Economic Complexity in Panama: Assessing Opportunities for Productive Diversification

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Economic Complexity in Panama: Assessing opportunities for productive diversification

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Executive Summary

Panama has been one of the fastest growing economies in the world over the previous years. The country has leveraged on the activities surrounding the Canal to duplicate its income per capita in a decade. A modern sector specialized in logistics, financial services, communications and trade, has spurred economic growth and provided a consistent foreign exchange surplus in the balance of services. Building up the service sector has in turn demanded a lot of investment in construction, the leading growing sector in Panama, tripling its share within gross domestic product (GDP) in ten years. Private non-residential construction, and large public infrastructure projects such as the expansion of the Canal and the Metro of Panama City, account for most of the boom. Another pillar of growth over the acceleration period has been trade, namely leveraging on Panama's excellent trade infrastructure to channel merchandise from Asia to Central America and the Caribbean. A last, a vibrant air traffic hub was created in Panama City.

Growth has decelerated recently, mostly as a consequence of a slow down on construction, and deterioration of trade volumes going through Colón Free Trade Zone, in particular those on route to Venezuela and Colombia (Hausmann, Santos and Obach, 2016).¹ Non-residential private investment in construction cannot indefinitely grow at a faster rate than the economic sectors it caters. Once the stock of basic infrastructure needed for the expansion of the service sector is in place, construction will decrease its relative importance and decelerate. Also, to continue to spur growth at the observed pace via public infrastructure would require a permanent portfolio of mega projects in execution. The key challenge for Panama is to identify what are the drivers of growth that will take over as the spearheads of the economy.

The expansion of the Canal opens a great opportunity for Panama to start thinking in diversifying into more complex economic activities, while at the same time expanding its sources of foreign exchange. Given that not all of the activities have the same likelihood of succeeding in every place, it is essential to evaluate the skills that the economy has developed around the services surrounding the Canal, and identify activities (good and services) of higher value-added where these skills can be redeployed.

But that shall not be the only focus of the industrial policy. One of the most striking features about Panama is its high level of income inequality. The construction boom has created a large demand for low-skilled workers, and certainly had some benefits in terms of poverty and inequality reduction. Even after that, Panama remains

¹ In the case of Venezuela, decreased trade volumes resulted from the collapse of imports amidst a foreign-exchange crisis. The case of Colombia is different, as the country unilaterally decided to impose an additional 10% tariffs on textiles and footwear coming from the Colón Free Zone. In February 2016 Panama demanded arbitration of a World Trade Organization Expert Panel. The issue remains unsolved.

among the most unequal countries in the world.² Now that the construction boom is expected to decelerate, and a modern service sector demanding high skills is taking the lead on growth, there is a risk of losing the progress achieved in terms of poverty and inequality. These dynamics only highlight the need to promote more complex economic activities across all provinces of Panama, in order to deconcentrate growth and make it more inclusive. This report is aimed at evaluating what are the skills that Panama has developed at a national and sub-national levels, and based on those skills identify more complex activities where these skills could be redeployed.

We know that a consistent feature of development, both across and within countries, is that richer places tend to produce a larger variety of goods, that on average very few countries are able to make. To the contrary, relatively poorer countries and regions tend to produce fewer goods, that on average many places are able to make. That goes against the conventional wisdom stating that societies should specialize in a narrow set of activities where they have competitive advantages.

The progressive accumulation of productive capacities and know-how, which allows places to manufacture competitively a larger variety of goods, does provide an account more consistent with the observed. The intuition to this theory, originally presented by Hausmann and Hidalgo (2009), is based on the idea that capabilities and know-how are not observable, but are signaled by the number and nature of the products that a place is able to manufacture competitively. Regions lacking many capacities will only be able to assemble a relatively modest number of activities, which will also be feasible in many other places, and therefore will not bring much value added. Countries that accumulate many capacities will be able to amass a relatively large number of activities, which will only be replicable in a small number of places. As they expand their stock of productive capacities, developing regions diversify their productive mix into less common activities.

Within this context, the process of diversification poses a chicken-and-egg dilemma: Nobody wants to acquire skills for an industry that does not exist, and as long as those skills are not present it is unlikely the industry will show-up. Hidalgo and Hausmann (2009) have provided a clue on how societies have come around the dilemma: Countries do not diversify randomly, they rather spread towards activities that demand similar capabilities than the ones they already have. Current productive capacities and know-how can be recombined and redeployed into new, “adjacent”, economic activities.

This report identifies productive capabilities already in place in Panama, as signaled by the variety and ubiquity of products that is already able to manufacture and export competitively. Once there, it moves on to identifying opportunities for

² By 2012 the GINI coefficient in Panama was 0.52, the fourth highest in the world. Source: World Development Indicators, World Bank.

productive diversification based on technological proximity of products or industries. Since the whole idea is based in identifying productive capabilities, any assessment based on Panama's exports needs to correct for re-exporting. Using data provided by the National Customs Authority of Panama (ANA, for its Spanish acronym), we were able to pin down Panama true exports of goods. The picture that emerges shows a very low number, near 1% of GDP, concentrated around low-complexity agricultural and mining products.

Given its very basic structure of exportable goods, our analysis of potential diversification opportunities for Panama identified as the most attractive opportunities more downstream products within the Food and Vegetables category. The list comprises products used by the printing industry (supply materials for newspaper, journals and magazines), paper and paperboard products (paperboard labels, toilet paper, cartons). Beverages also ranked well (water, beer, other fermented beverages), as did other preparations of cereals, flour, and starch (bakery products, malt, cereals). A more strategic sector that showed up, one that demands covering longer distances in terms of capabilities, was Chemicals and plastics. Dyes, paints and inks (mostly paint and varnishes), plastics (polyamides, plastic sheets, plastic tubes and fittings, packing lids) and soaps, waxes and paints (lubricants, cleaning products, soap) were the sections within this sector that came out with more potential.

Our approach in exportable goods provides a roadmap to identify potential opportunities in exportable goods, but overlooks the fact that Panama's strongest capabilities and know-how are to be found in the exportable service sector. To address that, we relied on more granular data on observable capacities used by different sectors, as reported in population and economic censuses. These type of data also give us the opportunity to measure technological proximities in different ways. An initial approach would be to capture the tendency for economic activities to co-locate in different provinces or districts within Panama (same criteria used to identify opportunities on exportable goods). Another is to leverage on administrative or statistical datasets that measure cross-sector labor flows. From an intuitive standpoint this is a very attractive approach, as it considers two industries adjacent if labor flows between them are relatively more intense.³ At last, a separate approach to measure proximity between pairs of industries in based on occupations. According to this criteria, two industries are assumed to be closer from a technology standpoint, the more similar the occupations they tend to employ.

We do not have to make leaps of faith regarding any of this criteria. We applied each of them on data coming from censuses, and tested their capacity to predict the economic activity that showed at the province and district level ten years down the road. In the case of Panama, the proximity-matrix built on all three criteria had

³ We did not obtain access to the relevant data to advance this exercise in Panama from its Social Security Agency, but have converted back to the Panamanian standards the distances and proximities derived from the Swedish labor-flow matrix as developed by Neffke and Hartog (2014).

predictive power, but the one based on occupation similarities between pairs of industries proved to be the most powerful. Using occupation-similarities, we identified opportunities for diversification for each of the thirteen provinces of Panama. Within the text of the paper we have chosen three illustrative examples of provinces that have very distinct characteristics that justify different approaches to export diversification: Colón, Darién, and Chiriquí.⁴

Colón is a relatively developed region, and as such exhibits a significant variety of industries, that on average are only found in few Panamanian provinces. Interesting opportunities are relatively close, which in turn could help in expanding the complexity of its province by making even further opportunities accessible. The potential for diversification in Colón shows up in modern services such as in logistics and a variety of commerce and trade services. Surprisingly, we find relevant manufacturing sectors at a nearby distance, such as plastics (plates, sheets, vases, containers), foodstuffs (beer, preparations of meat and fish), and paper (newspapers, journal, periodicals, cartons).

Eastern Panama seems to have the least complex and connected industrial structure in the country. As such, the most promising sectors are still at a significant distance in terms of capabilities. Darién is a case in point. Some of the opportunities that come up in our analysis, such as education and health services, probably reflect relative the insufficiencies of State footprint in the poorest province in Panama. Other than that, the most interesting sectors such as manufacture of paper products (newsprint, paper, dairies and other edibles) and construction materials (cement) shall be considered strategic bets, and will require significant State effort to ignite. Other sectors associated with the tourism industry (ecotourism) and logistic service associated to transport of goods are more feasible, if limited in complexity and scope.

Somewhere between Colón and Darién lays Chiriquí. Its diversification opportunities are not as abundant and nearby as the former, and yet not as steep as the latter. Several medium-high complexity manufacturing goods are at relatively feasible distance, mostly related to minerals (metal press, forged metal, primary products derived from iron, coke ovens), construction materials (cement, lime, cast), and goods derived from wood (carpentry, musical instruments). Also, the presence of several activities in wholesale commerce and transport logistics suggests that it could also leverage its position as bordering province to the rest of Central America to develop the sectors that are already relatively close to its productive structure.

These results should not be considered neither a mandate, nor the output of a process aimed at picking the winners in the lottery of industrial policy. Our approach has only resulted in a roadmap to guide the search for strategic sectors

⁴ While we explore these three cases at length in the paper, visualizations and tables identifying opportunities for productive diversification in the remaining provinces in Panama are in the appendix.

that could potentially help Panama in diversifying its productive capabilities and competitive exports. Our list only points out to potential sectors that demand capabilities that, to a varying extent, are already in site on each of the provinces. A more in-depth industry analysis shall ensue, in order to establish which capabilities are missing and what can be done to ease their supply in an efficient way.

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1. Introduction

It is a consistent pattern that as countries or communities tend to develop, they tend to diversify their productive structures into increasingly singular economic activities. In Figure 1, we visualize the diversity and average ubiquity of the export baskets of different countries, along with their level of economic development. The salient feature of this visualization is that, on average, richer countries lay on the high-diversity, low-ubiquity end of the graph, while poorest countries are to be found in the low-diversity, high-ubiquity quadrant. That is to say, rich countries are able to manufacture and export a large number of goods, which on average a smaller number of countries are able to make. To the contrary, poor countries tend to produce and export relatively fewer goods, which on average many other countries are able to make.

Figure 1. Diversity, Average Ubiquity and GDP per Capita (2013-2014)

These patterns are also evident in evaluating subnational industrial structures. Most developed cities or regions diversify into relatively exceptional economic sectors, while the least developed remain concentrated into fewer, more ubiquitous activities. Panama is no exception. Figure 2 and Figure 3 illustrate this dynamic using the level of average industrial ubiquity and the level of occupational diversity⁵ per location at the Province and at the District level, respectively. Again, richer areas of the country move towards the bottom-right end of the visualization, while poorer regions concentrate in the upper-left area.

⁵ The relevance of occupation-based metrics in discussing subnational complexity patterns will be explained below.

Making sense of this fact is not straightforward, as the usual narrative stemming from the economic literature is that societies should specialize in a relatively narrow set of activities where they can amass competitive advantages. Yet again conventional wisdom is not consistent with reality. Alternatively, the view of the progressive accumulation of productive capacities and know-how as the path to

economic development⁶ can account for this fact. The intuition about our “Economic Complexity” perspective about economic development goes as follows:

- Productive capacities and pieces of tacit know-how, which are not perfectly observable, are combined in the development of different economic sectors.
- Regions that lack many capacities will only be able to assemble a relatively modest number of activities, which will also be feasible in many other regions.
- To the contrary, regions that accumulate many capacities will be able to assemble a relatively large number of activities, many of which will only be replicable in a very small group of other regions.
- As they expand their stock of productive capacities, developing regions become able to diversify their productive mix into less common activities.

