403	3987
Cocoa beans, whole or broken, raw or roasted	190	1855
Palm oil and its fractions, not chemically modified	121	5970
Gold, unwrought, semi-manufactured, powder form	61	3689
Rice	57	5257
Dates, figs, pineapple, avocado, guava, fresh or drie	55	6059
Tobacco unmanufactured, tobacco refuse	31	2311
Coffee, coffee husks and skins and coffee substitutes	23	2747

Source: Author's Calculation using UN COMTRADE. Products with PRODY<GDP, sorted by export share.

Ecuador's PPP-adjusted GDP per capita in 2007 was $7035, according to the World Bank's world development indicators. In this table we can see that many of its exports are typical of countries that are much poorer. Bananas (which are almost 10 percent of the export basket) are typical of countries that have a similar, although slightly lower, GDP per capita of $6711. Crustaceans, cut flowers, and cocoa beans on the other hand are typical of countries with half of

Ecuador's level of income. If one thinks of GDP per capita as the typical wage, then these sectors are typical of countries paying wages less than one-half of Ecuador's.

What are the sectors pulling up Ecuador's *EXPY*? The products contributing most to Ecuador's current level of export sophistication are listed below.

Table 2

Top 10 Contributors to Ecuador's *EXPY*, 2007

Product Name	PRODY (PPP)	Exports (US M)	Contribution to EXPY
Petroleum oils, oils from bituminous minerals, crude	13648	6930	7435
Motor vehicles for the transport of goods	13812	234	254
Motor vehicles for transport of persons (except buses	19215	104	157
Coal-tar distillation products including oils	13652	111	119
Medicaments, therapeutic, prophylactic use, in dosage	22698	44	78
Fruit, nut, edible plant parts nes, prepared/preserve	12408	79	77
Stoves, ranges/barbecues,etc, non-electric, iron/stee	14198	60	67
New pneumatic tyres, of rubber	21621	29	50
Turbo-jets, turbo-propellers/other gas turbine engine	27868	18	40
Chemical industry products nes	14316	29	33

Source: Author's calculation using UN COMTRADE. Products with PRODY>EXPY, sorted by their total contribution to EXPY (export share multiplied by PRODY).

Many oil-exporting countries have a higher level of GDP per capita than Ecuador. This is due primarily to the smaller Gulf States, which have a very high oil endowment per capita. Other 'rich country' export products from Ecuador include small SUVs and light trucks, exported to its neighbors under the automotive integration program. Although not significant in terms of the export shares observed above, these vehicle exports are a significant contributor to export sophistication. Finally, it is important to note that despite the fact that food and agricultural goods make up many of Ecuador's unsophisticated exports, there are also some agrifood sectors (usually with greater value-added) which support much higher wages and are pulling up *EXPY*, such as exports of prepared/preserved fruit and nut products, which are typical of countries with a GDP per capita much higher than Ecuador's.

Ecuador's lagging level of export sophistication suggests that upgrading to new, more sophisticated activities that pay higher wages is an important challenge for the country. But how does this process work, and how can it be facilitated? This is taken up in the following section, which examines the process by which new activities enter the export basket. This is a more dynamic view that will also illustrate that although in static terms the country's oil sector is

relatively more 'sophisticated' (high *EXPY*) and its agricultural activities unsophisticated (low *EXPY*), the latter may be valuable in terms of leading to the emergence of new activities.

5. Export Connectedness

In standard trade theory, moving to new export products (structural transformation) is a passive consequence of changing comparative advantage based on factor accumulation. However, there are many reasons why structural transformation may be more complicated than this picture suggests. Several factors may create market failures such as industry-specific learning by doing (Arrow 1962; Bardhan 1970) or industry externalities (Jaffe 1986). There may also be technological spillovers between industries (Jaffe, Trajtenberg, and Henderson 1993). Alternatively, the process of finding out which of the many potential products best express a country's changing comparative advantage may create information externalities (Hausmann and Rodrik 2003, Klinger 2007) as those that identify the goods provide valuable information to other potential entrepreneurs but are not compensated for their efforts.

Hausmann and Klinger (2006 and 2007) and Hidalgo et al. (2007) investigate the determinants of the evolution of the level of sophistication of a country's exports, and find that these barriers are less binding when moving to 'nearby' products. This is based on the idea that every product involves highly specific inputs such as knowledge, physical assets, intermediate inputs, labor training requirements, infrastructure needs, property rights, regulatory requirements, or other public goods. Established industries somehow have sorted out the many potential failures involved in assuring the presence of all of these inputs, which are then available to subsequent entrants in the industry. But firms that venture into new products will find it much harder to secure the requisite inputs. For example, they will not find workers with experience in the product in question or suppliers who regularly furnish that industry. Specific infrastructure needs such as cold storage transportation systems may be non-existent, regulatory services such as product safety and phyto-sanitary permits may be difficult to obtain, and so on.

The assets and capabilities needed to produce one good are imperfect substitutes for those needed to produce another good, but this degree of specificity will vary. Correspondingly, the probability that a country will develop the capability to be good at producing one good is related to its installed capability in the production of other similar, or nearby goods for which the

currently existing productive capabilities can be easily adapted. The barriers preventing the emergence of new export activities are less binding for nearby products which only require slight adaptations of existing capacity.

This is shown by first developing a measure of distance between products. The distance between each pair of products is measured based on the probability that countries in the world export both. If two goods need the same capabilities, this should show up in a higher probability of a country having comparative advantage in both. Formally, the inverse measure of distance between goods i and j in year t, which is called proximity, equals

$$\varphi_{i,j,t} = \min\left\{P\left(x_{i,t} \mid x_{j,t}\right), P\left(x_{j,t} \mid x_{i,t}\right)\right\} \quad (4)$$

where for any country c

$$x_{i,c,t} = \begin{cases} 1 & if \quad RCA_{i,c,t} > 1 \\ 0 & \quad otherwise \end{cases} \quad (5)$$

and where the conditional probability is calculated using all countries in year t. This is calculated using disaggregated export data across a large sample of countries from the World Trade Flows data from Feenstra et al. (2005) and UN COMTRADE.

The heterogeneity of the product space can be shown econometrically, yet it is much more revealing to illustrate these pairwise distances graphically. Using the tools of network analysis, we can construct an image of the product space (Hidalgo et al., 2007). Considering the linkages as measured in the 1998-2000 period, we first create the maximum spanning tree by taking the one strongest connection for each product that allows it to be connected to the entire product space. This is shown below.

Figure 5

Maximum Spanning Tree
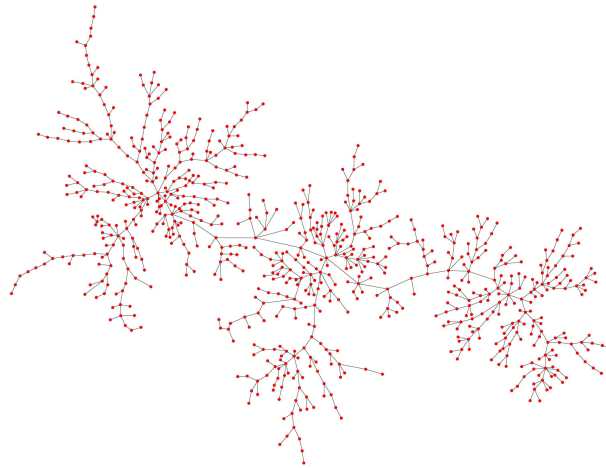
The next step is to overlay this maximum spanning tree with the stronger links, and color-code them based on their proximity. In the Figure below, each node is a product, its size determined by its share of world trade. In these graphs, physical distances between products are meaningless: proximity is shown by color-coding the linkages between pairs of products. A light-blue link indicates a proximity of under .4, a beige link a proximity between .4 and .55, a dark-blue link a proximity between .55 and .65, and a red link a proximity greater than .65 (remember, larger proximity means the products are closer together). Links below 0.55 are only shown if they make up the maximum spanning tree, and the products are color-coded based on their Leamer (1984) commodity group.

Figure 6

A Visual Representation of the Product Space
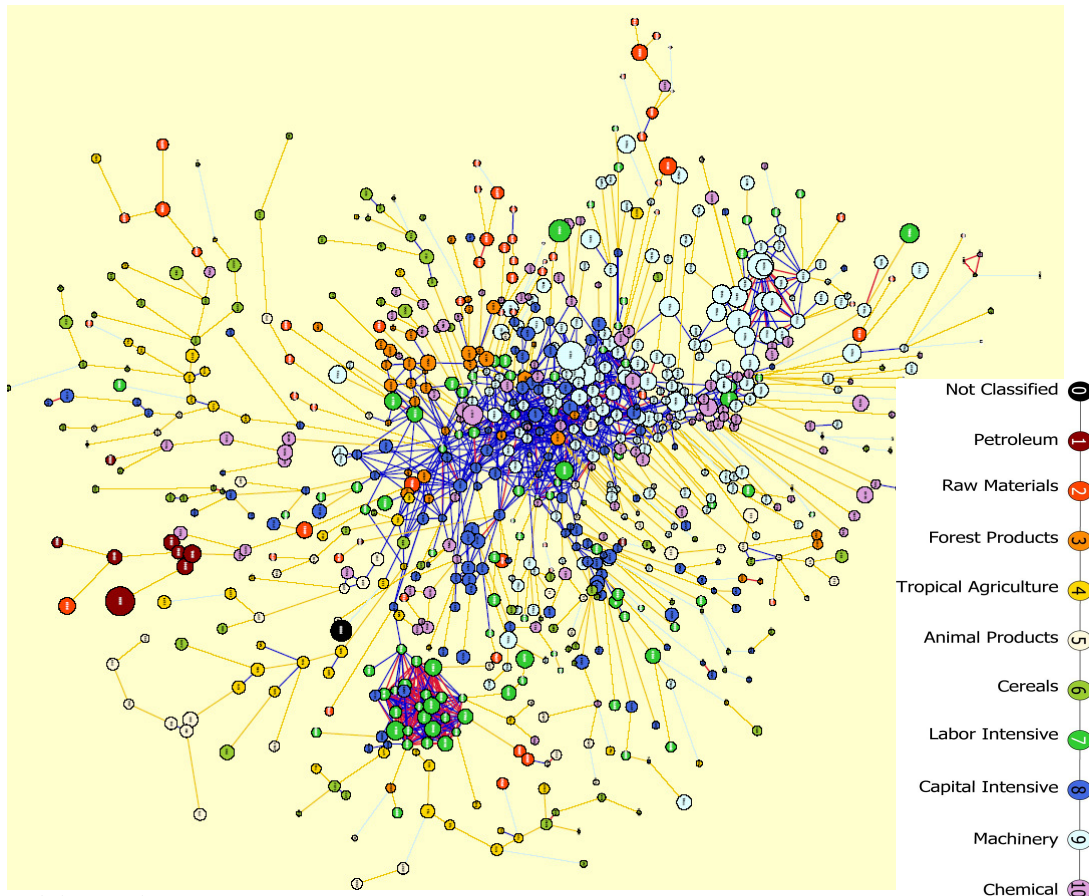
Source: Hidalgo et al. (2007).

We can immediately see from the figure above that the product space is highly heterogeneous. There are peripheral products that are only weakly connected to other products. There are some groupings among these peripheral goods, such as petroleum products (the large red nodes on the left side of the network), seafood products (below petroleum products), garments (the very dense cluster at the bottom of the network), and raw materials (the upper left to upper periphery). Furthermore, there is a core of closely connected products in the center of the network, mainly of machinery and other capital intensive goods.

This heterogeneous structure of the product space has important implications for structural transformation. If a country is producing goods in a dense part of the product space, then the process of structural transformation is much easier because the set of acquired capabilities can be easily re-deployed to other nearby products. However, if a country is specialized in peripheral products, then this redeployment is more challenging as there is not a

13

set of products requiring similar capabilities. The process of structural transformation can be impeded due to a country's orientation in this space.

In order to analyze how a country's production is distributed in this space, and how that structure changes over time, we can place a black square over every product in which a country has significant exports[1] in a particular year. The figures below show Ecuador's position and movement within the product space in 1975, 1985, 1995, 2000, and 2006, as well as some comparator countries in 2000.

Figure 7

Ecuador's Location in the Product Space
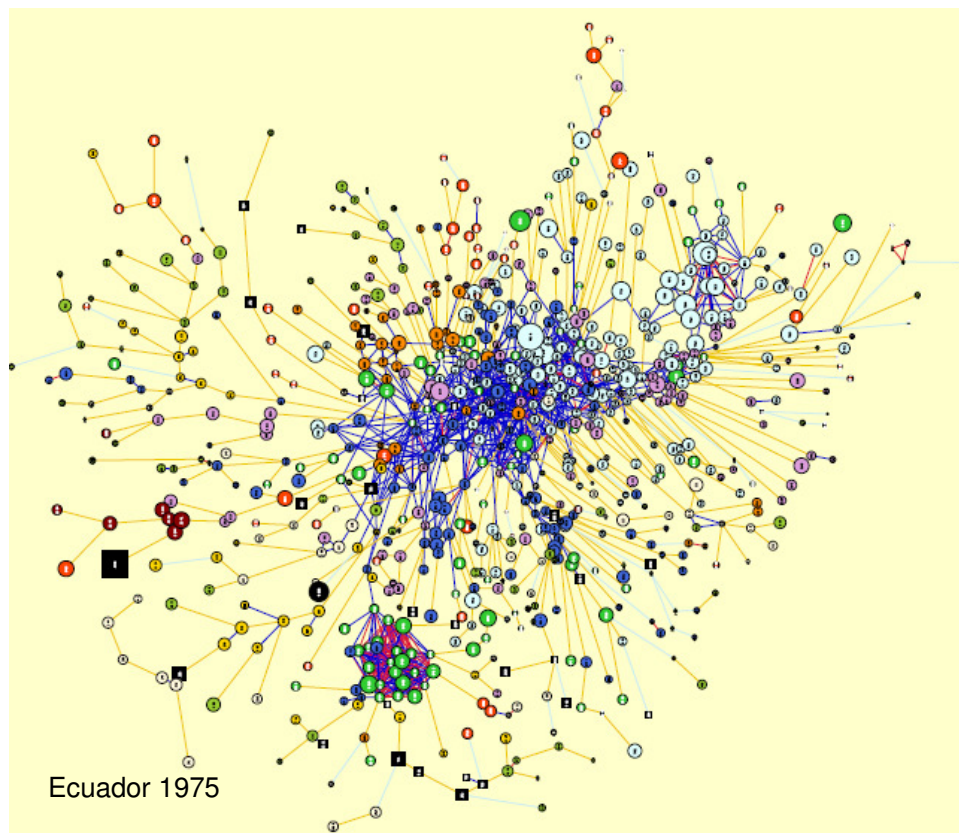
Ecuador 1975

Ecuador 1985

Ecuador 1995

15

Ecuador 2000

Ecuador 2006
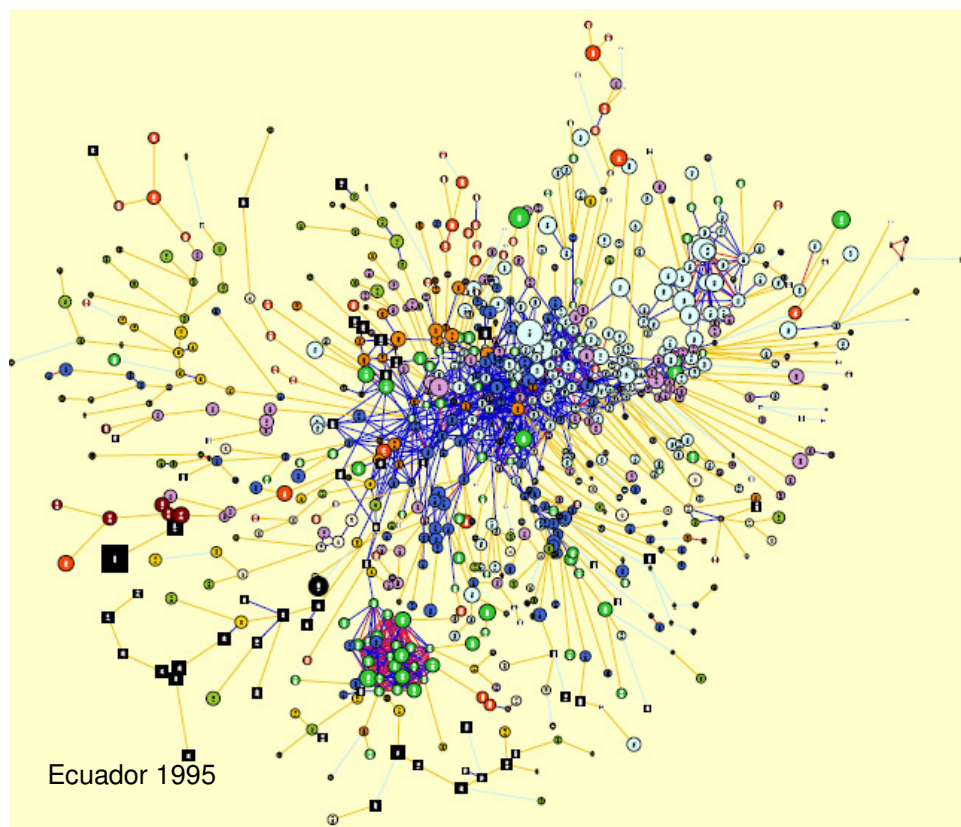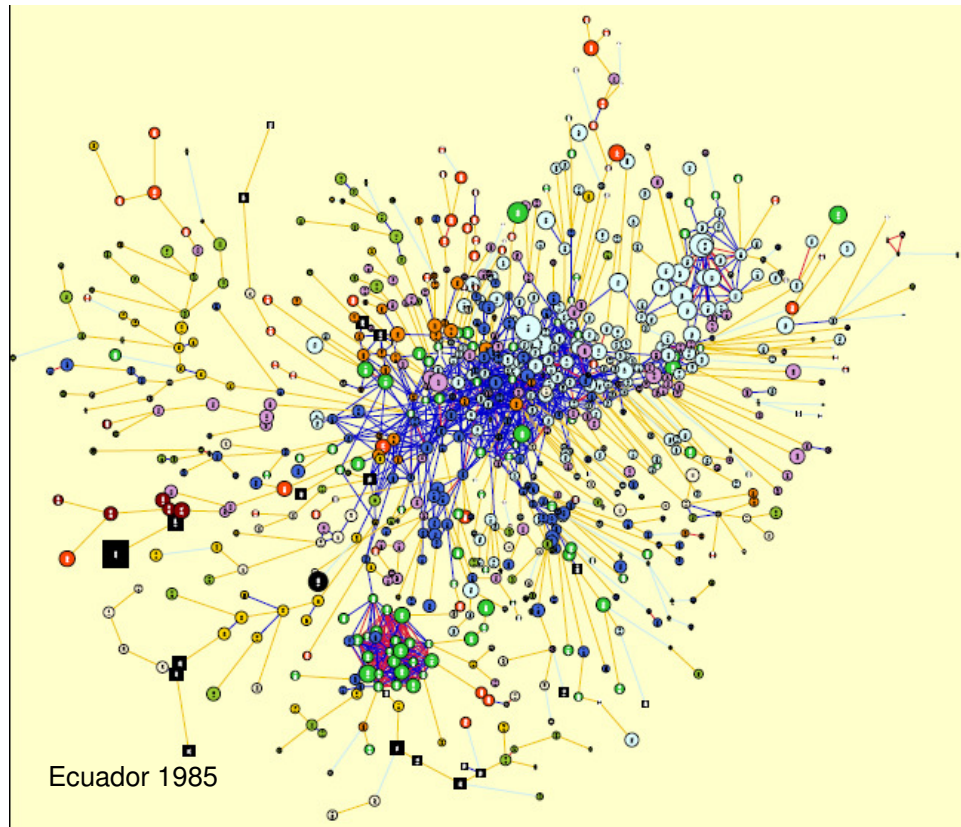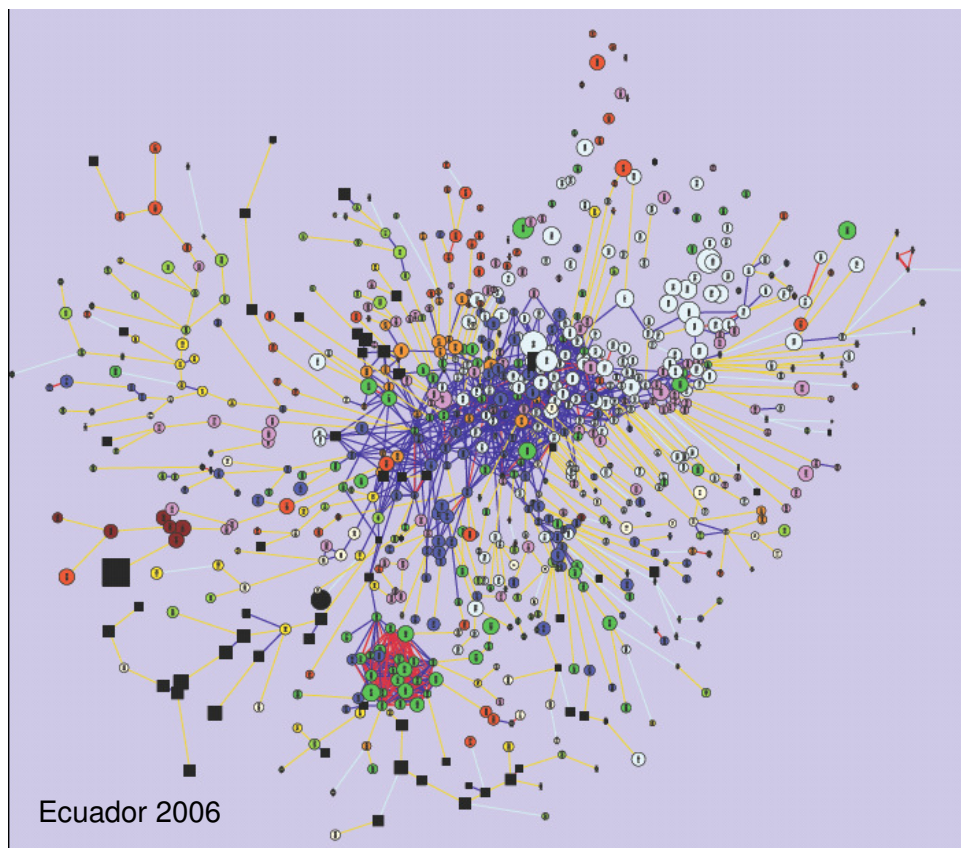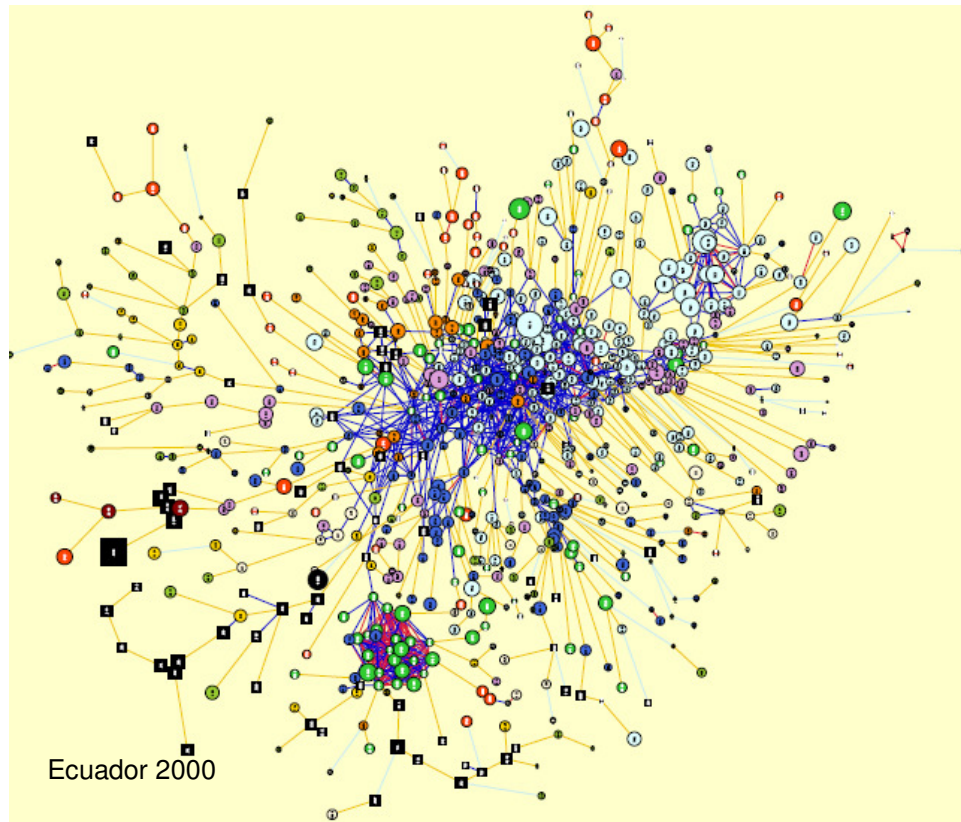
Source: Author's calculations using Hidalgo et al. (2007).