From this perspective, the concept of productive diversity and average ubiquity of a region’s productive mix are indicative of its level of economic development. The Economic Complexity Index (ECI) balances these concepts iteratively to correct the noise in one with the average values of the other⁷. Figure 4 and Figure 5 show the countries with the lowest and highest levels of economic complexity in 2013-2014 respectively.

Figure 4. Economic Complexity Index (Lowest values in 2013-2014)

⁶ Hausmann and Hidalgo (2009).

⁷ The relationship between ECI, diversity and average ubiquity is not 1-to-1 precisely because deviations in one are corrected for the other. For example, Japan is much more less diversified than other countries in the top of the ECI distribution, but since its export basket is shaped by very low ubiquity products, it ends up being the country with the highest ECI value in our distribution.

Figure 5. Economic Complexity Index (Highest values in 2013-2014)

In the context of country-level export patterns, ECI values have been found to be excellent predictors of economic activity and future economic growth⁸. Figure 6 shows the strong relationship between ECI between 2013-2014 and GDP per capita in the same period. From this visualization, we can estimate that GDP per Capita in Panama is about twice the amount expected given the complexity of its current good export structure⁹.

⁸ See <http://atlas.cid.harvard.edu/book>

⁹ This study blends a Panama specific dataset that guarantees that export values add truly Panamanian exports only, with the standard UNCOMTRADE data of exports per product by country.

ECI values are also strong predictors of subnational income levels in Panama. Figure 7 shows the association between monthly-declared incomes per capita¹⁰ and the occupation based ECI¹¹.

¹⁰ Monthly incomes might seem surprisingly low. This is because data extracted from the population census is affected by a significant number of individuals that decide not to report their incomes, hence lowering the per capita observed or reported incomes in comparison to standard expectations.

¹¹ Now again, the use of occupation based complexity metrics for the subnational case will be discussed in section four and in the technical appendix.

The process of expansion of the productive capacities in a society does not occur at random. Due to the same coordination failures that prevent individuals from mastering specialized skills that are not demanded by their economies, the incentives for the organic accumulation of productive capacities are endogenous to the capacities that are already available, and how they can be recombined into new, “adjacent possible”, economic activities. The degree of “technological proximity” between pairs of products or industries can be estimated in a number of ways.

In an international trade context, these proximities have been estimated as the tendency for the exports of different pairs of goods to co-locate in the same countries of origin¹². These estimates lead to the development of the concept of the Product Space, a network visualization that shows each product most closely connected to those other products to which it tends to co-locate to the most. Figure 8 shows its structure, displaying a clear tendency for aggregate sectors to cluster together.

Figure 8 - The International Product Space

Source: atlas.cid.harvard.edu

It has been shown that in time, countries tend to diversify their exports into products that are absent but relatively proximate from a technology standpoint (from a Product Space perspective) to their current export structure¹³. That is, the metric of “density” of a country’s export basket around an absent product associates

¹² See <http://atlas.cid.harvard.edu/book>

¹³ See Implied Comparative Advantage by Hausmann, Hidalgo, Yildirim and Stock (2014)

positively and robustly with the chances of the exports of such product to appear and grow.

Hence, this metric can help assess the opportunities for export diversification of countries. This sense *feasibility* has to be balanced with variables that capture a sense of *opportunity* in adding a product to a country's export basket. From an economic complexity perspective, this can be measured by two indices:

- Product Complexity Index (PCI): The analogous of the ECI applied to products.
- Complexity Outlook Gain Index (COG): Measures how the connectivity of the country's export basket in the Product Space improves by diversifying into such product

The purpose of this paper is to look for evidence in a diverse array of datasets to address the question of what productive diversification opportunities are available for Panama, its 12 provinces and 75 districts. More specifically, the paper addresses the following topics:

1. Measuring Panama's *true* exports of goods without accounting for re-exports.
2. Assessing Panama's position in the Product Space and determining its strategic position for export diversification.
3. Visualizing and discussing export diversification opportunities according to three strategic approaches.
4. Determining the best possible approach to measure the technological proximity between pairs of industries within Panama in terms of their capacity to predict future growth and appearance.
5. Assessing the strategic position for industrial diversification of all provinces and districts within Panama.
6. Illustrating the process of identifying and exploring productive diversification opportunities at the sub-national level, for three Panamanian provinces of different strategic situation.

The paper is structured as follows. Section 2. Panama's Export Diversification Opportunities discusses about Panama's current export structure and its diversification opportunities. Section 3. Measuring technological similarity between economic sectors addresses the question of what's the best approach to measure industrial technological similarity within Panama, by examining a number of plausible and measurable alternatives. 4. Regional industrial diversification opportunities assesses how to measure industrial diversification opportunities, and presents relevant analysis for three Panamanian provinces. General conclusions and recommendations are presented in Section 5. Conclusions and policy recommendations.

2. Panama's Export Diversification Opportunities

2.1. Panama's true exports of goods in 2013 and 2014

For years 2013 and 2014, UNComtrade¹⁴ suggest that the value goods exports originated in Panama added up to \$12.5 billion, in a rather diversified array. However, after discounting the imports for each product¹⁵, the sum of positive net exports by product shrinks to about \$3.4 billion, which concentrate in a much more constrained number of products. The explanation for this drastic difference is the relevance of re-exporting activities for the Panamanian economy¹⁶.

A fair assessment of Panama's exports of goods should limit to Customs registers of transactions that can be linked to a domestic source through a certificate of origin. The National Customs Authority of Panama (ANA for its Spanish acronym) was kind enough to provide a joint dataset of Panamanian export transactions in 2013-2014¹⁷. This export data registers the country of origin of the exported product. Hence, our definition of Panama's true exports of goods in this period is the sum by product of all transactions that are registered as originated either in Panama or in especially identified regions within Panama (i.e. Colón Free Zone).

The picture obtained from analyzing this data is much different from the one of diversified exports of \$12 billion in 2013-2014. The total value of exports of goods in this period assessed from ANA's dataset is about \$1.1 billion. Figure 9, Figure 10 and Figure 11 show how these reduced exports of goods concentrate mostly on Agricultural and Mining products, of low or mid-low complexity.

Looking at this data with more depth, specific products that shape the bulk of the country's exports in each complexity block can be identified (Figure 12 to Figure 15).¹⁸ At the low complexity level, Bananas and Gold dominate the exports of goods. At the mid-low complexity level, exports of goods concentrate in ethyl alcohols, meats and cheese, and paper related products. The latter also capture the largest exports of mid-high complexity goods, with the addition of flat-rolled iron. Finally, paintings, inks and aldehydes account for most exports of high complexity products.

¹⁴ As reported in the Atlas of Economic Complexity – see <http://atlas.cid.harvard.edu>

¹⁵ This study refers to specific product to product categories in the HS classification system, revision 3 (1992) at 4 digits

¹⁶ Re-export activities consist in temporary importing goods to be later exported after minor domestic value added.

¹⁷ Mention that the dataset does not allow to differentiate years.

¹⁸ The following bar graphs only show export products in which Panama show a Relative Comparative Advantage index above the unit. See Balassa (1964) for a justification of this metric for the purpose of assessing a country's comparative advantage.

Figure 9. Exports of goods by product section

Source: ANA and own Calculations

Figure 10. Exports of goods by economic complexity group

Source: ANA and own Calculations

Figure 11. Exports of goods by product section and economic complexity group

Source: ANA and own Calculations

Figure 12. Products Exported Competitively from Panama (2013-2014 - Low Complexity)

Figure 13. Products Exported Competitively from Panama (2013-2014 - Medium-Low Complexity)

Figure 14. Products Exported Competitively from Panama (2013-2014 - Medium-High Complexity)

Figure 15. Products Exported Competitively from Panama (2013-2014 - High Complexity)

2.2. Panama's Strategic Approach to Export Diversification

While there is no automatic way to visualize this data in the Product Space, it is possible to visualize the UNComtrade data and impose especial constraints to consider Panamanian exports of a given product as competitive. A country is considered to have a comparative advantage in a product if its share within the country's export basket is larger than the share of the product on worldwide exports. This index, known as Relative Comparative Advantage, would hence need to be larger than the unit. In studying the location of Panamanian exports of goods in the Product Space with the UNComtrade data, we use an RCA threshold of 3. Figure 16 shows how the only area of the Product Space that is robustly populated by Panamanian exports is the agriculture cluster. While this does not mean that Panama is only competitive in these products, it does underscore the point that Panama's export structure is relatively peripheral and concentrated in low complexity products.

Figure 16. Panama's position in the Product Space (RCA > 3)

Source: atlas.cid.harvard.edu

Using the ANA data, products with RCA below the unit can be visualized according to their distance to Panama's current export structure, their COI and their Complexity Block. Figure 17 shows these three metrics for all "missing products" in Panama (products with a RCA lower than one). The first apparent finding is that the added opportunity of each missing product is, on average, higher for products that are more distant from Panama's current export structure. Now again, this is a common feature of countries with relatively peripheral export structures. However, the notable vertical dispersion observed at different distances suggests that there are significant optimization opportunities in assessing which products should be considered.

Figure 17. Distance, Opportunity Gain and Complexity (Panama, 2013-2014)

To making sense of all this data demands an exercise of aggregation and decomposition. Figure 18 and Figure 19 show what product sections and sectors¹⁹ average out missing products in ways that suggest their strategic position.

Some optimization lessons become apparent immediately from Figure 18. Missing products in Vegetables and Foodstuffs are closer and more strategic than those in the Minerals section. This case is also apparent when comparing Transport Vehicles with Textiles and Furniture; when comparing Chemicals and Plastics with Metals and Stone & Glass; and when comparing Machinery to Electronics. Figure 19 allows for further precision, pointing to a number of relatively close Agricultural products and Foodstuffs that outweigh other products with similar distance in both COG and PCI (Edible preparations, Beverages, Oils, Wood, Dairy Products, Cocoa and Meat). At higher distances, we see Chemical Products (Soaps, Dyes, Pharmaceuticals and Plastics) along with Machineries dominating the opportunity scores at their respective distances.

¹⁹ Product sectors are defined as the 2-digit level of detail of the HS classification system, revision 3 (1992). Product sections are aggregates of these 2-digit sectors used by the Center for International Development in the Colombian and Mexican subnational atlases of economic complexity. See <http://datlascolombia.com> and <http://complejidad.datos.gob.mx>.

Figure 22. Distance, Opportunity Gain and Complexity (Panama, 2013-2014 - Medium-High Complexity)

Figure 23. Distance, Opportunity Gain and Complexity (Panama, 2013-2014 - High Complexity)

While there is a better understanding of the economic activities where opportunities for export diversification may roam, narrowing the analysis to the product level requires a way to reduce the dimensionality of the variables for measuring feasibility and opportunity. This need opens the question of how to reduce this dimensionality.

Countries that are very peripheral and have little opportunities for organic diversification into new interesting sectors may put a prime on opportunity, while

countries that are low in complexity but have good connectivity to increasingly complex product might emphasize on short distances. Finally, countries with adequate complexity but difficulty for improving organically can opt for a more parsimonious, balanced strategy.

These are the principles behind Figure 24, which shows the normalized ECI values for different countries in the world, along with their Complexity Outlook Indexes (COI)²⁰. The analysis becomes more intuitive if we proceed clockwise from the bottom-left. Countries in that quadrant of the graph should prioritize “*Strategic Bets*” for products that enhance their connectivity and complexity, despite being far from their current and peripheral export structure. Countries in the upper left quadrant are not very complex, but their good connectivity from a Product Space perspective suggests that they might have some “*Ripe Fruits*”, close products that might enhance their complexity significantly. Countries in the upper-right quadrant are both relatively complex and well connected, which suggests that they are in a good situation and with plenty of room to continue growing organically. Finally, countries in the bottom-right quadrant already show significant levels of export complexity, but lack the connectivity to continue improving organically. For countries on the right-hand side of the chart, a more “*Balanced*” strategy, equally weighing feasibility and opportunity, is advised.

Figure 24. ECI vs. COI (International Trade, 2013-2014)

²⁰ The Complexity Outlook Index (COI) is a country specific measure of how well positioned a country is in the international product space, by assessing the aggregate distance to all missing products in its export basket. More peripheral export structures will have worse COI than more central ones. The Complexity Outlook Gain Index (COG) is a product-country specific measure that assesses how the aggregation of a particular product to a country's export basket improves said country's COI, or the quality of its position in the Product Space. The mathematics behind these indices are discussed in the Technical Appendix.

Hence, where a country is located in these quadrants might hints on the strategic approach to export diversification that should be followed: “Strategic Bets”, “Ripe Fruit”, or “Balanced”. While strictly speaking Panama lays in the “Strategic Bets” quadrant, it is noteworthy that it is very close to the center of the visualization. This implies that there are little grounds to justify any of these specific approaches.

Therefore, we proceed to identify export diversification opportunities according to each of the three strategic approaches. Definitions and methods for producing the relevant scores for the “Strategic Bets”, “Balanced”, and “Ripe Fruit” approaches are shown below, along with visualizations and tables displaying aggregate product sections that show highest approach scores, and the top 50 missing products according to each strategy.

2.2.1. Strategic Bets

This approach prioritizes opportunity over feasibility. That is, the strategic bets approach score is a weighted average of normalized values of each dimension, setting 40% weight in Density,²¹ 40% in COG, and 20% on PCI. This approach is suggested for the bottom-left quadrant in Figure 24, for countries with low scores in both complexity and connectivity in the Product Space. Figure 25 sorts all product sections according to average Strategic Bets score of their missing products in Panama. The figure suggests that special emphasis should be placed on Transport Vehicles, Chemicals and Machinery. Figure 26 and Table 1 show the top 50 products according to Strategic Bets score, displaying additional information about them.

Figure 25. Product sectors (Section Level) by Strategic Bets approach (Panama, 2013-2014)

²¹ As the inverse metric of distance, the density of a product increases the closest it is to the export structure of a given country. The mathematical expressions to calculate these metrics for both the export of products and the employment of industries are discussed in the Technical Appendix.

Figure 26. Strategic Products (Strategic Bets Approach, Panama, 2013-2014)

Table 1. Top 50 Products for export diversification according to the Strategic Bets Approach

Rank	Product	Sector	Section	Density	PCI	COG	Exports	Score
1	Slag wool, rock wool and similar mineral wools	Articles of stone, plaster, cement, etc.	Stone and glass	0.0981	2.9279	1.1565	14684	0.9573
2	Machinery for making printing components	Miscellaneous Machinery	Machinery	0.0893	3.3457	1.2404	754	0.9448
3	Polyamides	Plastics	Chemicals and plastics	0.0779	3.8560	1.3509	6	0.9248
4	Tapes, cassettes, records and compact disks	Electrical machinery and equipment	Electronics	0.0888	3.4420	1.2041	101744	0.9123
5	Springs of iron or steel	Articles of iron or steel	Metals	0.0828	3.6007	1.2816	481	0.9088
6	Diagnostic or laboratory reagents	Miscellaneous chemical products	Chemicals and plastics	0.0833	3.7330	1.2470	0	0.8968
7	Compression-ignition internal combustion piston engines	Miscellaneous Machinery	Machinery	0.0737	3.8618	1.3879	167894	0.8938
8	Other lifting machinery	Miscellaneous Machinery	Machinery	0.0953	3.0076	1.0942	94842	0.8641
9	Equipment for the treatment of materials by a change of temperature	Miscellaneous Machinery	Machinery	0.0861	3.3549	1.1853	176427	0.8433
10	Electric signal and traffic controls	Electrical machinery and equipment	Electronics	0.0926	3.0642	1.1007	7000	0.8341
11	Industrial electric furnaces	Electrical machinery and equipment	Electronics	0.0823	3.4063	1.2346	0	0.8340
12	Instruments for measuring flow or other variables of liquids or gases	Apparatuses (optical, medical, etc.)	Machinery	0.0807	4.0311	1.1812	171688	0.8300
13	Prepared culture media for micro-organisms	Miscellaneous chemical products	Chemicals and plastics	0.0759	4.0381	1.2558	0	0.8243
14	Transmission shafts	Miscellaneous Machinery	Machinery	0.0814	3.5340	1.2186	316934	0.8200
15	Textile articles for technical use	Impregnated, coated, covered or laminated textile fabrics	Textiles and furniture	0.0802	3.5485	1.2371	43	0.8192
16	Blood	Pharmaceutical products	Chemicals and plastics	0.0829	3.6872	1.1703	0	0.8158
17	Lubricants	Soaps, waxes, and paints	Chemicals and plastics	0.0774	3.1919	1.3134	5678	0.8051
18	Other plastic plates, sheets etc.	Plastics	Chemicals and plastics	0.1153	2.1326	0.7915	129473	0.7974
19	Vulcanized rubber plates	Rubber	Chemicals and plastics	0.0833	3.0893	1.2140	11439	0.7948
20	Pig and poultry fat, rendered	Animal or vegetable fats, oils or waxes	Vegetables, foodstuffs and wood	0.0877	2.9011	1.1562	0	0.7900
21	Other printed matter	Products of the printing industry	Vegetables, foodstuffs and wood	0.1185	2.2280	0.7162	142699	0.7888
22	Fork lift trucks	Miscellaneous Machinery	Machinery	0.0797	3.4394	1.2225	75688	0.7857
23	Pharmaceutical goods	Pharmaceutical products	Chemicals and plastics	0.0952	2.4443	1.0783	0	0.7823
24	Centrifuges	Miscellaneous Machinery	Machinery	0.0848	3.2749	1.1497	338944	0.7797
25	Appliances for thermostatically controlled valves	Miscellaneous Machinery	Machinery	0.0845	3.1690	1.1658	29332	0.7782
26	Dairy machinery	Miscellaneous Machinery	Machinery	0.0974	2.6846	1.0044	968	0.7767
27	Refractory cements	Miscellaneous chemical products	Chemicals and plastics	0.0972	2.5235	1.0255	195	0.7747
28	Lathes for removing metal	Miscellaneous Machinery	Machinery	0.0709	4.0134	1.2870	0	0.7711
29	Instruments for physical or chemical analysis	Apparatuses (optical, medical, etc.)	Machinery	0.0786	4.2100	1.1309	20867	0.7703
30	Machines having individual functions n.e.c.	Miscellaneous Machinery	Machinery	0.0835	3.4933	1.1344	906145	0.7698
31	Parts of railway locomotives	Trains	Transport vehicles	0.0855	3.1085	1.1449	0	0.7678
32	Tractors	Vehicles	Transport vehicles	0.0820	3.1939	1.1821	505613	0.7573
33	X-ray machines	Apparatuses (optical, medical, etc.)	Machinery	0.0737	3.9562	1.2283	179877	0.7548
34	Parts of tractors and special purpose vehicles	Vehicles	Transport vehicles	0.0807	3.1886	1.2002	693449	0.7518
35	Gaskets and similar joints of metal sheeting	Miscellaneous Machinery	Machinery	0.0803	3.6280	1.1485	0	0.7478
36	Acrylic polymers	Plastics	Chemicals and plastics	0.0759	3.4190	1.2422	3688	0.7427
37	Other agricultural machinery	Miscellaneous Machinery	Machinery	0.0972	2.8489	0.9459	0	0.7367
38	Newspapers, journals and periodicals	Products of the printing industry	Vegetables, foodstuffs and wood	0.1077	2.2800	0.8363	127049	0.7358
39	Other articles of iron or steel	Articles of iron or steel	Metals	0.0953	2.6973	0.9935	322323	0.7338
40	Parts and accessories for metal working machines	Miscellaneous Machinery	Machinery	0.0808	3.6325	1.1242	42463	0.7333
41	Knives and blades for machines	Metal tools and tableware	Metals	0.0819	3.3289	1.1426	3203	0.7328
42	Flat rolled products of other alloy steel, width < 600 mm	Iron and steel	Metals	0.0767	3.6984	1.1818	0	0.7298
43	Orthopedic appliances	Apparatuses (optical, medical, etc.)	Machinery	0.0922	3.1187	0.9821	89294	0.7220
44	Harvesting or agricultural machinery	Miscellaneous Machinery	Machinery	0.0918	2.6871	1.0412	52688	0.7218
45	Vehicle Bodies	Vehicles	Transport vehicles	0.0720	3.8982	1.2260	31823	0.7198
46	Paints and varnishes, nonaqueous	Dyes, paints, inks, etc.	Chemicals and plastics	0.1231	1.5972	0.6371	541089	0.7168
47	Machinery parts, not containing electrical features, n.e.c.	Miscellaneous Machinery	Machinery	0.0920	2.8498	1.0124	28123	0.7164
48	Automatic regulating instruments	Apparatuses (optical, medical, etc.)	Machinery	0.0809	3.4447	1.1239	35051	0.7133
49	Radiators for central heating of iron or steel	Articles of iron or steel	Metals	0.0939	2.7965	0.9751	0	0.7058
50	Pickling preparations for metal surfaces	Miscellaneous chemical products	Chemicals and plastics	0.0689	3.7680	1.2728	0	0.6991

Source: UNCOMTRADE, World Bank WDI, ANA and Own Calculations.

2.2.2. Balanced Approach

This approach weighs equally feasibility and opportunity. That is, the balanced approach score is a weighted average of the normalized values of the Density, COG and PCI for missing products that sets 50% weight in Density and 25% in both COG and PCI. This approach is suggested for the quadrants to the right in Figure 24.

Figure 27 sorts all product sections according to average scores of their missing products in Panama. It suggests that special emphasis should be placed on Vegetables and Foodstuffs, Transport Vehicles and Chemicals. Figure 28 and Table 2 show the top 50 products according to the Balanced score, with some additional information about each.