16

Figure 8

Location in the Product Space, Comparators

Argentina 2000

Brazil 2000

Colombia 2000

Peru 2000

Compared to Ecuador, Argentina and Brazil have more activities in the industrial core of the product space. Colombia and Peru do as well, but to a lesser extent. Looking over time, we

see that Ecuador has traditionally occupied a very peripheral part of the product space, with the oil sector dominating. Recently, the country has diversified into other areas of the product space, particularly aquiculture and agricultural activities. Although these are also peripheral, they are better connected in the product space than the oil sector.

The intuition behind this is the following: to successfully exploit oil, a country needs the natural resource endowment, a government that can provide property rights for that resource, and a handful of investors to exploit. These productive capacities are useful for the oil sector and potentially other extractive sectors, but not for many other activities. Agricultural activities require institutions to support more diffuse property rights and private actors, while agroprocessing activities require agronomists, entrepreneurs, and factories. These productive capabilities can be used for a host of other activities, resulting in their being better connected in the product space.

In order to evaluate how connected a particular product is for a country, the distance between products must be combined with export data to measure how close any potential product is to that country's export basket as a whole. This measure, from Hausmann and Klinger (2006), is called density: the density of current production around any good. This is the distance of good *i* from country *c*'s export basket at time *t*. It is the sum of all paths leading to the product in which the country is present, divided by the sum of all paths leading to the product. Density varies from 0 to 1, with higher values indicating that the country has achieved comparative advantage in many nearby products, and therefore should be more likely to export that good in the future.

$$density_{i,c,t} = \left(\frac{\sum_k \varphi_{i,k,t} x_{c,k,t}}{\sum_k \varphi_{i,k,t}} \right) \quad (6)$$

Hausmann and Klinger (2007) show that this measure of density is indeed highly significant in predicting how a country's productive structure will shift over time: countries are much more likely to move to products that have a higher density, meaning they are closer to their current production. This can be observed in looking at Ecuador's map over time.

Using calculated densities, we can show graphically how this product space looks from the point of view of Ecuador's firms. Each product not currently exported with comparative advantage has a particular distance from the country's current export basket, measured by density. In addition, each of these products has a level of sophistication, measured by *PRODY*. We can plot each of these products according to their distance. The x-axis is the inverse of log (density), meaning that a *smaller* value represents a product that is *closer* to the current productive structure, and the y-axis is sophistication, with products color-coded by Leamer commodity cluster. This is shown below for Ecuador. The horizontal line drawn is where the *PRODY* of the good equals the *EXPY* of the country or region. Products below that line are less sophisticated than the country's export basket as a whole.

Figure 9

Proximity vs. Sophistication: the Efficient Frontier, 2007
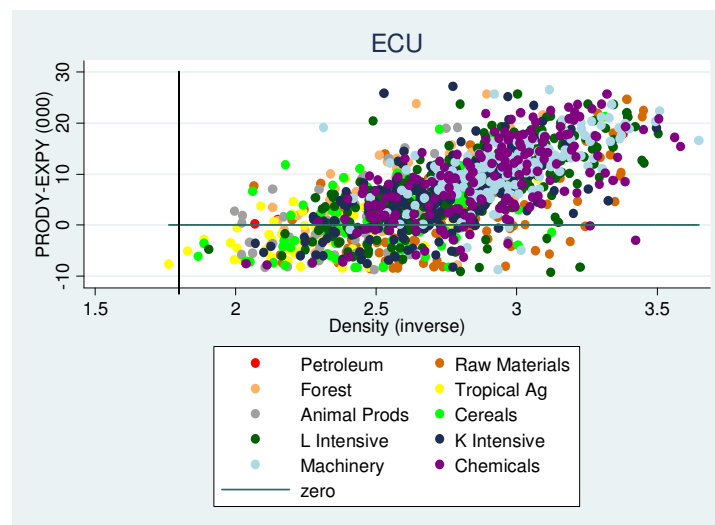
Note: "Animal Prods" is Animal Products, "L intensive" means Labor Intensive, "Tropical Ag" is Tropical Agriculture, and "K intensive" corresponds to Capital Intensive. As for the country name, ECU is Ecuador. Source: Author's calculations using UN COMTRADE.

From the point of view of adding valuable new exports to the current basket, the ideal location on this plane is the upper-left quadrant: goods that are close and also highly sophisticated. This figure suggests a tradeoff between proximity and export sophistication. The products that are closest to the current export basket (and therefore further to the left) are easiest to move toward, yet these nearest products are often not of a high level of sophistication. The more sophisticated products are further away from the current structure of production.

Furthermore, there is an efficient frontier in this tradeoff. Some products are both further away and of lower sophistication than other potential exports, while there are others that have a high *PRODY* and are relatively nearby. Sophistication versus distance is an important tradeoff that we will return to when exploring Ecuador's opportunities for future structural transformation.

Below are equivalent figures for comparator countries. A vertical line has been inserted at a density of 2 to aid in comparisons.

Figure 10

Proximity vs. Sophistication: the Efficient Frontier
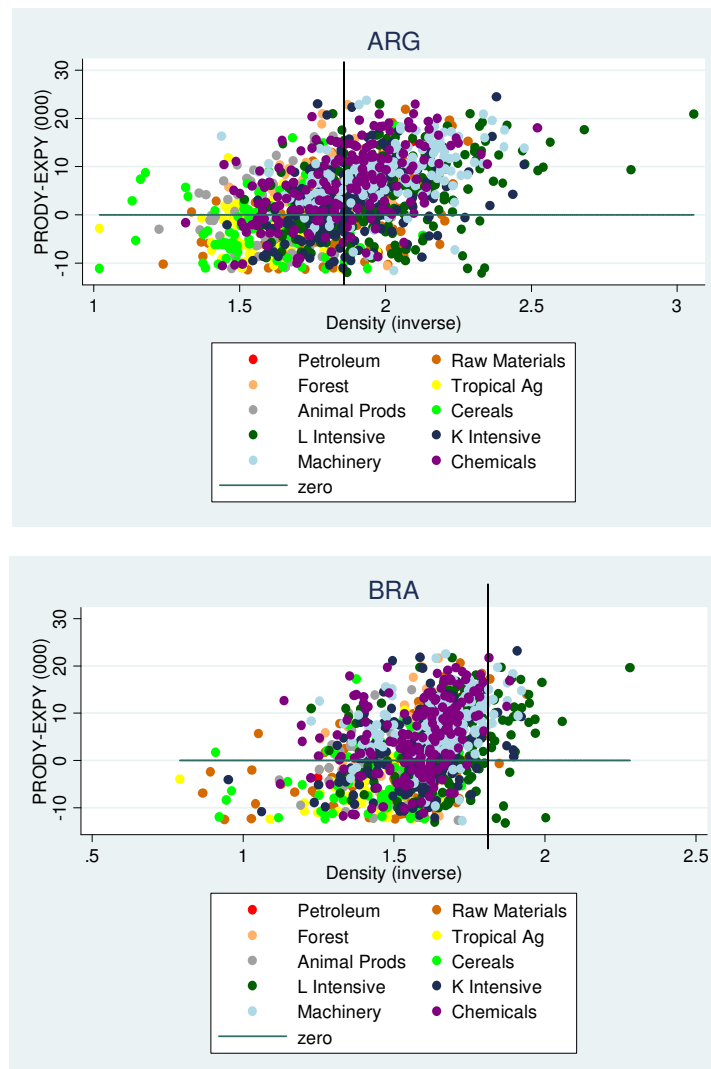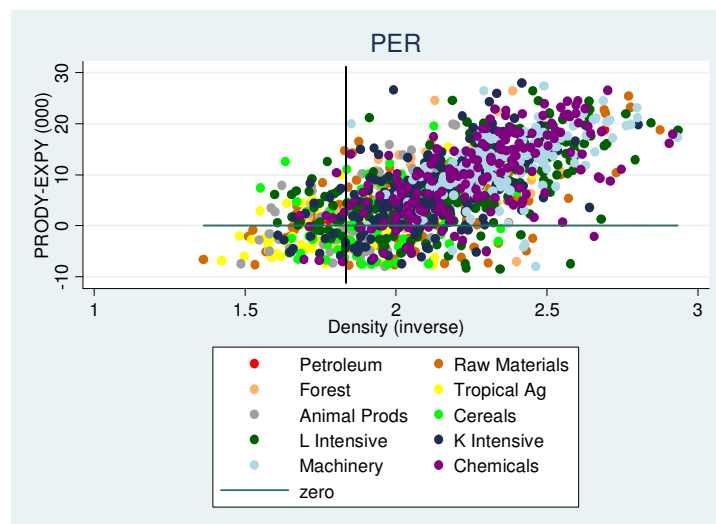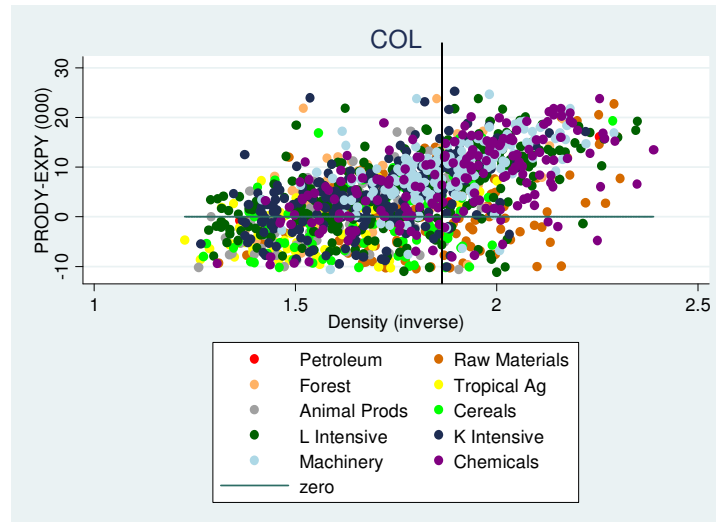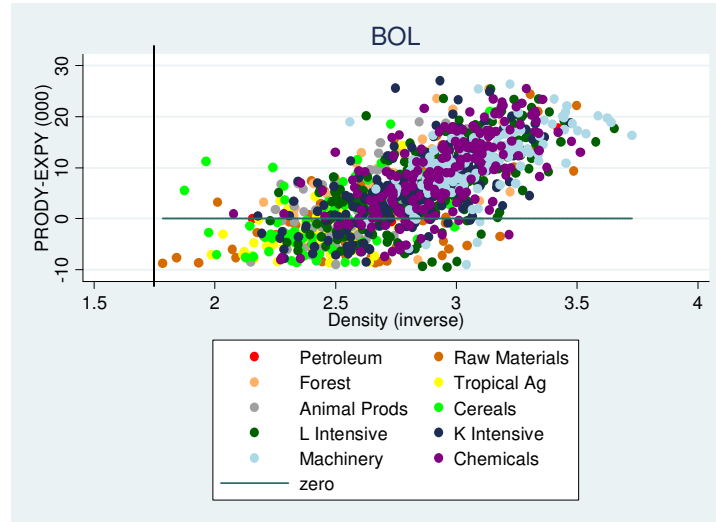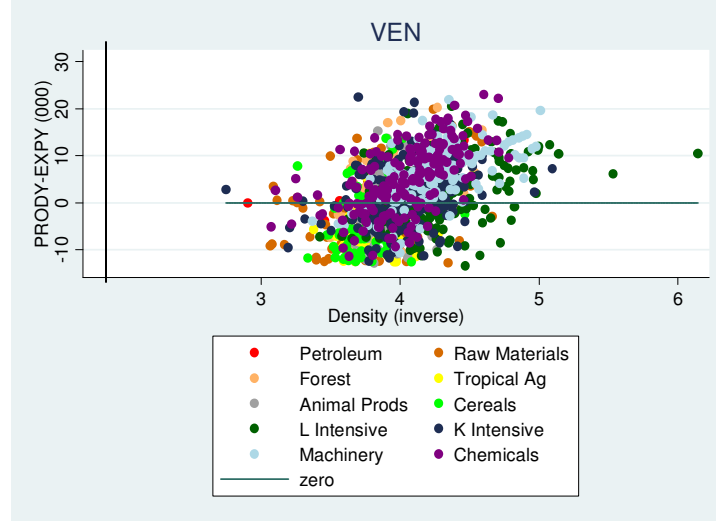
Selected Comparators, 2007

Note: "Animal Prods" is Animal Products, "L intensive" means Labor Intensive, "Tropical Ag" is Tropical Agriculture, and "K intensive" corresponds to Capital Intensive. As for the country names, ARG is Argentina, BRA is Brazil, BOL is Bolivia, COL is Colombia, PER is Peru, and VEN is Venezuela
Source: Author's calculations using UN COMTRADE. Note: VEN data is for 2006.