Figure 27. Product sectors (Section Level) by Balanced approach (Panama, 2013-2014)

Figure 28. Strategic Products (Balanced Approach, Panama, 2013-2014)

Table 2. Top 50 Products for export diversification according to the Balanced Approach

Rank	Product	Sector	Section	Density	PCI	COG	Exports	Score
1	Other printed matter	Products of the printing industry	Vegetables, foodstuffs and wood	0.1185	2.2280	0.7162	142699	0.8181
2	Beer	Beverages	Vegetables, foodstuffs and wood	0.1466	0.1509	0.2370	8905	0.8010
3	Other plastic plates, sheets etc.	Plastics	Chemicals and plastics	0.1153	2.1326	0.7915	129473	0.7852
4	Paints and varnishes, nonaqueous	Dyes, paints, inks, etc.	Chemicals and plastics	0.1231	1.5972	0.6371	541089	0.7747
5	Slag wool, rock wool and similar mineral wools	Articles of stone, plaster, cement, etc.	Stone and glass	0.0981	2.9279	1.1565	14684	0.7715
6	Milk	Dairy products	Vegetables, foodstuffs and wood	0.1323	0.9589	0.4205	61962	0.7394
7	Food preparations not elsewhere specified	Miscellaneous edible preparations	Vegetables, foodstuffs and wood	0.1312	1.1673	0.3832	149921	0.7255
8	Sausages	Preparations of meat or fish	Vegetables, foodstuffs and wood	0.1241	1.3679	0.5742	139276	0.7247
9	Pleasure or sport boats	Ships	Transport vehicles	0.1353	0.7290	0.3261	210380	0.7107
10	Machinery for making printing components	Miscellaneous Machinery	Machinery	0.0893	3.3457	1.2404	754	0.7065
11	Paper and paperboard labels	Paper and paperboard	Vegetables, foodstuffs and wood	0.1314	0.9894	0.3792	5612	0.7005
12	Postage or revenue stamps	Art	Textiles and furniture	0.1375	0.3483	0.3109	0	0.6921
13	Other lifting machinery	Miscellaneous Machinery	Machinery	0.0953	3.0076	1.0942	94842	0.6915
14	Tapes, cassettes, records and compact disks	Electrical machinery and equipment	Electronics	0.0888	3.4420	1.2041	101744	0.6874
15	Newspapers, journals and periodicals	Products of the printing industry	Vegetables, foodstuffs and wood	0.1077	2.2800	0.8363	127049	0.6815
16	Bakery products	Preparations of cereals, flour, starch or milk	Vegetables, foodstuffs and wood	0.1393	0.3768	0.2038	1910670	0.6686
17	Medicaments, packaged	Pharmaceutical products	Chemicals and plastics	0.1075	2.4696	0.7657	18865164	0.6632
18	Plastic tubes and fittings	Plastics	Chemicals and plastics	0.1283	1.0601	0.4010	472384	0.6627
19	Surveying instruments	Apparatuses (optical, medical, etc.)	Machinery	0.1376	0.2613	0.2725	221371	0.6584
20	Other fermented beverages	Beverages	Vegetables, foodstuffs and wood	0.1218	1.2779	0.5595	0	0.6565
21	Electric signal and traffic controls	Electrical machinery and equipment	Electronics	0.0926	3.0642	1.1007	7000	0.6501
22	Diagnostic or laboratory reagents	Miscellaneous chemical products	Chemicals and plastics	0.0833	3.7330	1.2470	0	0.6451
23	Aluminum structures (bridges, towers etc)	Aluminium	Metals	0.1171	1.7396	0.5789	87737	0.6421
24	Cleaning products	Soaps, waxes, and paints	Chemicals and plastics	0.1198	1.4301	0.5589	305352	0.6388
25	Springs of iron or steel	Articles of iron or steel	Metals	0.0828	3.6007	1.2816	481	0.6374
26	Dairy machinery	Miscellaneous Machinery	Machinery	0.0974	2.6846	1.0044	988	0.6342
27	Packing boxes	Wood	Vegetables, foodstuffs and wood	0.1209	1.4490	0.5073	71735	0.6327
28	Ice cream	Miscellaneous edible preparations	Vegetables, foodstuffs and wood	0.1282	0.8355	0.4047	30479	0.6311
29	Glaziers' putty	Dyes, paints, inks, etc.	Chemicals and plastics	0.1108	1.8131	0.7564	158238	0.6305
30	Malt extract	Preparations of cereals, flour, starch or milk	Vegetables, foodstuffs and wood	0.1237	1.1266	0.4858	425466	0.6302
31	Fermented milk products	Dairy products	Vegetables, foodstuffs and wood	0.1248	1.1757	0.4329	91	0.6286
32	Refractory cements	Miscellaneous chemical products	Chemicals and plastics	0.0972	2.5235	1.0255	195	0.6195
33	Cullet and other scraps of glass	Glass and glassware	Stone and glass	0.1325	0.3490	0.3583	22316	0.6195
34	Paints and varnishes, aqueous	Dyes, paints, inks, etc.	Chemicals and plastics	0.1214	1.1875	0.5301	106094	0.6188
35	Other agricultural machinery	Miscellaneous Machinery	Machinery	0.0972	2.8489	0.9459	0	0.6186
36	Polyamides	Plastics	Chemicals and plastics	0.0779	3.8560	1.3509	6	0.6170
37	Toilet paper	Paper and paperboard	Vegetables, foodstuffs and wood	0.1223	1.4705	0.4194	1310949	0.6132
38	Equipment for the treatment of materials by a change of temperature	Miscellaneous Machinery	Machinery	0.0861	3.3549	1.1853	176427	0.6121
39	Industrial monocarboxylic fatty acids	Miscellaneous chemical products	Chemicals and plastics	0.0999	2.7281	0.8531	2685510	0.6024
40	Packing lids	Plastics	Chemicals and plastics	0.1308	0.6894	0.2994	1469948	0.6006
41	Pharmaceutical goods	Pharmaceutical products	Chemicals and plastics	0.0952	2.4443	1.0783	0	0.5991
42	Machinery for soil preparation or cultivation	Miscellaneous Machinery	Machinery	0.1056	2.2258	0.7765	68139	0.5991
43	Instruments for measuring flow or other variables of liquids or gases	Apparatuses (optical, medical, etc.)	Machinery	0.0807	4.0311	1.1812	171668	0.5975
44	Trailers and semi-trailers	Vehicles	Transport vehicles	0.1042	2.2602	0.8098	315917	0.5954
45	Chocolates	Cocoa	Vegetables, foodstuffs and wood	0.1183	1.4399	0.5219	118805	0.5901
46	Structures and their parts, of iron or steel	Articles of iron or steel	Metals	0.1167	1.7677	0.4957	1846141	0.5894
47	Other articles of iron or steel	Articles of iron or steel	Metals	0.0953	2.6973	0.9935	322323	0.5872
48	Blood	Pharmaceutical products	Chemicals and plastics	0.0829	3.6872	1.1703	0	0.5865
49	Machinery for the industrial preparation of food or drink	Miscellaneous Machinery	Machinery	0.1028	2.2483	0.8376	129029	0.5824
50	Orthopedic appliances	Apparatuses (optical, medical, etc.)	Machinery	0.0922	3.1187	0.9821	89294	0.5793

Source: UNCOMTRADE, World Bank WDI, ANA and Own Calculations.

2.2.3. Ripe Fruit Approach

This approach emphasizes feasibility over opportunity. That is, the Ripe Fruit approach score is a weighted average of the normalized values of the Density (65%), COG (20%) and PCI (15%) for missing products. A Ripe Fruit approach is suggested for countries in the upper-left quadrant in Figure 24, with relatively low complexity but relatively high connectivity in the Product Space. Figure 29 sorts all product sections according to the average Ripe Fruit score of their missing products in Panama. Again, it suggests that special emphasis should be placed on Vegetables and Foodstuffs, Transport Vehicles, and Minerals.²² Figure 30 and Table 3 show the top 50 products according to the Ripe Fruit score, with additional information.

Figure 29. Product sectors (Section Level) by Ripe Fruit approach (Panama, 2013-2014)

Figure 30. Strategic Products (Ripe Fruit Approach, Panama, 2013-2014)

²² Minerals shall be taken with care, as long as they might only be feasible in places with very particular natural endowments that are not replicable.

Table 3. Top 50 Products for export diversification according to the Ripe Fruit Approach

Rank	Product	Sector	Section	Density	PCI	COG	Exports	Score
1	Beer	Beverages	Vegetables, foodstuffs and wood	0.1466	0.1509	0.2370	8905	1.1705
2	Wheat or meslin flour	Flours, starches and malts	Vegetables, foodstuffs and wood	0.1549	-1.3291	-0.2396	8955	1.0341
3	Cements	Salt, sulphur, lime, cement, etc.	Minerals	0.1507	-0.5906	-0.1689	26286	1.0221
4	Legumes	Vegetables	Vegetables, foodstuffs and wood	0.1581	-2.2071	-0.3174	0	1.0059
5	Postage or revenue stamps	Art	Textiles and furniture	0.1375	0.3483	0.3109	0	0.9876
6	Bakery products	Preparations of cereals, flour, starch or milk	Vegetables, foodstuffs and wood	0.1393	0.3768	0.2038	1910670	0.9856
7	Petroleum oils, refined	Mineral fuels, oils and waxes	Minerals	0.1452	-0.5565	0.0378	2112292	0.9793
8	Pleasure or sport boats	Ships	Transport vehicles	0.1353	0.7290	0.3261	210380	0.9696
9	Cereal residues	Food residues and animal feed	Vegetables, foodstuffs and wood	0.1550	-2.2531	-0.2146	1882	0.9687
10	Surveying instruments	Apparatuses (optical, medical, etc.)	Machinery	0.1376	0.2613	0.2725	221371	0.9638
11	Milk	Diary products	Vegetables, foodstuffs and wood	0.1323	0.9589	0.4205	61962	0.9569
12	Cigars and cigarettes	Tobacco	Vegetables, foodstuffs and wood	0.1442	-0.3477	-0.0213	0	0.9438
13	Cereal flours	Flours, starches and malts	Vegetables, foodstuffs and wood	0.1460	-1.0426	-0.0243	0	0.9292
14	Food preparations not elsewhere specified	Miscellaneous edible preparations	Vegetables, foodstuffs and wood	0.1312	1.1673	0.3832	149921	0.9286
15	Paper and paperboard labels	Paper and paperboard	Vegetables, foodstuffs and wood	0.1314	0.9894	0.3792	5612	0.9150
16	Flour of dried legumes	Flours, starches and malts	Vegetables, foodstuffs and wood	0.1511	-1.8334	-0.2125	0	0.9059
17	Other live animals	Live animals	Vegetables, foodstuffs and wood	0.1501	-1.8105	-0.1690	17126	0.9029
18	Confectionery sugar	Sugar and candy	Vegetables, foodstuffs and wood	0.1376	0.2462	0.1350	164372	0.8971
19	Cullet and other scraps of glass	Glass and glassware	Stone and glass	0.1325	0.3490	0.3583	22316	0.8794
20	Paints and varnishes, nonaqueous	Dyes, paints, inks, etc.	Chemicals and plastics	0.1231	1.5972	0.6371	541089	0.8756
21	Plastic tubes and fittings	Plastics	Chemicals and plastics	0.1283	1.0601	0.4010	472384	0.8529
22	Sausages	Preparations of meat or fish	Vegetables, foodstuffs and wood	0.1241	1.3679	0.5742	139276	0.8518
23	Zinc waste and scrap	Zinc	Metals	0.1381	-0.2338	0.0870	0	0.8483
24	Other printed matter	Products of the printing industry	Vegetables, foodstuffs and wood	0.1185	2.2280	0.7162	142699	0.8463
25	Soap	Soaps, waxes, and paints	Chemicals and plastics	0.1451	-1.0404	-0.1680	0	0.8406
26	Packing lids	Plastics	Chemicals and plastics	0.1308	0.6894	0.2994	1469948	0.8383
27	Ice cream	Miscellaneous edible preparations	Vegetables, foodstuffs and wood	0.1282	0.8355	0.4047	30479	0.8329
28	Legumes, dried	Vegetables	Vegetables, foodstuffs and wood	0.1554	-2.6213	-0.4706	0	0.8286
29	Used clothes and textiles	Other made up textile articles	Textiles and furniture	0.1343	0.0744	0.1653	38311	0.8124
30	Wood charcoal	Wood	Vegetables, foodstuffs and wood	0.1491	-1.9461	-0.2891	19800	0.8101
31	Jams, jellies and marmalades	Preparations of vegetables, fruit, or nuts	Vegetables, foodstuffs and wood	0.1343	0.1267	0.1455	1250	0.8074
32	Other plastic plates, sheets etc.	Plastics	Chemicals and plastics	0.1153	2.1326	0.7915	129473	0.7909
33	Fermented milk products	Diary products	Vegetables, foodstuffs and wood	0.1248	1.1757	0.4329	91	0.7873
34	Soups and broths	Miscellaneous edible preparations	Vegetables, foodstuffs and wood	0.1284	0.5627	0.3410	186601	0.7850
35	Waters	Beverages	Vegetables, foodstuffs and wood	0.1338	0.0771	0.1297	33161	0.7845
36	Molasses	Sugar and candy	Vegetables, foodstuffs and wood	0.1468	-1.5462	-0.2863	0	0.7842
37	Electrical energy	Mineral fuels, oils and waxes	Minerals	0.1325	-0.0069	0.2118	0	0.7821
38	Malt extract	Preparations of cereals, flour, starch or milk	Vegetables, foodstuffs and wood	0.1237	1.1266	0.4858	425466	0.7790
39	Floating structures for scrapping	Ships	Transport vehicles	0.1384	-0.8123	0.0287	0	0.7783
40	Other fermented beverages	Beverages	Vegetables, foodstuffs and wood	0.1218	1.2779	0.5595	0	0.7768
41	Paints and varnishes, aqueous	Dyes, paints, inks, etc.	Chemicals and plastics	0.1214	1.1875	0.5301	106094	0.7445
42	Packing boxes	Wood	Vegetables, foodstuffs and wood	0.1209	1.4490	0.5073	71735	0.7431
43	Toilet paper	Paper and paperboard	Vegetables, foodstuffs and wood	0.1223	1.4705	0.4194	1310949	0.7419
44	Cleaning products	Soaps, waxes, and paints	Chemicals and plastics	0.1198	1.4301	0.5589	305352	0.7384
45	Worked cereal grains	Flours, starches and malts	Vegetables, foodstuffs and wood	0.1336	-0.5510	0.1559	0	0.7366
46	Containers for compressed or liquified gas	Articles of iron or steel	Metals	0.1300	0.3201	0.1760	132264	0.7278
47	Cereal foods	Preparations of cereals, flour, starch or milk	Vegetables, foodstuffs and wood	0.1261	0.7384	0.3156	270538	0.7271
48	Animal or vegetable fats and oils, hydrogenated	Animal or vegetable fats, oils or waxes	Vegetables, foodstuffs and wood	0.1371	-0.8154	-0.0356	132432	0.7150
49	Aluminum structures (bridges, towers etc)	Aluminium	Metals	0.1171	1.7396	0.5789	87737	0.7066
50	Other vegetables, prepared or preserved	Preparations of vegetables, fruit, or nuts	Vegetables, foodstuffs and wood	0.1352	-0.5122	-0.0447	114707	0.6878

Source: UNCOMTRADE, World Bank WDI, ANA and Own Calculations.

Independently of the particular approach followed, there are certain sections and products that appear repeatedly in the list of potential products. This is consistent with the fact that Panama lies at the very center of the Complexity Outlook vs. Economic Complexity schedule (Figure 24), and therefore it is hard to pin down a single strategy for identifying potential sectors.

There are many products within the **Vegetables and Foodstuffs** category, that made the three lists of potential products according to each of the three different criteria. It is noteworthy that when we look at the strategy that weighs more on proximity, 31 of the 50 products ranked (63%) belong to Vegetables and Foodstuffs. That is one of the alternatives of productive diversification: To add capabilities and begin expanding products downstream from the low complexity products that Panama is nowadays able to export competitively. Within these area, and following the ranking of the 50 most attractive products for each strategy, the most salient opportunities appear to be related to the paper-industry, such as **products used by the printing industry** (supply materials for newspaper, journals and magazines), **paper and paperboard products** (paperboard labels, toilet paper). **Beverages** were also well ranked (water, beer, other fermented beverages), as well as preparations of **cereals, flour, and starch** (bakery products, malt, cereals).

The second sector that shows up consistently in the rankings are **Chemicals and plastics**. The fact that the products belonging to this category were more pervasive in the ranking of strategies other than Reap Fruits (24% of all Strategic Bets and 28% of the ranking on the more Balanced strategy), clearly indicates that it entails more risk, i.e. jumping longer distances in the product space forest. **Dyes, paints and inks** (mostly paint and varnishes), **plastics** (polyamides, plastic sheets, plastic tubes and fittings, packing lids) and **soaps, waxes and paints** (lubricants, cleaning products, soap) were the sectors that came out with more potential within our analysis.

The analysis provided abroad should be considered as a roadmap to guide the search for strategic sectors that could potentially help Panama in diversifying its productive capabilities and competitive exports. Our analysis only suggests that these sectors demand some capabilities that Panama might already have in place. A more industry-detailed analysis based on this roadmap shall help in determining what are these sectors intensive on, and out of those which capabilities are already on the ground, and which are still missing, and how they can be attracted.

3. Measuring technological similarity between economic sectors

The previous discussion about export diversification opportunities in Panama was based on a measure of technological similarity between tradable products. The values in the “proximity matrix” used for this exercise measured the tendency of

different pairs of products to co-originate from the same countries, or more specifically, the minimum of the conditional probabilities for a country to be competitive in one product, given that it is competitive on other.

The theoretical principle behind this metric is that different activities require different capabilities, but some activities overlap in a large portion of their required capabilities. If two sectors require a similar set of capabilities (For example, male shirts and female shirts), the fact that one of them is feasible in a country suggests the presence of many of the required capabilities of the other, and hence a higher likelihood for competitiveness in the other.

While the required capabilities of different sectors are unobservable, their tendency to co-originate in an international trade setting is perfectly measurable as a proxy for the similarity of required capacities. Building on this proximity matrix, Hausmann et al (2014) find evidence that presence of technologically similar activities (as measured by the Density measure) associates positively with the future growth and appearance of economic sectors in different countries.

However, this metric cannot be used in assessing industrial diversification opportunities for provinces and districts within Panama, since this exercise requires information about non-tradable activities, which are the largest economic sectors in Panama today. Hence, a different approach to measuring technological similarity between industry pairs needs to be used for this purpose.

An initial approach could be to capture the tendency for economic activities to co-locate in different provinces or districts within Panama, using the same conditional probability method for the employment by sector-region within Panama. While plausible, this approach could lead to biases, as economic activities might tend to co-locate not due to technological similarities but due to urban scaling issues. For instance, the Theater and Central Government activities may appear to be very close technologically when they tend to co-locate because employment in both concentrates in large cities.

Other approaches take advantage of more granular data about actually observable capacities being used by different sectors in order to estimate the similarity in all industry pairs. One approach is to leverage on administrative or statistical datasets that measure cross-sector labor flows. This alternative measures the relative frequency of labor flows between industry pairs as a measure of the tendency for such sectors to use the same human talent. This is the principle behind the skill-relatedness metric derived for a Swedish context (see Neffke and Henning, 2013; Neffke, Otto and Weyh, 2016), as well the Colombian²³ and Mexican²⁴ Atlases of Economic Complexity. Sadly, the authors did not obtain access to the relevant data to advance this exercise in Panama from its Social Security Agency (CSS, for its

²³ <http://datlascolombia.com>

²⁴ <http://datos.complejidad.gob.mx>

Spanish acronym). However, the Swedish labor-flow matrix was expressed in an industry classification system that could be converted back into an adapted version of the Panamanian edition of the International Standardized Industry Classification (ISIC) in its third revision.

Finally, a separate approach to measure the overlap in explicit capacities being used by different economic activities takes advantage of statistical sources that capture the occupations or tasks of the labor force in each of the economic sectors. This approach suggests that sectors that overlap in an important part of their occupation vectors will tend to require relatively similar talents to be developed effectively. In the Panamanian case, the population census captures information for both the economic activity and the occupation for each of the surveyed individuals that report being part of the work force. The same conditional probability approach in the co-location case would now be used on an industry-occupation dataset to assess the technological similarity between industry pairs. That is, measuring the minimum of the conditional probabilities that an occupation is relatively important for one sector, given that it is relatively important for the other. The Brazilian subnational economic complexity tool “DataViva” follows this approach²⁵.

In order to address which is the right methodological approach to the question of predicting future growth and appearance of economic activities for Panamanian provinces and districts, we replicate the empirical approach followed by Hausmann et al (2014) to predict the growth rate (intensive margin) and the probability of appearance and disappearance (extensive margin) of different industries (in terms of employment) between 2000 and 2010. We measure the size of each activity per province and district from the Population Censuses for both years.

The specification of the empirical model for the intensive margin specification follows:

$$\log(E_{ir}^{t+10}/E_{ir}^t) = \beta_0 + \beta_1 \log(E_{ir}^t) + \beta_2 \log(D_{ir}^t) + \theta_i + \theta_r + \varepsilon_{ir}$$

In this specification, the meaning of its components is the following:

- “i” means industry,
- “r” means region (province or district, depending on the regression),
- “t” is the year 2000, and t+10 is the year 2010,
- “ E_{ir}^t ” means employment in industry “i” and region “r” in the year 2000,
- “ D_{ir}^t ” means the Density in industry “i” and region “r” in the year 2000,
- “ θ_i ” means industry fixed effects,
- “ θ_r ” means region fixed effects,
- “ ε_{ir} ” means statistical error.

²⁵ <http://dataviva.info>

This regression was executed with the densities computed from the co-location proximities (“coloc”), the Swedish labor-flow proximities (“swe”) and the occupation vector proximities (“occ”). Clustering of standard errors at the industry or region levels were added as robustness checks. In the case of district-level regressions, specifications with region fixed effects and clustering of standard errors at the province level were also considered. Table 4 shows the regression results at the province level, while Table 5 and Table 6 show the regression results at the district level.