It is clear that firms seeking to move to newer, more sophisticated export sectors in these countries face quite widely differing option sets. Venezuela is quite isolated, while countries like Argentina, Brazil, and Colombia have a much larger number of nearby opportunities that span almost all potential sectors.

We can aggregate this measure of density, which is for a country around any single product, to an overall measure of the connectedness of a country's export basket. This country-level measure is called 'open forest'. A higher value indicates that the current export basket is a part of the product space that is well connected to other new and valuable opportunities for structural transformation. In other words, a high open forest indicates that the country is located in a dense part of the product space. A low value of open forest indicates the country is specialized in a sparse, unconnected part of the product space. In essence, this number summarizes the visual analysis conducted above with the product space maps.

Open forest is calculated as follows:

$$
open\_forest_{c,t} = \sum_i \sum_j \left[\frac{\varphi_{i,j,t}}{\sum_i \varphi_{i,j,t}} \left(1 - x_{c,j,t}\right) x_{c,i,t} PRODY_{j,t} \right] \quad (7)
$$

23

As with export sophistication, there is a positive relationship between income and open forest, with richer countries specialized in more connected parts of the product space. Yet, there is variation in this relationship, and countries that have managed to move into a relatively well-connected part of the product space given their level of development enjoy faster subsequent structural transformation (Hausmann and Klinger 2006).

Open forest is basically a numerical summary of how well 'connected' a country's export basket is in the product space maps shown above. The evolution of open forest since 1985 is shown below for Ecuador and some comparator countries.

Figure 11

Open Forest over Time (Constant 2000 US$ PPP)
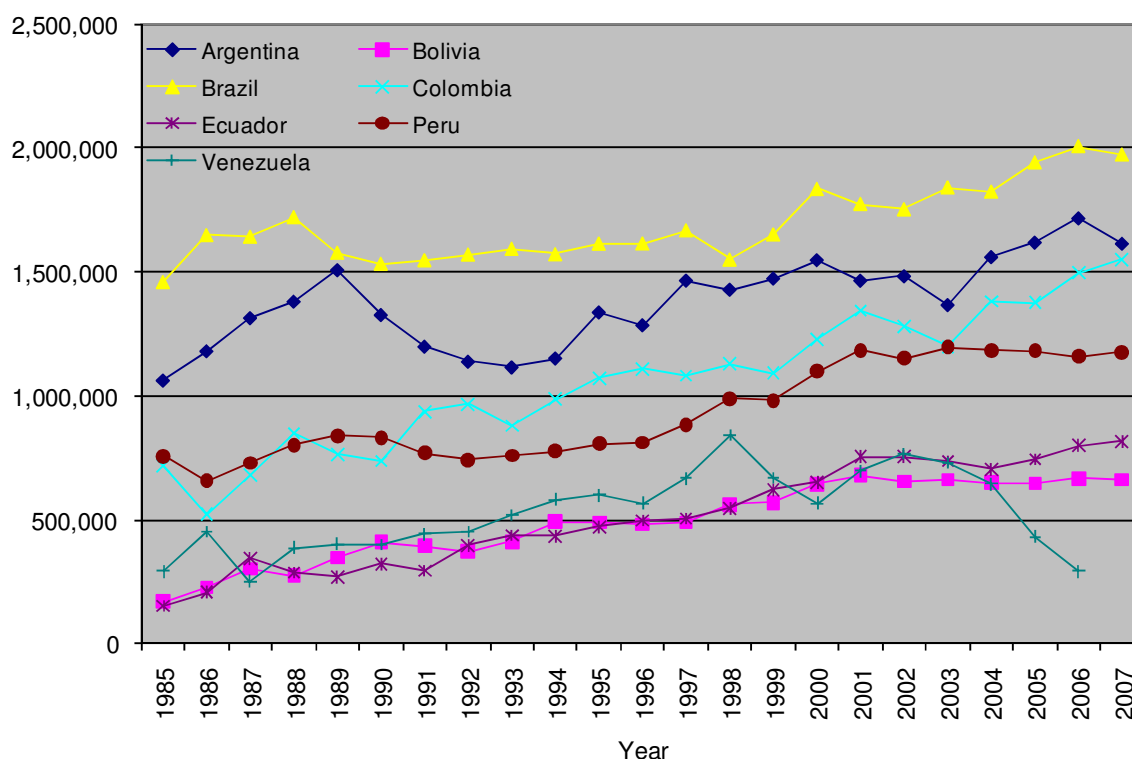
Source: Author's calculations using Feenstra (2005) and UN COMTRADE.

This figure has some similarities, but also notable differences from the evolution of export sophistication (*EXPY*). But rather than measuring the static value of exports, open forest is a measure of their 'option value' in terms of leading to new export activities. Thus, although

24

Argentina began 1985 with a more sophisticated export basket than that found in Brazil, Brazil's export activities were better connected in the product space at that time. This means that Brazil's export activities were more likely to themselves lead to other more sophisticated activities. In light of this, it is then not as much of a surprise that Brazil's export sophistication overtook Argentina's in the two subsequent decades. Similarly, Colombia's export composition as of 1985 was relatively well connected, even though the activities prevalent at that time were relatively unsophisticated. Again, in light of the Hausmann and Klinger's (2007) result that a higher open forest predicts faster subsequent structural transformation, it is not surprising that Colombia enjoyed more rapid growth of *EXPY*.

We can see in this figure that the countries which now are suffering rather lagged export upgrading—Ecuador, Venezuela, and Bolivia—as far back as 1985 were specialized in export activities at the periphery of the product space. But we can also see that Ecuador is not in as bad a relative position when considering the 'option value' of its current export basket as compared to its sophistication: although it had the lowest *EXPY* as of 2007, Ecuador's open forest was higher than both Venezuela's and Bolivia's, suggesting that is has greater opportunities for structural transformation moving forward. These opportunities will be explored in the final section.

But first, we can also consider this dimension of connectedness from the point of view of Ecuadorian firms. In terms of their connectedness in the product space, not all goods are created equal. Some products are in a dense part of the product space, meaning that they are intensive in capabilities that are easily deployed to a wide range of other goods. The implication is that successfully producing these goods would create capabilities with significant value for other new products. On the other hand, other products are located in the periphery, or in a part of the product space where Ecuador has already achieved comparative advantage and acquired the requisite productive capabilities. Therefore, these products have a low strategic value, because successfully producing them would offer little in terms of future structural transformation.

The strategic value of every good not currently exported with comparative advantage can be measured using open forest. This is done by calculating what would happen to open forest if that good were added to the export basket. If a product is closely connected to a wide range of other valuable products not currently exported by Ecuador, it would result in a large increase in

open forest, and therefore have high strategic value because it would greatly expand the country's option set.

Repeating the same exercise performed above on export sophistication and distance, the distance of all products not exported with comparative advantage by Ecuador in 2007 is plotted against their strategic value. The x-axis continues to be the inverse of log (density), meaning that a *smaller* value represents a product that is *closer* to the current productive structure. The y-axis is strategic value (the increase in open forest if that product were added to the export basket), with higher values indicating greater additions to open forest, and therefore, greater strategic value. Again, the ideal location is the upper-left quadrant: products that are nearby, meaning easier to move to, and that have high strategic value, meaning that they themselves lead to new and nearby opportunities for structural transformation.

Figure 12

Proximity vs. Strategic Value: the Efficient Frontier, 2007
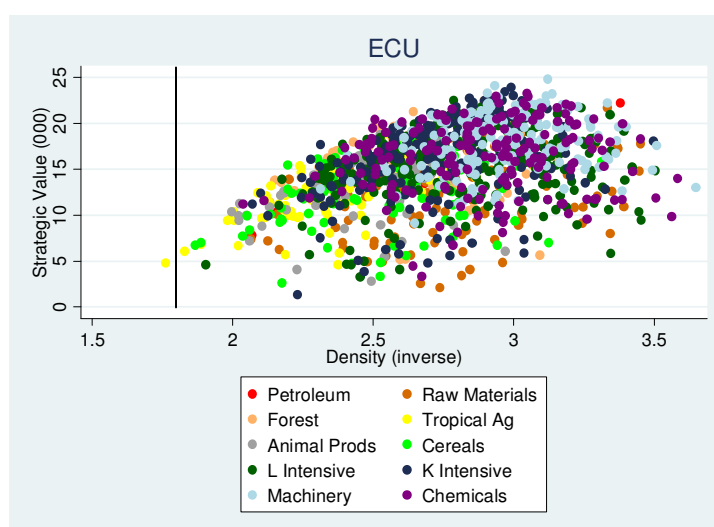
Note: "Animal Prods" is Animal Products, "L intensive" means Labor Intensive, "Tropical Ag" is Tropical Agriculture, and "K intensive" corresponds to Capital Intensive. As for the country name, ECU is Ecuador. Source: Author's calculations using UN COMTRADE.

Just as was the case with the plots of distance versus *PRODY*, there is a tradeoff between distance and strategic value. Countries are more likely to successfully move to goods that are close to what they currently produce, because such goods require similar capabilities. Yet, such goods may or may not have much strategic value. They may be in a sparse part of the product

26

space or may be so close that they do not imply the development of new capabilities that can be redeployed in other directions. So moving closer is easier, but moving further may be more valuable in terms of future structural transformation. Moreover, there is an efficient frontier in this tradeoff, because some potential exports are both closer to the current export basket and more strategically valuable than others.

Interestingly, in the case of Ecuador there seems to be a cluster of agriculture and animal products making up the closest section of the efficient frontier, followed by some forestry and labor-intensive sectors. The sectoral composition of the strategic value versus distance efficient frontier will be explored in the following section.

Below are equivalent figures for comparator countries. A vertical line has been inserted at a density of 2 to aid in comparisons.