Table 4. Intensive margin regression specifications at the province level

VARIABLES	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]
log[E(t)]	-0.0360*** (0.00187)	-0.0360*** (0.00297)	-0.0360*** (0.00619)	-0.0389*** (0.00187)	-0.0389*** (0.00276)	-0.0389*** (0.00566)	-0.0369*** (0.00174)	-0.0369*** (0.00272)	-0.0369*** (0.00602)	-0.0391*** (0.00204)	-0.0391*** (0.00303)	-0.0391*** (0.00689)
log[D_coloc(t)]	-0.00399 (0.00460)	-0.00399 (0.00569)	-0.00399 (0.00853)							-0.000938 (0.00465)	-0.000938 (0.00622)	-0.000938 (0.00995)
log[D_swe(t)]				-0.000452 (0.000551)	-0.000452 (0.000642)	-0.000452 (0.000554)				-0.000723 (0.000555)	-0.000723 (0.000630)	-0.000723 (0.000517)
log[D_occ(t)]							0.0215*** (0.00803)	0.0215* (0.0110)	0.0215 (0.0147)	0.0270*** (0.00992)	0.0270** (0.0130)	0.0270** (0.00957)
Constant	0.0416* (0.0220)	0.0416 (0.0270)	0.0416 (0.0405)	0.0746*** (0.00830)	0.0746*** (0.00869)	0.0746*** (0.00777)	0.153*** (0.0349)	0.153*** (0.0483)	0.153** (0.0651)	0.186*** (0.0448)	0.186*** (0.0571)	0.186** (0.0735)
Observations	3,528	3,528	3,528	2,376	2,376	2,376	3,528	3,528	3,528	2,376	2,376	2,376
R-squared	0.711	0.711	0.711	0.577	0.577	0.577	0.712	0.712	0.712	0.578	0.578	0.578
FE	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind	Province & Ind
Cluster	None	Industry	Province	None	Industry	Province	None	Industry	Province	None	Industry	Province

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5. Intensive margin regression specifications at the district level (I)

VARIABLES	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]
log[E(t)]	-0.0356*** (0.000809)	-0.0356*** (0.00266)	-0.0356*** (0.00213)	-0.0356*** (0.00352)	-0.0270*** (0.00352)	-0.0352*** (0.000871)	-0.0352*** (0.00227)	-0.0352*** (0.00148)	-0.0352*** (0.00198)	-0.0166*** (0.00405)	
log[D_coloc(t)]	0.00181 (0.00195)	0.00181 (0.00479)	0.00181 (0.00210)	0.00181 (0.00233)	0.0222*** (0.00263)						
log[D_swe(t)]						-0.000171 (0.000161)	-0.000171 (0.000221)	-0.000171 (0.000185)	-0.000171 (0.000207)	0.00151*** (0.000301)	
log[D_occ(t)]											
Constant	0.0276*** (0.00803)	0.0276 (0.0181)	0.0276*** (0.00748)	0.0276*** (0.00857)	0.119*** (0.0119)	0.0302*** (0.00438)	0.0302*** (0.00468)	0.0302*** (0.00152)	0.0302*** (0.00187)	0.0393*** (0.00256)	
Observations	22,050	22,050	22,050	22,050	22,050	14,850	14,850	14,850	14,850	14,850	
R-squared	0.610	0.610	0.610	0.610	0.583	0.440	0.440	0.440	0.440	0.354	
FE	District & Ind	District & Ind	District & Ind	District & Ind	Province & Ind	District & Ind	District & Ind	District & Ind	District & Ind	Province & Ind	
Cluster	None	Industry	District	Province	Province	None	Industry	District	Province	Province	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Intensive margin regression specifications at the district level (II)

VARIABLES	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]	log[E(t+10)/E(t)]
log[E(t)]	-0.0356*** (0.000808)	-0.0356*** (0.00258)	-0.0356*** (0.00215)	-0.0356*** (0.00353)	-0.0257*** (0.00333)	-0.0349*** (0.000873)	-0.0349*** (0.00230)	-0.0349*** (0.00147)	-0.0349*** (0.00200)	-0.0233*** (0.00269)
log[D_coloc(t)]						-0.00476** (0.00200)	-0.00476* (0.00426)	-0.00476** (0.00258)	-0.00476** (0.00206)	0.0110** (0.00382)
log[D_swe(t)]						-0.000224 (0.000161)	-0.000224 (0.000222)	-0.000224 (0.000186)	-0.000224 (0.000214)	-1.03e-05 (0.000199)
log[D_occ(t)]	0.00677*** (0.00135)	0.00677** (0.00298)	0.00677** (0.00257)	0.00677*** (0.00155)	0.0209*** (0.00589)	0.00729*** (0.00188)	0.00729*** (0.00357)	0.00729*** (0.00239)	0.00729*** (0.00135)	0.0156* (0.00859)
Constant	0.0444*** (0.00583)	0.0444*** (0.0113)	0.0444*** (0.00871)	0.0444*** (0.00561)	0.116*** (0.0277)	0.0376*** (0.0103)	0.0376* (0.0209)	0.0376*** (0.0123)	0.0376*** (0.00692)	0.149*** (0.0248)
Observations	22,050	22,050	22,050	22,050	22,050	14,850	14,850	14,850	14,850	14,850
R-squared	0.610	0.610	0.610	0.610	0.583	0.441	0.441	0.441	0.441	0.382
FE	District & Ind	District & Ind	District & Ind	District & Ind	Province & Ind	District & Ind	District & Ind	District & Ind	District & Ind	Province & Ind
Cluster	None	Industry	District	Province	Province	None	Industry	District	Province	Province

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The most important finding to be learned from the intensive margin regressions, at both the province and district levels, is that the lagged density metric based on occupation proximity shows the most robust positive association with future employment growth at the industry/region level of analysis among the three alternative approaches followed to estimate the technological similarity between pairs of sectors. The robust negative coefficients in the lagged value of employment are expected, since larger industry/region cells will tend to grow slower (this mean-reversion term is ubiquitous in the literature).

At the province level, we find no evidence of a statistically significant association between the Co-location and Swedish densities, while the Occupation proximity density has a positive and significant effect. While the association becomes insignificant after clustering standard errors at the province level, we see that in regression specifications that simultaneously control for all three alternative densities, only the Occupation proximity density shows a positive and significant coefficient, which is also robust to the clustering of standard errors at the industry or province levels.

At the district level, we find positive and significant coefficients for the Co-location and Swedish densities, but only in the specification that includes fixed effects and clustering of standard errors at the province level. However, the Occupation proximity density shows positive and significant coefficients for all its specifications. In the joint densities regressions, Co-location and Swedish densities show either negative or insignificant associations with employment growth, while the Occupation proximity density shows robust positive and significant coefficients. On average, between the province specifications and the district specifications that control by fixed effects at the province level, an increase of 1% in the Occupation proximity density associates with a 0.021% increase in the employment in an industry-region cell.

Additional interest is set on whether higher (lower) values of these density metrics help predict the chances of appearance (disappearance) of missing (absent) industries. To address this hypothesis, Hausmann et al (2014) outline an extensive margin specification in two stages:

- First Stage: A Probit model is executed to test whether density values associate positively with the presence of a sector.
- Second Stage: If a positive association is found, then the differences between predicted probabilities and the binary variable that determines presence are calculated. These “residuals” of the first stage are then used as independent variables in a second Probit predicting a binary variable for initially absent sectors that determines whether they appeared (1) or not (0). For sectors that were initially absent, the inverse applies – that is, the second Probit runs on a binary variable that shows whether the sector disappeared (1) or not (0).

In the second stage, the expected coefficient for the “appearance” regression is negative, since all residuals for absent sectors should be negative and higher absolute values hypothetically associate with sectors that should have been present, but were not. The inverse is true for the “disappearance” regression: since all residuals should be positive for initially present sectors, and higher residuals hypothetically associate with sectors that shouldn’t have been present but were, then we expect a positive coefficient between the residual and the chance of disappearance.

Another important aspect of these specifications is that the definition of presence is determined as a location quotient higher than 0.25, and the definition of absence is determined as a location quotient lower than 0.05²⁶. The goal of defining absence and presence in this discontinuous manner is to be even more restrictive on the events of appearance and disappearance, avoiding that small changes in employment may mistakenly suggest the occurrence of an extensive event. With this definition, for the variable Appearance to take the value of one, that sector-location cell should have observed an increase of its location quotient of at least five-fold. Inversely, for the variable Disappearance to take the value of one, that sector-location cell should have observed a shrinking of its location quotient to at least 1/5 of its original value.

Table 7 and Table 8 show the results of the first stage and second stages of the extensive margin regressions at the province and district levels respectively.

²⁶ The location quotient of a region-industry cell is the analogous to the RCA metric in the international trade context. That is, the location quotient is the fraction of the employment of an industry in a given location as a share of the full employment of the location, by the fraction of the employment of that industry in all of Panama by the full size of the Panamanian work force.

Table 7. Extensive margin regression specifications at the province level

VARIABLES	First Stage			Second Stage - Residuals on Appearance			Second Stage - Residuals on Disappearance		
	Presence	Presence	Presence	Appearance	Appearance	Appearance	Disappearance	Disappearance	Disappearance
log[D_coloc(t)]	0.916*** (0.0274)			-0.461*** (0.166)			0.372*** (0.141)		
log[D_swe(t)]		0.111*** (0.00642)			-0.619** (0.250)			0.258 (0.357)	
log[D_occ(t)]			0.880*** (0.0314)			-0.450*** (0.171)			0.478*** (0.168)
Constant	2.032*** (0.0648)	0.444*** (0.0358)	1.775*** (0.0662)	-0.921*** (0.0572)	-0.924*** (0.113)	-0.934*** (0.0625)	-1.117*** (0.0592)	-1.662*** (0.169)	-1.177*** (0.0740)
Observations									

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8. Extensive margin regression specifications at the district level

VARIABLES	First Stage			Second Stage - Residuals on Appearance			Second Stage - Residuals on Disappearance		
	Presence	Presence	Presence	Appearance	Appearance	Appearance	Disappearance	Disappearance	Disappearance
log[D_coloc(t)]	0.887*** (0.0139)			-0.989*** (0.0648)			0.662*** (0.0672)		
log[D_swe(t)]		0.0703*** (0.00251)			-0.798*** (0.142)			1.681*** (0.188)	
log[D_occ(t)]			0.718*** (0.0176)			-0.927*** (0.0775)			0.885*** (0.0801)
Constant	1.623*** (0.0303)	-0.0229 (0.0153)	1.236*** (0.0381)	-1.154*** (0.0210)	-1.064*** (0.0517)	-1.169*** (0.0255)	-1.089*** (0.0353)	-2.092*** (0.117)	-1.254*** (0.0458)
Observations									

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Other than the coefficient of the second stage regression on disappearances for the Swedish density residuals (which shows statistically insignificant results), all other regressions for both provinces and districts show coefficients with the expected sign and with statistically significant values. All coefficients in the first stage show positive and significant coefficients, suggesting that higher density values for all three approaches associate with a higher probability of a sector to be considered present. The negative coefficients in the appearance regressions suggest that originally absent sectors with higher original density values are more likely to appear than sectors with lower original density values. The positive coefficients in the disappearance regressions suggest the inverse: initially present sectors with lower original density values have a higher chance to disappear.

While the extensive margin regressions are encouraging for all three density approaches, the fact that results for the Occupation proximity densities in the intensive margin specifications are largely superior to those of the Co-location and Swedish densities, suggests that the analysis of industrial diversification opportunities for provinces and districts should be developed considering the occupation similarity proximity matrix. We now proceed to analyze industrial diversification opportunities.

4. Regional industrial diversification opportunities

After reaching a conclusion on using occupation proximity based metrics of density (and its inverse, distance) to assess the feasibility of missing sectors in different provinces or districts within Panama, the question of how to measure complexity for locations and for industries remains open.

In the international trade context, the ECI and the PCI are estimated with an iterative correction process between diversity and ubiquity. Estimating these metrics is trickier in a subnational and industrial context – in particular for a country with the dimensions of Panama, as the number of economic activities and locations is much shorter. Since we cannot import these metrics externally, one option is to use the occupational diversity of the occupation vector of each sector as our measure of industrial complexity; and a measure of regional complexity similar to ECI, but based on the iterative correction of a region's occupational diversity and an occupation's regional ubiquity.

The principles behind these alternatives are justified in the economic development paradigm we have discussed thus far: Increasing the productive capabilities in a society as the secret to economic development. Under this view, the process of specialization of work at the individual level leads to the industrial diversification of regions into increasingly complex activities. As used in the Brazilian Atlas of Economic Complexity “DataViva”, occupational diversity in a sector is an indicator of the number of specific skills that need to be assembled for the successful

development of a given economic activity – the more occupations, the more complex the sector becomes.

All the same, regions capable of assembling a very diverse array of relatively unique productive occupations, will be better suited to recombine them successfully in the development of relatively complex economic activities. The advantage of being able to explicitly observe capabilities by capturing the occupations of censused individuals in the workforce is also complemented by the fact that the Panamanian occupation system breaks down at a more granular level than ISIC's decomposition of economic activities²⁷.