Figure 13

Proximity vs. Strategic Value: the Efficient Frontier
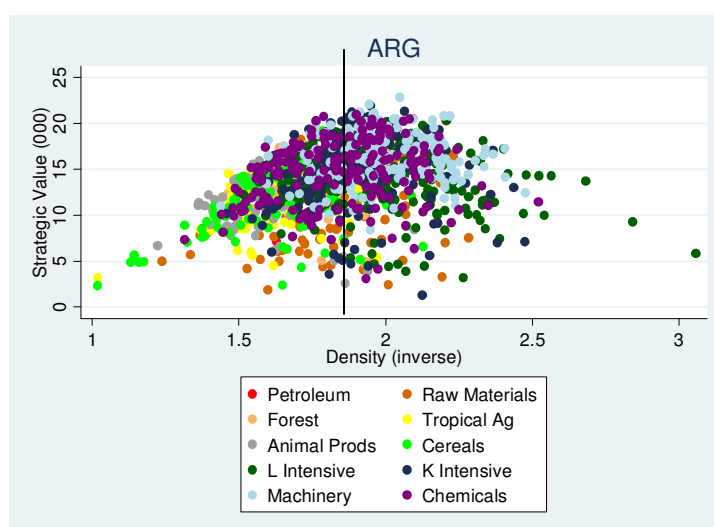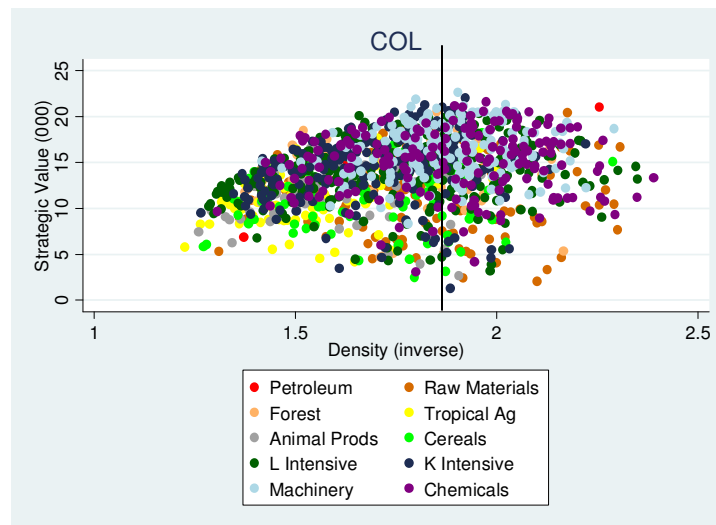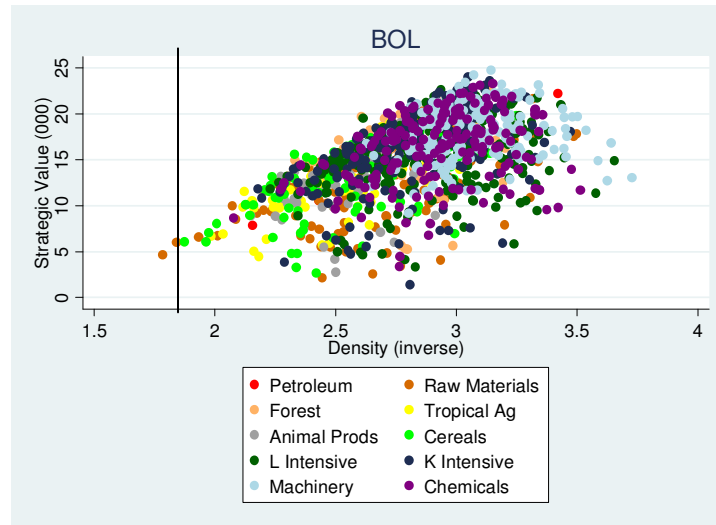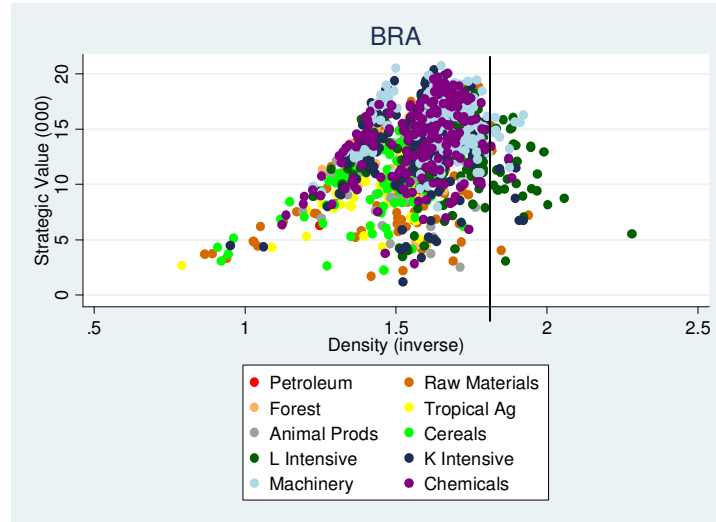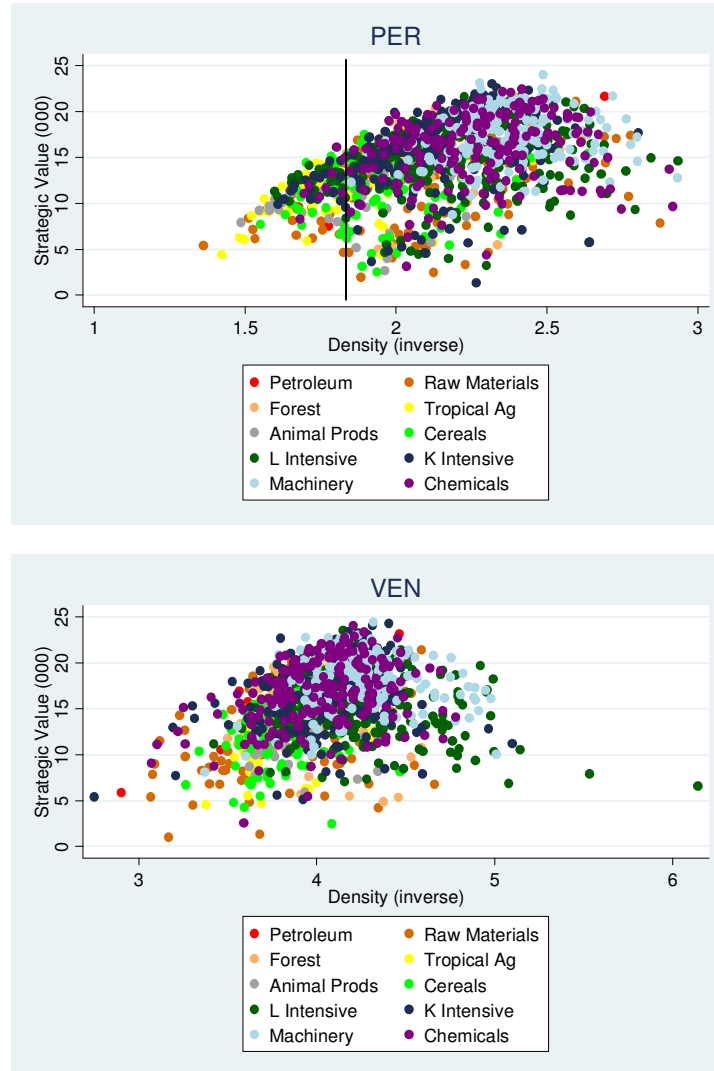
Selected Comparators, 2007

PER

VEN

Note: "Animal Prods" is Animal Products, "L intensive" means Labor Intensive, "Tropical Ag" is Tropical Agriculture, and "K intensive" corresponds to Capital Intensive. As for the country names, ARG is Argentina, BRA is Brazil, BOL is Bolivia, COL is Colombia, PER is Peru, and VEN is Venezuela
Source: Author's calculations using UN COMTRADE. Note: VEN data is for 2006.

These figures suggest very diverse efficient frontiers across countries. The efficient frontier of Peru seems to be dominated by agriculture and related sectors, whereas Colombia and Brazil quickly fill in with heavier industry. Moreover, the degree of the distance versus strategic value tradeoff is quite different across countries. There is little need to jump further to reach the highest strategic value sectors in Brazil or Argentina, whereas Colombia and Peru face a more gradual climb to reach very well-connected activities.

The following section examines the composition of Ecuador's efficient frontier more closely, using these metrics to identify promising new sectors for export diversification.

6. Analyzing Ecuador's Efficient Frontier

Productive activity requires different types of inputs, some of which are provided by the market while others are provided by the government. Among the latter, some are public goods in the sense that they are non-rivalrous and non-excludable, such as property rights, regulation, security, and certification rules. Others do not have those characteristics but have been taken over to a large extent by governments because of other forms of market failures, including infrastructure, education, labor training, and certification services.

The sector specificity of these public inputs is reflected in the fact that countries have literally hundreds of thousands of pages of economically relevant legislation and hundreds of government agencies. Each one of these pages of legislation and each public agency have a differential effect on different sectors.

The high number of public inputs is not unlike the plethora of privately provided inputs. However, public inputs suffer from the fact that most of them have no price, so there is no decentralized mechanism to reveal information. Moreover, there is no clear incentive for governments to respond to the information, as the profit motive is not a relevant or powerful incentive for public policy. Even if the information and incentive problems are addressed, the government often does not have a decentralized self-organizing mechanism to mobilize resources: these are most frequently mobilized through centralized budgetary processes.

This creates major challenges for public policy. First, how to ensure the best possible provision of public inputs to existing activities, given the information, incentives and resource mobilization problems mentioned above? Second, how to identify the industries that could have existed with an alternative provision of public inputs but that do not exist precisely because of these missing inputs?

Luckily, such efforts can be guided by the rich set of data and indicators that we have used in this paper, which allow us to systematically scan Ecuador's opportunity space and evaluate which sectors should be easier for Ecuadorian firms to enter versus those that would be more difficult, and which sectors would be worth the effort versus those without much strategic value.

A first pass at understanding the nearby opportunities for structural transformation in Ecuador is simply to identify those sectors that are nearest to the existing capability set in which

the country has not yet achieved comparative advantage. These highest-density sectors, with an RCA of less than one, are the country's 'lowest-hanging fruit' and are listed below, followed by a listing of the nearest sectors within each Leamer commodity group.

Table 3

Ecuador's 'Low-Hanging Fruit', 2007

Product Name	Exports (US M)	Density	PRODY (PPP)
Coconuts, Brazil nuts and cashew nuts, fresh or dried	1.2	0.133	2722
Vegetable products, nes	142.5	0.122	1238
Solid cane or beet sugar and chemically pure sucrose	7302.8	0.121	4979
Vegetables nes, fresh or chilled	1232.2	0.119	6562
Fish,cured, smoked, fish meal for human consumption	1965.0	0.119	16614
Molluscs	2006.6	0.119	5902
Oil seeds and oleaginous fruits nes	10.4	0.118	2170
Gold, unwrought, semi-manufactured, powder form	61398.5	0.116	3689
Wheat or meslin flour	101.8	0.114	6580
Cotton waste, including yarn waste and garnetted stoc	0.0	0.114	6301
Cocoa shells, husks, skins and waste	50.4	0.113	1616
Leguminous vegetables, fresh or chilled	75.7	0.113	2548
Other spices	74.3	0.112	5731
Natural rubber and gums, in primary form, plates, etc	2098.5	0.112	4686
Plants, plant parts for perfumery, pharmacy, etc,	1242.2	0.112	7159
Cereal flours other than of wheat or meslin	341.4	0.111	5125
Citrus fruit, fresh or dried	945.9	0.111	11626
Fruits nes, fresh	731.5	0.110	14079
Molasses from the extraction or refining of sugar	2.6	0.110	4256
Margarine, edible animal or veg oil preparations nes	4126.8	0.110	6497

Note: Products with RCA<1 in 2007 (non-minerals), sorted by density. Source: Author's calculations using UN COMTRADE.

Table 4

Ecuador's 'Low-Hanging Fruit' by Leamer Group, 2007

Leamer Group	Product Name	Exports (US M)	Density	PRODY (PPP)
Forest Products	Ornaments of wood, jewel, cutlery caskets and cases	725.4	0.106	8420
	Wood charcoal (including shell or nut charcoal)	209.2	0.104	6552
	Hoopwood, split poles, pile, pickets and stakes	0.0	0.102	4105
	Paper, board containers, packing items, box files, et	5801.4	0.100	9017
	Wood continuously shaped along any edges	1958.8	0.098	11788
Tropical Agriculture	Coconuts, Brazil nuts and cashew nuts, fresh or dried	1.2	0.133	2722
	Solid cane or beet sugar and chemically pure sucrose	7302.8	0.121	4979
	Vegetables nes, fresh or chilled	1232.2	0.119	6562
	Leguminous vegetables, fresh or chilled	75.7	0.113	2548
	Other spices	74.3	0.112	5731
Animal Products	Vegetable products, nes	142.5	0.122	1238
	Fish,cured, smoked, fish meal for human consumption	1965.0	0.119	16614
	Molluscs	2006.6	0.119	5902
	Plants, plant parts for perfumery, pharmacy, etc,	1242.2	0.112	7159
	Vegetable material for stuffing or padding	0.0	0.108	3625
Cereals, etc.	Oil seeds and oleaginous fruits nes	10.4	0.118	2170
	Wheat or meslin flour	101.8	0.114	6580
	Cotton waste, including yarn waste and garnetted stoc	0.0	0.114	6301
	Cocoa shells, husks, skins and waste	50.4	0.113	1616
	Cereal flours other than of wheat or meslin	341.4	0.111	5125

Labor Intensive	Documents of title (bonds etc), unused stamps etc	28.8	0.106	4718
	Matches	113.3	0.105	6589
	Photo-copying apparatus	3.2	0.103	6175
	Womens, girls blouses & shirts, knit or crochet	175.0	0.102	14833
	T-shirts, singlets and other vests, knit or crochet	4304.3	0.101	10440
Capital Intensive	Floor coverings with a base of paper or of paperboard	0.0	0.107	3538
	Twine, cordage, rope and cable	277.5	0.103	11159
	Sheep or lamb skin leather, without wool on	0.0	0.102	3689
	Mats, screens, articles nes of plaiting materials	17.2	0.099	3539
	Bovine or equine leather, no hair, not chamois, paten	4119.9	0.099	10233
Machinery	Insulated wire and cable, optical fibre cable	17387.2	0.090	8711
	Floating structures nes (rafts, stages, buoys/beacons	4.0	0.089	14757
	Refrigerators, freezers and heat pumps nes	10859.2	0.084	14842
	Public-transport type passenger motor vehicles	11862.1	0.079	11924
	Special purpose ships, vessels, nes	0.0	0.075	9686
Chemical	Essential oils, resinoids and terpenic by-products	160.0	0.103	2102
	Fertilizer mixtures in packs of < 10kg	572.9	0.101	10155
	Paints and varnishes nes, water pigments for leather	122.3	0.092	2337
	Prepared explosives, except propellant powders	0.0	0.092	10690
	Hair preparations	535.4	0.091	14627

Note: Products with RCA<1 in 2007 (non-minerals), sorted by density. Top five in each Leamer group. Source: Author's calculations using UN COMTRADE.