Strategic approaches to industrial diversification for Panamanian provinces and districts can be determined under these occupation-based core metrics of economic complexity – technological proximity between industries and complexity of locations and industries. As was the case with Figure 24 for Panama as a whole, Figure 31 and Figure 32 plot the relative position of provinces and districts in terms of complexity and in terms of technological connectivity to missing industries. These figures show how the interoceanic region is the most complex of the country, yet has limitations in its capacity to diversify organically due to relatively poor connectivity. It also shows that western Panama, while not relatively complex, accounts for the regions with best connectivity to central and complex sectors. At last, they evidence the relative peripheral and non-complex nature of economic activities in eastern Panama.

Figure 31. ECI vs. COI (Occupation Proximity, Panamanian Provinces, Year 2010)

²⁷ The occupation classification system used for the Population Census of 2000 accounts for 1644 occupations. The corrected version of the ISIC Rev 3 classification that allows full concordance between the 2000 and the 2010 editions accounts only for 325 economic activities.

Figure 32 - ECI vs. COI (Occupation Proximity, Panamanian Districts, Year 2010)

For illustrative purposes, this study will discuss the industrial diversification strategy for one eastern province (in the strategic bets approach quadrant), one interoceanic province (in the balanced approach column) and one western province (in the ripe fruit quadrant). The visualization appendix attached to this study displays all the relevant visualizations for all strategic approaches for all provinces and districts within Panama (including the Panama-wide export diversification visualizations discussed above).

4.1. Interoceanic region: The case of Colón

Figure 33 displays missing sectors for Colón grouped together and plotted by distance, COG and economic complexity block. As expected for a relatively developed region in terms of its domestic counterparts, we find that relatively few sectors are missing, and that high complexity and COG industries tend to be relatively close to other activities.

Figure 33. Distance, Opportunity Gain and Complexity (Colón)

Figure 34 shows these numbers aggregated by economic sectors, and displaying average metrics of the industries that are missing Colón and form part of the respective sector. While Agriculture offers the nearest opportunities, the sector accounts for very low complexity and connectivity opportunities. Much more interesting are the logistics and commerce sectors, that are both closer and more strategic than most other economic sectors. Utilities, real estate and financial activities show more distantly and with relatively lower complexity levels than logistics and commerce, yet they show the highest connectivity improvement potential for Colón among all sectors in the economy.

Figure 34. Strategic Aggregated Sectors (Colón)

Figure 35 to Figure 38 show the same metrics from Figure 34, identifying sectors by name and separating them by complexity block.

Figure 35. Distance, Opportunity Gain and Complexity (Colón - Low Complexity)

Figure 36. Distance, Opportunity Gain and Complexity (Colón - Medium-Low Complexity)

Figure 37. Distance, Opportunity Gain and Complexity (Colón Province - Medium-High Complexity)

Figure 38. Distance, Opportunity Gain and Complexity (Colón Province - High Complexity)

As discussed, the interoceanic region of the country falls in the Balanced Approach quadrant for industrial diversification. In reducing the dimensionality of the feasibility and opportunity metrics of missing products, the same criteria as the one discussed in the international trade section was applied. Figure 39 shows the average balanced approach scores of missing industries in each of the economic sectors. This graph comes to underscore the previous finding that most interesting

opportunities given Colón's strategic stance are likely in commerce and logistics activities. These are followed by construction, utilities and agriculture.

Figure 39. Industrial Sectors by Balanced approach (Colón Province)

In visualizing the most interesting opportunities for Colón at the specific industry level, Figure 40 and Table 9 show the top 50 industries in terms of the balanced approach scores, displaying also their relevant economic complexity metrics. Interestingly enough, in addition to the expected findings in **logistics and commerce**; we find **relevant manufacturing sectors** that do overlap with the ones we have already identified as potential when analyzing export diversification opportunities for goods in Panama. It should be noted that Manufacturing did not appear on Figure 39 with a high average score, due to the fact that these schedule is built on sub-sectors averages, and other bulks of manufacturing sector pulling the sector average downwards.²⁸ That should not prevent us from observing the list of manufactures that made the top 50 industries according to their score on the Balanced approach.

Plastics (plates, sheets, vases, containers), **Foodstuffs** (beer, fermented beverages, preparations of meat and fish), and **paper** (newspapers, journal, periodicals, cartons), are a few of the manufacturing items making the list of the top 50 missing industries for Colón that had also showed up in our analysis in 4.1. Interoceanic region: The case of Colón. On the other hand, the relevance of commerce and logistics in this strategic list also points to the possibility of redeploying existing capabilities to opportunities for export diversification in the logistic and air hub around the Panama Canal and Colón Free Zone.

²⁸ It should be noted that Manufacturing is the sector that accounts for the most individual industries amongst the ones reported.

Figure 40. Strategic Industries (Balanced Approach, Colón)

Table 9. Top 50 missing activities for industrial diversification for Colón (Balanced)

Rank	Industry	Section	Density	Complexity	COG	Employment	Score
1	Pesca	Agriculture	0.3492		129	0.2869	306 1.7811
2	Actividades de distribución de películas, video y	Commerce Activities	0.2470		525	1.1895	821 1.3991
3	Venta de vehículos automotores	Commerce Activities	0.2618		284	1.7231	284 1.2631
4	Venta al por mayor de alimentos, bebidas y tabaco	Commerce Activities	0.2647		331	1.1784	577 1.2131
5	Venta al por mayor de otros productos	Commerce Activities	0.2642		217	1.8924	84 1.2051
6	Venta al por mayor de materiales de construcción,	Commerce Activities	0.2621		308	1.3955	204 1.1991
7	Otras actividades complementarias de transporte aé	Logistics	0.2657		306	1.2303	46 1.1891
8	Construcción de obras de ingeniería civil	Construction	0.2696		370	0.6588	1215 1.1891
9	Otros tipos de transporte regular de pasajeros por	Logistics	0.3236		35	0.3613	825 1.1511
10	Reparación y mantenimiento de maquinaria y equipo	Manufacturing Industries	0.2634		310	1.1569	81 1.1321
11	Transporte regular por vía aérea	Logistics	0.2695		210	1.4854	37 1.1171
12	Venta de partes, piezas y accesorios de vehículos	Commerce Activities	0.2699		174	1.6154	216 1.0861
13	Venta al por menor de aparatos, artículos y equipo	Commerce Activities	0.2470		340	1.4509	542 1.0471
14	Fabricación de productos de plástico, envases de p	Manufacturing Industries	0.2610		216	1.5910	36 1.0311
15	Actividades de correo distintas de las actividades	Logistics	0.2689		160	1.5868	140 1.0241
16	Venta al por mayor de materias primas agropecuaria	Commerce Activities	0.2590		258	1.2637	22 0.9721
17	Venta al por menor de artículos de ferretería, pin	Commerce Activities	0.2633		237	1.2084	667 0.9701
18	Elaboración de bebidas malleadas y malla	Manufacturing Industries	0.2569		221	1.5787	98 0.9701
19	Otras actividades complementarios de transporte te	Logistics	0.2698		174	1.3232	90 0.9701
20	Elaboración de productos lácteos, helados	Manufacturing Industries	0.2537		264	1.3669	89 0.9391
21	Procesamiento y conservación de pescado y de produ	Manufacturing Industries	0.2731		164	1.1425	3 0.9291
22	Alquiler de otros tipos de maquinaria y equipo, n.	Real Estate and Other Business Activities	0.2506		219	1.6983	97 0.9071
23	Venta al por menor de otros productos en almacenes	Commerce Activities	0.2708		168	1.0761	644 0.8751
24	Alquiler de equipo de construcción o demolición de	Construction	0.2577		211	1.2380	67 0.8261
25	Producción de carne y de productos cármicos	Manufacturing Industries	0.2567		236	1.1250	36 0.8251
26	Fabricación de otros artículos de papel y cartón	Manufacturing Industries	0.2507		188	1.6166	39 0.8001
27	Elaboración de otros productos alimenticios, n.c.p	Manufacturing Industries	0.2499		221	1.3773	21 0.7741
28	Telecomunicaciones	Logistics	0.2243		344	1.6887	428 0.7701
29	Venta al por menor de productos farmacéuticos y me	Commerce Activities	0.2539		205	1.2426	267 0.7481
30	Edición de periódicos, revistas y publicaciones pe	Manufacturing Industries	0.2336		255	1.7862	68 0.7441
31	Fabricación de azúcar	Manufacturing Industries	0.2632		191	0.8946	2 0.7331
32	Elaboración de aceites y grasas de origen vegetal	Manufacturing Industries	0.2624		152	1.1709	11 0.7321
33	Otras actividades empresariales, n.c.p. (Fotocopia	Real Estate and Other Business Activities	0.2212		365	1.5871	114 0.7301
34	Venta al por menor en almacenes no especializados	Commerce Activities	0.2742		165	0.5617	2947 0.7231
35	Actividades de otras asociaciones, n.c.p.; casa cl	Other Services	0.2312		347	1.2150	67 0.7061
36	Fabricación de jabones y detergentes, preparados p	Manufacturing Industries	0.2541		144	1.4912	12 0.7001
37	Extracción de piedra, arena y arcilla	Mining and Oil Extraction	0.2626		151	1.0455	66 0.6851
38	Fabricación de vidrio y de productos de vidrio	Manufacturing Industries	0.2496		190	1.3571	45 0.6841
39	Investigación y desarrollo de las ciencias natural	Real Estate and Other Business Activities	0.2348		320	1.1676	65 0.6831
40	Fabricación de artículos de hormigón, cemento yeso	Manufacturing Industries	0.2608		163	1.0278	134 0.6761
41	Elaboración de productos de molinería	Manufacturing Industries	0.2578		171	1.0476	16 0.6541
42	Elaboración de bebidas no alcohólicas; embotellado	Manufacturing Industries	0.2512		149	1.4487	11 0.6471
43	Alquiler de equipo de transporte por vía terrestre	Real Estate and Other Business Activities	0.2427		137	1.8412	20 0.6281
44	Actividades de asesoramiento empresarial y en mate	Real Estate and Other Business Activities	0.2254		259	1.7704	457 0.6121
45	Fabricación de sustancias químicas básicas, except	Manufacturing Industries	0.2531		115	1.4921	2 0.6111
46	Venta al por menor de combustible para automotores	Commerce Activities	0.2541		141	1.2482	247 0.5991
47	Acondicionamiento de edificios	Construction	0.2456		258	0.8646	861 0.5921
48	Actividades inmobiliarias realizadas con bienes pr	Real Estate and Other Business Activities	0.2272		262	1.5762	825 0.5731
49	Publicidad	Real Estate and Other Business Activities	0.2239		249	1.7917	59 0.5701
50	Mantenimiento y reparación de vehículos automotore	Commerce Activities	0.2626		162	0.6836	1405 0.5701

4.2. Eastern Panama: The case of Darién

As was discussed above, Eastern Panama seems to have the least complex and connected industrial structure in the country. As opposed to what Figure 33 showed for Colón, Figure 41 shows that most interesting sectors from an opportunity standpoint have low feasibility given Darién's industrial structure.

Figure 41. Distance, Opportunity Gain and Complexity (Darién Province)

Figure 42 shows aggregate sectors and average metrics of missing industries in Darién. Education services show up at a feasible distance, high level of complexity, and above average COG. Logistics associated to transport services; hotels and restaurants show relatively high connectivity and complexity opportunities at a medium feasibility level. At last, real estate and commercial activities show the highest complexity and connectivity opportunities relatively distant to Darién's current industrial structure.

Figure 42. Strategic Aggregated Sectors (Darién Province)

Figure 43 to Figure 46 show specific missing industries by complexity block.