These are 'new' in the sense that Ecuador is not currently an exporter of consequence[2], although there could very well be significant production for the domestic market. But although new, these products have a very high density, meaning that most other countries in the world that export what Ecuador exports, also export these goods. So the question is: why not Ecuador?

It could be that for some of these products, there is a very sensible reason why most countries like Ecuador are significant exporters but Ecuador is not. But for many, 'why not Ecuador' is not so clear. Ecuador has been able to achieve comparative advantage in most products that other successful exporters of certain varieties of nuts and oilseeds have. This suggests that many of the product-specific capabilities required for nuts and oilseeds (including those provided by the public sector) already exist in Ecuador, yet the country has not yet become a significant exporter of them. The data show that with no other information, one would expect very strongly that Ecuador could be a successful exporter in these sectors. So, why not oil seeds and nuts in Ecuador? It may be that the public sector by act or omission may be preventing that sector from emerging, or there may be a market failure preventing it that could be corrected through policy.

The data above are therefore useful to help guide the search for what particular inputs are missing for new export activities to emerge in Ecuador. Since these are sector-specific, learning what these missing inputs are can't be done at such a high level of aggregation that the specificity is lost. The unique needs of the oilseed industry likely will not become apparent in

---

[2] Defined as having a RCA of 0.5 or greater, meaning that the share of that product's export in Ecuador is greater than half the share of that product in global trade.

conversations with the president of the chamber of commerce, who represents the interest of the private sector as a whole. They also will probably not be detected by surveys such as the World Bank's Investment Climate Assessment or the World Economic Forum's Global Competitiveness Index.

Instead, sector-specificity requires this interaction to be at a much more disaggregated sector level. The data reveal which conversations and search efforts might be prioritized: the new activities that should be most likely to emerge in Ecuador. They can be matched to actual firms, and interactions with these firms can reveal the particular missing inputs and constraints to investment.

Yet when considering low-hanging fruit, we must keep in mind that the nearest sectors may not be the best areas of focus. As suggested by Figure 9, most of Ecuador's nearby sectors have an extremely low *PRODY*, much lower than the country's current GDP per capita, meaning they are typical of countries much poorer than Ecuador. Many of them are also in isolated parts of the product space, meaning they will likely generate less structural transformation in the future than other sectors with higher strategic value. We can therefore analyze the efficient frontier by exploring which sectors offer the best combinations of proximity, sophistication, and strategic value while also representing large market opportunities. This is done as follows: We consider all non-mineral products not exported with comparative advantage in 2007 that are 'up-market' for Ecuador (i.e. their *PRODY* is greater than Ecuador's *EXPY*) and are sufficiently close to Ecuador's current structure of production (with a density at least 1.5 standard deviations larger than the mean). Grouping these products into sectors, we present them first in terms of their strategic value and then in terms of their world market size. Sectors that feature prominently in both figures are very close to the current structure of production, meaning many of the sector-specific capabilities they require already exist in Ecuador. At the same time, these sectors are associated with higher-wage countries, have large international markets, and are in well-connected parts of the product space, meaning they will facilitate further structural transformation in the future.

33

Figure 14

Unoccupied Products 1.5σ above Average Density, Ecuador 2007,

Weighted by World Trade

(Industry's percentage of the total of all industries meeting this criteria)

- Manufacture of wearing apparel, except footwear
- Manufacture of plastic products not elsewhere classified
- Goods not elsewhere classified
- Manufacture of food products not elsewhere classified
- Manufacture of bakery products
- Agricultural and livestock production
- Sawmille, planing and other wood mills
- Tanneries and leather finishing
- Tobacco manufactures
- Manufacture of pulp, paper and paperboard
- Manufacture of dairy products
- Logging
- Malt liqors and malt
- Manufacture of fertilizers and pesticides
- Grain mill products
- Ocean and coastal fishing
- Manufacture of structural metal products
- Cordage, rope and twine industries
- Canning and preserving of fruits and vegetables
- Spinning, weawing and finishing textiles

Note: All products not exported with RCA>1 in 2007, dropped those with PRODY<EXPY, dropped minerals, dropped those with density that is not at least 1.5 standard deviations above the mean for all non-exported products, combined into International Standard Industrial Classification (ISIC) revision 2 sectors, weighted by 2007 world exports of all those products in that sector meeting the above criteria. Source: UN COMTRADE.

Figure 15

Unoccupied Products 1.5σ above Average Density, Ecuador 2007,

Weighted by Strategic Value

(Industry's percentage of the total of all industries meeting this criteria)

- Manufacture of wearing apparel, except footwear
- Agricultural and livestock production
- Manufacture of food products not elsewhere classified
- Grain mill products
- Manufacture of plastic products not elsewhere classified
- Sawmille, planing and other wood mills
- Cordage, rope and twine industries
- Manufacture of bakery products
- Manufacture of pulp, paper and paperboard
- Canning and preserving of fruits and vegetables
- Manufacture of fertilizers and pesticides
- Goods not elsewhere classified
- Logging
- Spinning, weawing and finishing textiles
- Manufacture of dairy products
- Manufacture of structural metal products
- Tobacco manufactures
- Tanneries and leather finishing
- Malt liqors and malt
- Ocean and coastal fishing

Note: All products not exported with RCA>1 in 2007, dropped those with PRODY<EXPY, dropped minerals, dropped those with density that is not at least 1.5 standard deviations above the mean for all non-exported products,

The themes that emerge from this analysis are:

- Manufacturing of apparel

- Manufacturing of simple plastics (e.g. household and bathroom articles)

- Agricultural products (non-traditional fruits) and seafood

- Food products (preparations, condiments, powders, cereal)

- Some forestry and mill products

These sectors are very nearby current production, and they enjoy both large global demand and strategic value.

However, as we saw above, there is a tradeoff between strategic value and distance: the nearest products do not involve the development of new capabilities that have many alternative uses not yet exploited. Therefore, any attempt to increase the option value of the export package would require movement to further away-products. We therefore repeat the analysis above, decreasing the minimum distance from 1.5 standard deviations to 1. This gives an idea of how, as ambition increases, the composition of the efficient frontier changes.

Figure 16

Unoccupied Products 1σ above Average Density, Ecuador 2007,

Weighted by World Trade

(Industry's percentage of the total of all industries meeting this criteria)

- Manufacture of wearing apparel, except footwear
- Manufacture of furniture and fixtures, except primarily of metal
- Manufacture of plastic products not elsewhere classified
- Iron and steel basic industries
- Non-ferrous metal basic industries
- Manufacture of dairy products
- Goods not elsewhere classified
- Machinery and equipment except electrical not elsewhere classified
- Manufacture of bakery products
- Manufacture of soap and cleaning preparations, perfumes, cosmetics and other toilet preparations
- Manufacture of food products not elsewhere classified
- Agricultural and livestock production
- Slaughtering, preparing and preserving meat
- Tobacco manufactures
- Sawmills, planing and other wood mills
- Tanneries and leather finishing
- Manufacture of pulp, paper and paperboard
- Manufacture of prepared animal feeds
- Logging
- Manufacture of structural clay products
- Spinning, weaving and finishing textiles
- Malt liqors and malt
- Manufacture of fertilizers and pesticides
- Manufacture of structural metal products
- Manufacture of synthetic resins, plastic materials and man-made fibres except glass
- Grain mill products
- Canning and preserving of fruits and vegetables
- Ocean and coastal fishing
- Forestry
- Printing, publishing and allied industries
- Manufacture of wooden and cane containers and small can ware
- Cordage, rope and twine industries
- Shipbuilding and repairing
- Wine industries
- Manufacture of chemical products not elsewhere classified
- Manufacture of fabricated metal products except machinery and equipement not elsewhere classified
- Manufacture of motorcycles and bicycles

Note: All products not exported with RCA>1 in 2007, dropped those with PRODY<EXPY, dropped minerals, dropped those with density that is not at least 1 standard deviation above the mean for all non-exported products, combined into International Standard Industrial Classification (ISIC) revision 2 sectors, weighted by 2007 world exports of all those products in that sector meeting the above criteria. Source: UN COMTRADE.

Figure 17

Unoccupied Products 1σ above Average Density, Ecuador 2007,

Weighted by Strategic Value

(Industry's percentage of the total of all industries meeting this criteria)

Legend:
- Manufacture of wearing apparel, except footwear
- Agricultural and livestock production
- Manufacture of food products not elsewhere classified
- Manufacture of plastic products not elsewhere classified
- Manufacture of dairy products
- Spinning, weaving and finishing textiles
- Manufacture of bakery products
- Non-ferrous metal basic industries
- Manufacture of soap and cleaning preparations, perfumes, cosmetics and other toilet preparations
- Manufacture of furniture and fixtures, except primarily of metal
- Slaughtering, preparing and preserving meat
- Grain mill products
- Iron and steel basic industries
- Manufacture of structural metal products
- Sawmille, planing and other wood mills
- Cordage, rope and twine industries
- Tobacco manufactures
- Canning and preserving of fruits and vegetables
- Printing, publishing and allied industries
- Manufacture of wooden and cane containers and small can ware
- Machinery and equipment except electrical not elsewhere classified
- Manufacture of prepared animal feeds
- Manufacture of pulp, paper and paperboard
- Manufacture of structural clay products
- Forestry
- Manufacture of synthetic resins, plastic materials and man-made fibres except glass
- Manufacture of fertilizers and pesticides
- Manufacture of fabricated metal products except machinery and equipement not elsewhere classified
- Shipbuilding and repairing
- Goods not elsewhere classified
- Logging
- Manufacture of chemical products not elsewhere classified
- Tanneries and leather finishing
- Malt liqors and malt
- Wine industries
- Ocean and coastal fishing
- Manufacture of motorcycles and bicycles

Note: All products not exported with RCA>1 in 2007, dropped those with PRODY<EXPY, dropped minerals, dropped those with density that is not at least 1 standard deviations above the mean for all non-exported products, combined into International Standard Industrial Classification (ISIC) revision 2 sectors, weighted by 2007 strategic value of all those products in that sector meeting the above criteria. Source: UN COMTRADE.
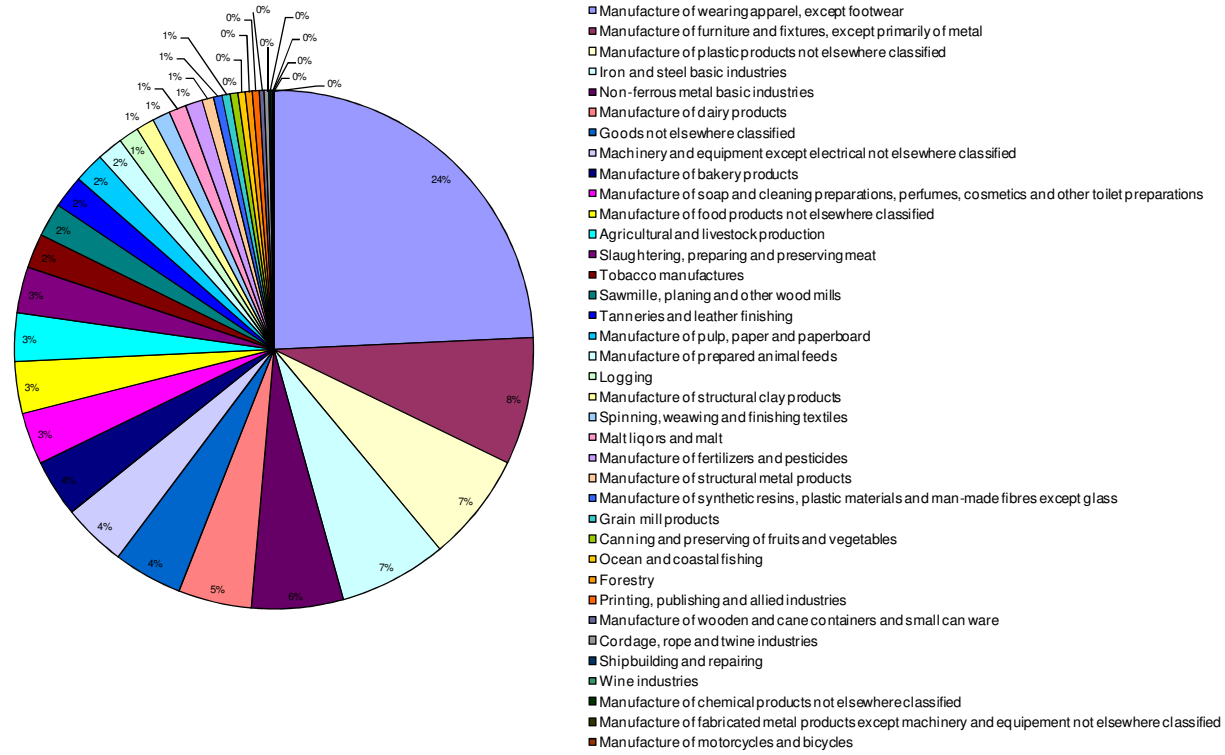
As one allows for potentially further jumps, some new themes are added to the efficient frontier. Moving from 1.5 to 1 standard deviation above the average distance as the cutoff, the following emerges:

- Additional garment products and textiles
- Furniture products (e.g. mattresses)
- Dairy products
- Metals and appliances (e.g. refrigerators)
- Soap and cosmetics

These sectors are further away, and therefore likely have fewer private actors in the economy existing at present, requiring more proactive study of either potential or foreign firms. This allows for even further jumps leading to the emergence of sectors such as the manufacture of drugs and medicines and other furniture and plastics manufactures.

The question is, what would it take for a vibrant and internationally competitive dairy or cosmetics industry to emerge in Ecuador? What types of investments in training and education would be required? What type of intellectual property rights regime would be needed? What is the cost-benefit of such investments? Asking such sector-specific questions is not picking winners, and the answers should draw on the relevant private sector actors, either local or international.

7. Ministry Priorities

The Ministry for the Coordination of Production, Competitiveness and Commercialization has itself been analyzing the economy of Ecuador to identify high-potential export sectors. This process, while using quantitative data, was likely done in a more qualitative and comprehensive way than the analysis conducted above. Such an approach has many benefits. It is not limited to sectors appearing in international trade data and therefore allows for a consideration of service sectors. And importantly, it allows for a much wider set of information to be incorporated in the analysis, such as projections of the future global market growth for each sector, and national and regional context.

However the downside of such an approach is that it does not allow for the systematic consideration of all[3] potential sectors at a disaggregated level, and therefore might overlook some high-potential opportunities, or bet against convincing empirical evidence. Therefore, just as the high-potential sectors identified above require strong second looks incorporating wider information and country context, the priority sectors identified by the Ministry can also be given a second look using the product space data.

The Ministry has identified 15 strategic sectors in its plan: flowers, processed fruits and vegetables, aquiculture, fish, forestry, metal products, tourism, logistics and transport, biofuels, software and consulting, textiles, leather and footwear, ceramics, construction, and artisan

---

[3] That is, all non-service export sectors that appear in international trade data.

products. Of these sectors, eight can be evaluated using export data, both at an aggregate level and at various sub-sectors[4].

First, we identify these strategic sectors in the tradeoffs between distance and sophistication and distance versus strategic value, as done above for the country as a whole. Those sectors that are targeted in the strategy are highlighted in red.

Figure 18

Proximity vs. Sophistication: Ministry's Priority Sectors, 2007
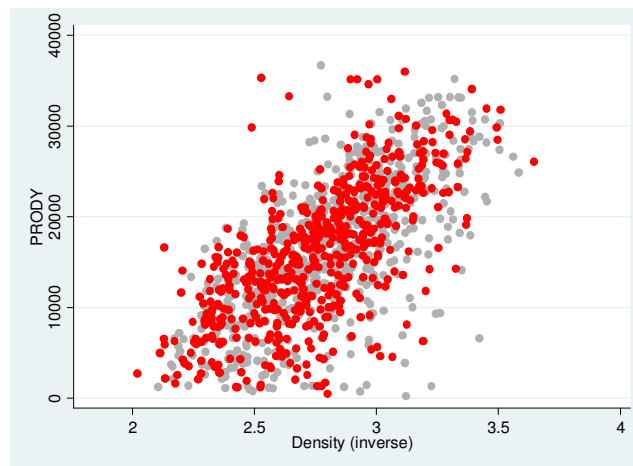
Source: Author's calculations using UN COMTRADE.

Figure 19

Proximity vs. Strategic Value: Ministry's Priority Sectors, 2007
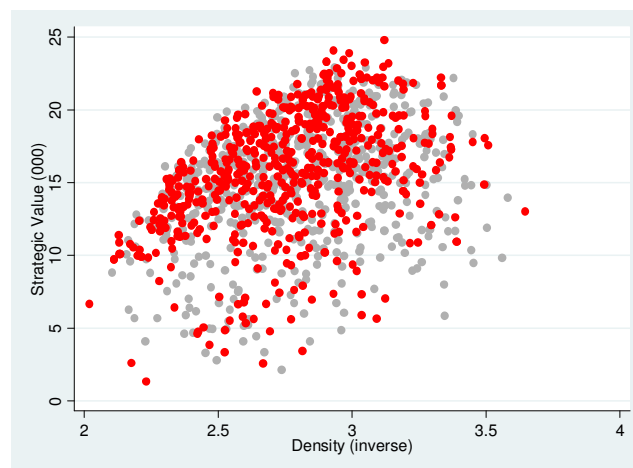
Source: Author's calculations using UN COMTRADE.

---

[4] The product codes for this analysis were graciously provided by David Molina of the Ministry for the Coordination of Production, Competitiveness and Commercialization.

Overall, the targeted sectors seem to be concentrated near the efficient frontier, particularly on the tradeoff between distance and strategic value. That is, the targeted sectors are either nearby, or if far away, at least have a high strategic value. Yet it is also noticeable from this figure that a large number of sectors fall under the Ministry's prioritization. Of the 1267 customs lines appearing in the 4-digit harmonized system, 619 fall within one (or more) priority sectors.

The strategy is therefore not very finely focused at the sectoral level, at least at this point. This may be a problem, since if you are targeting almost all sectors, it is not easy to learn the sector-specific inputs and constraints as you don't know where to look first. On the other hand, such a broad focus is not necessarily a bad thing, as it depends on the policy interventions employed and their ability to drill down to sector-specific requirements. Specific initiatives and policies will either have to be subjected to further filtering of these 'priority' sectors, or even better, this drilling down will have to emerge through interaction with, and some self-organization of, the relevant private sector actors.

We can look at each priority sector individually (some of them have been disaggregated slightly) and compare them in terms of these three variables: density (how 'nearby' is the sector: have other countries similar to Ecuador been successful in it, or is it a bet against the international experience), *PRODY* (how 'sophisticated' is the product: is it typical of countries with higher or lower wages), and strategic value (does this sector lead to other, as of yet unexploited opportunities). The results are shown below.

Table 5

Priority Sectors

Sector	Average Density	Average PRODY	Average Strategic Value
Flores	0.108	5319	10783
Metalmecánica	0.058	18945	16923
automotriz y transporte	0.059	17429	16849
biocombustibles	0.095	7095	11442
frutas y vegetales	0.097	9424	12033
linea blanca	0.066	18116	18771
pesca y acuicultura	0.119	10509	10789
silviculture y madera	0.078	15999	15424
textiles	0.074	13130	14601
not targeted	0.065	16035	14889

Source: Author's calculations using UN COMTRADE.

40

The very nearby strategic sectors in the Ministry's plan are flowers, fish and aquiculture, biofuels and fruits and vegetables (although it should be noted that the products identified as biofuels are also exported as simple grains: one can't differentiate between the two applications in this data). Not surprisingly, these nearby sectors have a relatively low strategic value, with fruits and vegetables being the highest. But there are noticeable differences in the degree of sophistication, with flowers having nearly half the *PRODY* of the aquiculture and fruits and vegetables sectors.

The sectors of intermediate distance are forestry, textiles, and appliances. These sectors are somewhat further away compared to the nearby sectors mentioned above, meaning that the country may not currently possess all of the necessary productive capabilities for them to emerge. However, they remain closer than those sectors excluded from the plan, and they have a relatively high strategic value (particularly the appliances subsector). They are also all typical of countries that are richer than Ecuador.

Finally, the metal-mechanic and automotive sectors are the most distant sectors included in the strategy. These sectors are typical of countries with radically different productive structures than Ecuador, and the empirical evidence suggests that they are very unlikely to emerge in the export basket in the near future. They are in the category of 'strategic bets', as they would require significant leaps in the product space to reach. They both have relatively high strategic value and sophistication. Yet, it is interesting to note that the appliances sub-sector has a similar *PRODY* and even higher strategic value, while being much closer to the current structure of production.

The Appendix contains these same variables for the strategic sectors, disaggregated by sub-sector, which allows for a finer analysis. This may be important for those sectors which include a large number of diverse products, as within the broad sector there may be a subset of highly valuable strategic sectors that are being washed out on average by others that are inside the efficient frontier. This illustrates the value of the product space data in terms of drilling down to a highly disaggregated level.

Although the devil is in the details in terms of how these sectors are actually supported, it does seem that on average the plan identifies sectors that are either nearby, or if further away, are at least worth the effort in terms of having a higher strategic value. Yet it also seems that the

prioritization could be further rationalized. The metal-mechanic and automotive sectors are of comparative sophistication and strategic value to appliances, yet are much further away, meaning that jumps to these products will be more difficult and would likely require greater coordination. Most importantly, the widely varying distances of the priority sectors can indicate what kind of policy approach is more or less appropriate for each sector. This is discussed in the final section.

8. Policy Implications

Appropriate policy approaches to facilitating structural transformation depend on how far away the relevant sector is from the current structure of production. Facilitating jumps to nearby products is likely to be very different from bringing about the emergence of 'strategic bets' that are far away in the product space.

The capabilities for nearby sectors, such as non-traditional fruits, aquiculture, and some forestry sectors, will already exist to some degree in the country. There are probably private sector actors considering these sectors, already producing for the local market, or in some cases already exporting. There are already counterparts in the private sector, and therefore to facilitate jumps the government needs a way to dialogue with them to learn the publically-provided sector-specific inputs that are missing. In order to identify sector-specific constraints, the dialogue must occur at a much more disaggregated level, and therefore have the necessary bandwidth to deal with that complexity (Hausmann 2008).

Organizing such a private-public dialogue at lower levels of aggregation is difficult, as there are hundreds of thousands of different business interests and limited government time and attention and it is not obvious what the right way of organizing the issues may be. Moreover, the country's productive structure and the structure of the product space are both changing over time. Therefore, this dialogue process should have the ability to bring in new sectors of the economy as new opportunities for structural transformation emerge.

Hausmann, Rodrik, and Sabel (2008) offer some specific policy proposals to achieve such a dialogue and overcome the three problems mentioned above: the information, incentive, and resource mobilization problems. We can identify some general design principles for these or any other policy initiative to promote public-private dialogue that can identify and act on sector-specific constraints and opportunities. Based on Hausmann and Rodrik (2006) and Hausmann, Rodrik, and Sabel (2008), these principals are:

42

- Let the private sector self-organize and coalesce around common requirements rather than placing them in pre-determined buckets, and allow new interests to engage the public sector rather than limiting it to those identified as high-potential at some given date. Although these lists of high-potential sectors can help prioritize discussions as well as decide on the allocation of scarce resources once these are identified, they shouldn't be taken as a final determination on where to focus efforts.

- The process should be transparent. This dialogue, particularly the requests from the private sector, should be public in order to limit rent-seeking and increase legitimacy of this endeavor vis-à-vis the rest of society so as to make sure that policy goals are in the public interest.

- Interventions should be focused on identifying and providing public inputs that increase a sector's productivity or allow it to come into being. Their effect should be to increase productivity, not subsidize low productivity. This is critical: in the past, some have argued that the low productivity in certain sectors should be subsidized because the sectors have some type of special spillovers to other sectors. Here, we aren't talking about subsidies to compensate for low returns. We are talking about investments in required public inputs that increase productivity and allow private returns to be realized.

- The private sector should be willing to invest its own funds in these sectors so that the investment passes a market test. Co-financing is a good signaling mechanism that there is real demand for the requisite input.

- Interventions should have clear criteria for success (to identify losers), accountability (to let losers go as early as possible), and sunset clauses (to ensure that no financial commitments are open-ended).

But while creating this high-bandwidth public-private dialogue will help overcome barriers to the emergence of nearby activities (as well as growth in existing sectors), it will likely not be sufficient for those high-potential sectors that are further away in the product space. Moving to more distant export activities is difficult. These long jumps do not occur with much regularity. While nearby activities require the same or similar capabilities to those already existing in the country, distant export activities have capability requirements that are very different. Firms that wish to jump to these new activities will face many missing capabilities, and

the wider range of these capabilities would have to appear simultaneously to make such jumps feasible.

In addition, it may not be as easy to learn what particular capabilities are missing. With nearby sectors, there are already firms in similar activities present in the economy. For many of the 'low-hanging fruit' sectors, there are already small amounts of exports from Ecuador, and there is most likely production for the domestic market as well. This means that there are existing firms in the country that can be engaged to learn what is missing. They are the counterparts for the dialogue discussed above. But for very distant activities, it is not as easy to find a counterpart, and more of a process of search, promotion (including actively seeking foreign direct investment), and evaluation is necessary.

Some general policy proposals to facilitate the search for distant opportunities and larger leaps in the product space are also provided in Hausmann, Rodrik, and Sabel (2008). The authors suggest either a 'venture fund' or a re-focusing of development banks on facilitating longer jumps. Such a body would have an open window that encourages investors to come with business plans for such activities and should identify what aspects of the business environment are problematic or missing for the industry to be viable. Financial support is granted in part to encourage the private sector to develop such plans and to reveal this publicly valuable information to the venture fund. The venture fund should act as an information revelation mechanism of the space of opportunities and obstacles and to prepare policy solutions to the obstacles identified. It should be evaluated not in terms of the amount of money they lend, but instead on the amount of investment it triggers by helping to fix the provision of public inputs, even if these investments are financed privately.

For some industries dominated by large international firms, this can be learned by engaging those international firms directly, encouraging them to invest in the country, and having them identify the problems that would limit their productivity. There could also be domestic firms in related industries whose problems may be indicative of those of the industries further afield. This process of learning the particular constraints to further-away sectors as well as cost/benefit analysis of the investments that they would require to emerge could also be subcontracted to management consulting firms.

The result would be the identification of interested parties willing to invest their own funds and conduct feasibility studies for a variety of potential strategic bets, identifying those

sector-specific capabilities that are missing and making proposals for policy reforms and public investments that would be required to allow these new activities to succeed, along with an attempt at cost-benefit analysis. The venture fund would be willing to partially co-finance these projects if requested by the private sector.

Another way to facilitate the search for new activities is to build a new industrial zone with its own management team. The zone would solve some easy to identify constraints such as power, water supply, transportation infrastructure for goods and workers, and access to regulatory and certification services. Beyond this, the management team will have to promote the use of the industrial zone by attracting new investors. These will have specific concerns about operating in the country, given its public inputs or other missing capabilities. The management team should have the capacity to analyze these missing inputs, explore ways to circumvent them, and inform the government of problems, solutions, and costs in order to assess whether addressing these problems is warranted in light of the potential new investments that it would crowd in.

Here again, the idea is that the industrial zone, like the venture fund, is really in the core business of exploring the space of opportunities and obstacles and identifying solutions that would trigger new activities. Every opportunity must be taken to design solutions that are as general as possible in order to have the widest possible effect on new activities beyond the investor who helped identify the obstacle.

These institutions are designed in this open-architecture search mode in order to avoid the well-known failures in directed industrial policies of the past that created white elephants rather than structural transformation. To this end, the guidelines for facilitating nearby jumps apply equally to such institutions, particularly the focus on productivity-enhancing investments and providing sector-specific public goods rather than subsidizing low productivity.

9. Conclusion

In this paper we have examined a host of new metrics to analyze structural transformation in Ecuador. These metrics have shown that Ecuador's export basket has not changed significantly over the past decade, and that within those existing products there is little room to grow by improving quality. Moreover, we have seen that existing export sectors are typical of countries

much poorer than Ecuador, and that country has not been adding new, more sophisticated products to its export package at the same rate as some of its comparators. However, while the current export basket is highly unsophisticated, it is not as poorly connected in the product space as other countries in the region, suggesting that there are opportunities for structural transformation moving forward.

We have used the data to identify new 'high-potential' sectors that represent attractive tradeoffs between proximity, sophistication, and strategic value. The same data have been used to analyze some of the strategic sectors already identified by the government, in order to help refine that list.

But these resulting lists of sectors are not meant to be an identification of spillover-rich 'winners' that are worthy of subsidies and support. Instead, they are meant to be a guide to what should be a constant process of the government searching for the sector-specific public inputs it must provide in order for structural transformation to occur.

There are many inputs that the government must provide to the production process, and these may be highly specific and broadly unknown to the authorities. Absent these specific public inputs, private returns would be very low, but with them, private returns would be very high. The task for the public sector is to figure out what specific infrastructure/regulation/institutions it should be providing to the private sector so that these new activities can emerge and structural transformation can occur. It would be best to learn these needs from those same entrepreneurs that have or would enter those sectors, and some policy guidelines for such a dialogue have been laid out. But with limited bandwidth, a cacophony of requests, and the desire for movements to more distant sectors in the product space, the government faces a significant challenge. The lists of sectors therefore can be used as a pointer for where to look first. The public sector can take a closer look at what it is doing by acts of omission or commission to prevent these particular sectors from emerging, and identify the public inputs needed to realize high returns and spur private investment.

Just as we must be careful to avoid the mistakes of industrial policy in the past, the high degree of specificity of public goods and institutions cannot be ignored just because it is "delicate to suggest sector-specific" policies (Cueva, Albornoz, and Avellan 2007, p. 77)[5]. The

---

[5] One could argue that the 'non-sector-specific' policies mentioned therein (human capital development, research and development spending, and promoting foreign investment) are themselves highly sector specific when one must

policy guidelines above are geared to dealing with this specificity while navigating the perils of traditional industrial policies. These offer a potential way forward that would allow Ecuador to accelerate its recently lagging structural transformation and accelerate economic growth and poverty reduction in the country.

consider actual implementation. Supporting primary education versus technical training for secondary school graduates versus public university education will favor some sectors over others. Does research and development spending mean university laboratories, corporate R&D in IT, or commercialization assistance for smaller-scale agricultural producers? What foreign investors will be engaged, and in what order? These 'horizontal' policies could benefit from recognition of their specificity, and some prioritization in light of it.

References

Arrow, K. 1962. "The Economic Implications of Learning by Doing." Review of Economic Studies 29(3):155-173.

Balassa, B. 1986 "Comparative Advantage in Manufactured Goods: a Reappraisal." The Review of Economics and Statistics 68(2): 315-19.

Bardhan, P. 1970. Economic Growth, Development, and Foreign Trade. New York: Wiley-Interscience.

Cueva, S., V. Albornoz and L. Avellan. 2007. "Ecuador – Binding Constraints to Growth." Inter-American Development Bank. October 2007.

Feenstra, R., R. Lipsey, H. Deng, A. Ma, and H. Mo. 2005. "World Trade Flows: 1962–2000." Working Paper #11040. Cambridge, MA: National Bureau of Economic Research.

Hausmann, R., J. Hwang, and D. Rodrik. 2006. "What You Export Matters." Working Paper #11905. Cambridge, MA: National Bureau of Economic Research.

Hausmann, R., and B. Klinger. 2006. "Structural Transformation and Patterns of Comparative Advantage in the Product Space." Harvard University Center for International Development Working Paper #128.

_____. 2007. "The Structure of the Product Space and the Evolution of Comparative Advantage." Harvard University Center for International Development Working Paper #146 (extended and revised version of #128).

Hausmann, R., and D. Rodrik. 2003. "Economic Development as Self-discovery." Journal of Development Economics, 72:603–633.

_____. 2006. "Doomed to Choose: Industrial Policy as a Predicament." Center for International Development Blue Sky Conference Paper, September.

Hausmann, R., D. Rodrik and C. Sabel. 2008. "Reconfiguring Industrial Policy: A Framework with an Application to South Africa." HKS Faculty Research Working Paper Series RWP08-031.

Hidalgo, C., B. Klinger, A. Barabasi and R. Hausmann. 2007. "The Product Space Conditions the Development of Nations." Science Magazine 317(5837): 482-487.

Hwang, J. 2006. "Introduction of New Goods, Convergence and Growth." Department of Economics, Harvard University. Mimeographed paper.

Jaffe, A. 1986. "Technological Opportunity and Spillovers of R&D: Evidence from Firm's Patents, Profits, and Market Value." American Economic Review 76(5):984–1001.

Jaffe, A., M. Trajtenberg and R. Henderson. 1993. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations." Quarterly Journal of Economics 108(3): 577-98.

Leamer, Edward E. 1984. Sources of Comparative Advantage: Theory and Evidence. Cambridge MA: The MIT Press.

Appendix

Sector	Sub-group	Average Density	Average PRODY	Average Strategic Value
Flores		0.108	5319	10783
Metalmecánica	Equipo electrónico y eléctrico	0.056	20951	17553
	Línea Blanca	0.066	18116	18771
	Manufacturas de metales	0.058	19305	17419
	Materias Primas	0.063	14952	13440
automotriz y transporte	Automotriz	0.061	16211	17330
	Metalmecánica	0.059	17863	16677
biocombustibles	Biocombustible	0.084	7402	17410
	Oleaginosas y cereales varios	0.096	7061	10779
frutas y vegetales	Aceites	0.090	9972	11312
	Azúcares	0.121	4979	9706
	Bebidas alcohólicas	0.077	13127	13267
	Cacao en grano	0.172	1855	4770
	Café en grano	0.136	2747	9725
	Coco	0.097	3455	6426
	Confituras y mermeladas	0.088	5849	13614
	Congelado	0.103	9395	14620
	Cortezas	0.097	6545	10453
	Fresco	0.099	12443	13619
	Fresco o refrigerado	0.094	9805	13371
	Fresco o seco	0.118	7742	10005
	Harina	0.095	11931	15854
	Harinas	0.082	8199	12392
	Jugos	0.120	7652	12100
	Maní	0.103	2078	10173
	NCP	0.084	12234	9948
	Preparaciones de cacao	0.107	7493	12657
	Preparaciones de café	0.106	9464	15117
	Preparaciones y conservas	0.092	12104	13480
	Raíces	0.117	14525	6569
	Residuos	0.086	8497	10954
	Salsas	0.095	11931	15854
	Seco	0.094	7750	14099
	Semillas	0.091	10800	12213
	Torta	0.087	3578	8322
	Vinagre	0.073	18856	13183
linea blanca	Cocinas y estufas	0.089	14099	16245
	Máquinas para lavar ropa	0.057	18566	19666
	Máquinas, aparatos y artefactos mecánicos y partes	0.050	21536	20138
	Refrigeradores	0.084	14842	17667
pesca y acuicultura	Aceites	0.113	21333	9406
	Congelado	0.132	7351	10088
	Fresco o refrigerado	0.130	7943	9942
	Harina	0.127	16130	8389
	Peces vivos	0.095	3633	13204
	Preparaciones y conservas	0.099	11863	13045
	Seco	0.119	16614	10876
silviculture y madera	Agroindustria	0.082	14692	14011
	Manufacturas de madera	0.082	13590	14690
	Muebles	0.078	14446	17615
	Papel y cartón	0.073	18650	16510
	Pasta de madera	0.057	13104	19050
	Prefabricados	0.083	14966	17391
	Primario	0.092	10316	13442
textiles	Confección	0.086	11260	14021
	textil	0.068	13966	14860
not targeted		0.065	16035	14889