Figure 43. Distance, Opportunity Gain and Complexity (Darién - Low Complexity)

Figure 44. Distance, Opportunity Gain and Complexity (Darién - Medium-Low Complexity)

Figure 45. Distance, Opportunity Gain and Complexity (Darién - Medium-High Complexity)

Figure 46. Distance, Opportunity Gain and Complexity (Darién - High Complexity)

Given its disadvantaged position, deep in the Strategic Bets quadrant, industrial diversification measures for Darién should prioritize opportunity over feasibility. Figure 47 shows what aggregate sectors fare best in averaging the Strategic Bets scores of its missing industries. Education services account for the highest scores, while health services (mid-high complexity), logistics (high complexity and mid opportunity gain) and hotels and restaurants (high complexity) concentrate the areas of opportunity.

Figure 47. Industrial Sectors by Strategic Bets approach (Darién)

Finally, Figure 48 and Table 10 show the top 50 missing industries in Darién, according to their Strategic Bets score. Some manufacturing activities make the cut within the top 50 (newsprint, paper, dairies and other edibles, cement, repair of transport equipment and plastics), but even as Strategic Bets (more weight on COG and ECI), they are to be found at the bottom of the list. Sections on **Education and Health services** probably reflect the **relative insufficiencies of State** footprint in Darién, the poorest province in Panama. Other than these (more a public good than an industry), it seems evident that sectors associated with the **tourism industry** (ecotourism) and **logistic service associated to transport** of goods are the most feasible opportunities.

Figure 48. Strategic Industries (Strategic Bets Approach, Darién)

Table 10. Top 50 missing activities for industrial diversification for Darién (Strategic Bets)²⁹

Rank	Industry	Section	Density	Complexity	COG	Employment	Score
1	Comisión del Canal de Panamá	Logistics	0.2123	439	1.2678	5	0.9858
2	Enseñanza superior	Education	0.2098	405	1.4116	48	0.9650
3	Otras actividades complementarias del transporte p	Logistics	0.1861	394	1.8213	11	0.9504
4	Otras actividades empresariales, n.c.p. (Fotocopia	Real Estate and Other Business Activities	0.1628	365	2.1640	5	0.8726
5	Actividades de distribución de películas, video y	Commerce Activities	0.1451	525	1.7418	102	0.8630
6	Investigación y desarrollo de las ciencias natural	Real Estate and Other Business Activities	0.1977	320	1.7392	4	0.8549
7	Venta al por mayor de maquinaria, equipo y materia	Commerce Activities	0.1343	348	2.4850	8	0.7698
8	Venta al por mayor a cambio de una retribución o p	Commerce Activities	0.1462	317	2.2658	44	0.6995
9	Telecomunicaciones	Logistics	0.1399	344	2.2348	33	0.6908
10	Otras actividades complementarias de transporte aé	Logistics	0.1718	306	1.8514	6	0.6834
11	Educación de adultos y otros tipos de enseñanza (C	Education	0.2021	271	1.4610	12	0.6668
12	Actividades de otras agencias de transporte, corre	Logistics	0.1515	298	2.1872	1	0.6664
13	Actividades de planos de seguridad social de afili	Public Administration	0.1855	282	1.6676	7	0.6564
14	Otras actividades de esparcimiento (Parques, galle	Other Services	0.1804	300	1.6533	35	0.6468
15	Venta al por mayor de enseres domésticos	Commerce Activities	0.1267	245	2.7873	2	0.6464
16	Venta al por mayor de materiales de construcción,	Commerce Activities	0.1501	308	2.1107	14	0.6411
17	Servicios sociales sin alojamiento	Health and Social Services	0.2902	120	0.5883	22	0.6377
18	Venta al por mayor de combustible sólido, líquido	Commerce Activities	0.1440	256	2.3891	2	0.6188
19	Venta al por mayor de otros productos	Commerce Activities	0.1345	217	2.7000	8	0.6106
20	Venta de vehículos automotores	Commerce Activities	0.1314	284	2.4511	4	0.6066
21	Otros tipos de intermediación monetaria	Financial Services	0.1480	257	2.2709	64	0.5973
22	Organizaciones y órganos extraterritoriales	Other Services	0.1656	199	2.2200	5	0.5925
23	Actividades de arquitectura e ingeniería y activid	Real Estate and Other Business Activities	0.1702	308	1.6534	11	0.5858
24	Edición de periódicos, revistas y publicaciones pe	Manufacturing Industries	0.1364	255	2.4444	5	0.5842
25	Actividades de asesoramiento empresarial y en mate	Real Estate and Other Business Activities	0.1411	259	2.3460	0	0.5833
26	Actividades inmobiliarias realizadas con bienes pr	Real Estate and Other Business Activities	0.1520	262	2.1312	6	0.5742
27	Venta al por menor de aparatos, artículos y equipo	Commerce Activities	0.1353	340	2.0587	14	0.5690
28	Venta al por mayor de materias primas agropecuaria	Commerce Activities	0.1560	258	2.0346	15	0.5528
29	Almacenamiento y depósito	Logistics	0.1343	223	2.5435	1	0.5501
30	Planes de seguros generales	Financial Services	0.1338	197	2.6391	4	0.5387
31	Publicidad	Real Estate and Other Business Activities	0.1354	249	2.3754	2	0.5336
32	Venta al por mayor de alimentos, bebidas y tabaco	Commerce Activities	0.1461	331	1.8245	46	0.5271
33	Actividades de agencias de viajes, organizadores d	Logistics	0.1618	215	2.0221	14	0.5060
34	Actividades de hospitales	Health and Social Services	0.2133	290	0.8217	208	0.4994
35	Alquiler de otros tipos de maquinaria y equipo, n.	Real Estate and Other Business Activities	0.1381	219	2.3633	9	0.4897
36	Venta al por mayor de otros efectos personales y p	Commerce Activities	0.1293	226	2.4674	2	0.4840
37	Elaboración de productos lácteos, helados	Manufacturing Industries	0.1421	264	2.0806	9	0.4808
38	Fabricación de cemento, cal y yeso	Manufacturing Industries	0.1521	219	2.1027	1	0.4775
39	Elaboración de otros productos alimenticios, n.c.p	Manufacturing Industries	0.1525	221	2.0843	4	0.4759
40	Reparación y mantenimiento de equipo de transporte	Manufacturing Industries	0.1669	248	1.7138	14	0.4701
41	Venta al por mayor de otros productos intermedios,	Commerce Activities	0.1323	230	2.3664	9	0.4688
42	Transporte por tuberías	Logistics	0.1655	176	2.0374	0	0.4641
43	Fabricación de productos farmacéuticos, sustancias	Manufacturing Industries	0.1285	175	2.6410	1	0.4560
44	Elaboración de bebidas malteadas y malta	Manufacturing Industries	0.1358	221	2.3143	4	0.4545
45	Alquiler de equipo de construcción o demolición do	Construction	0.1630	211	1.9033	5	0.4538
46	Fabricación de productos de plástico, envases de p	Manufacturing Industries	0.1331	216	2.3772	0	0.4521
47	Fabricación de otros artículos de papel y cartón	Manufacturing Industries	0.1403	188	2.3776	3	0.4516
48	Reparación y mantenimiento de maquinaria y equipo.	Manufacturing Industries	0.1433	310	1.7701	4	0.4402
49	Venta de vehículos automotores	Commerce Activities	0.1297	129	2.7843	0	0.4396
50	Oblención y dotación de personal	Real Estate and Other Business Activities	0.1378	131	2.6323	0	0.4356

4.3. Western Panama: The case of Chiriquí

As discussed previously, Western Panama is between the Interoceanic region and Eastern Panama in terms of economic complexity. The case of Chiriquí is representative, as its scatter of missing industries (Figure 49) is somewhere between that of Colón and that of Darién. The relationship between opportunity and distance is still positive, but visibly less steep than that of Darién. Several medium-high and high complexity sectors with interesting COG levels appear a medium

²⁹ Our hand-off statistical approach yield Logistics: Commission of the Panama Canal as the most feasible, which is clearly not a transferable economic activity.

distance, which suggest the attainability of very interesting sectors – as expected from its strategic position (Figure 31).

Figure 49. Distance, Opportunity Gain and Complexity (Chiriquí Province)

The aggregation of these metrics by sector confirms our initial intuition, as depicted in Figure 50. Mid-high complexity industries in Construction; and Hotels and Restaurants are relatively close. Moreover, tradable opportunities in agriculture and manufacturing seem to balance feasibility and connectivity in interesting ways. At last, commercial activities that account for the highest levels of complexity and COG appear only at a medium distance.

Figure 50. Strategic Aggregated Sectors (Chiriquí)

Again, Figure 51 to Figure 54 show specific industries by complexity blocks.

Figure 51. Distance, Opportunity Gain and Complexity (Chiriquí - Low Complexity)

Figure 52. Distance, Opportunity Gain and Complexity (Chiriquí - Medium-Low Complexity)

Figure 53. Distance, Opportunity Gain and Complexity (Chiriquí - Medium-High Complexity)

Figure 54 - Distance, Opportunity Gain and Complexity (Chiriquí - High Complexity)

Chiriquí is amongst the best-positioned provinces in the Ripe Fruit quadrant of Figure 31. Hence, Figure 55 shows aggregated industrial sector scores according to

the average score of their corresponding sections. Commercial activities, Logistics, Construction and Utilities seem to be the sectors offering the most interesting diversification opportunities for Chiriquí.

Figure 56 and Table 11 describe the characteristics of the top 50 industries in terms of their Ripe Fruit score. The diverse manufacturing industries that make the list suggest interesting opportunities for tradable development in Chiriquí, which was not apparent from the low aggregate scores obtained by manufacturing and agriculture in Figure 55. Again, this is due to other bulks of manufacturing sector pulling the sector average downwards due to high distances to Chiriquí's export structure. Having said that, the upper half of top 50 list of potential industries is populated by **manufacturing**, mostly related to **minerals** (metal press, forged metal, primary products derived from iron, coke ovens), **construction materials** (cement, lime, cast), and **goods derived from wood** (carpentry, musical instruments). Also, the presence of several activities in wholesale commerce and transport logistics suggests that it could also leverage its position as bordering province to the rest of Central America to develop the sectors that are already relatively close to its productive structure.

Figure 55. Industrial Sectors by Ripe Fruit approach (Chiriquí)

Figure 56. Strategic Industries (Ripe Fruit Approach, Chiriquí)

Table 11. Top 50 missing activities for industrial diversification for Chiriquí (Ripe Fruit)

Rank	Industry	Section	Density	Complexity	COG	Employment	Score
1	Fabricación de instrumentos musicales	Manufacturing Industries	0.4527	9	0.0399	0	1.6619
2	Terminación de edificios	Construction	0.4173	175	0.6985	685	1.5184
3	Fabricación de bicicletas y de sillones de ruedas	Manufacturing Industries	0.4266	2	0.0627	0	1.2639
4	Restaurantes, bares y cantinas	Hotels and Restaurants	0.3938	131	0.5438	4555	1.0660
5	Fabricación de partes y piezas de carpintería para	Manufacturing Industries	0.3859	74	0.9679	70	0.9550
6	Elaboración de piensos preparados	Manufacturing Industries	0.3635	132	1.7951	52	0.8865
7	Fabricación de cemento, cal y yeso	Manufacturing Industries	0.3505	219	1.9969	53	0.8620
8	Fabricación de productos de cerámica no refractari	Manufacturing Industries	0.3679	108	1.4490	21	0.8417
9	Procesamiento y conservación de pescado y de produ	Manufacturing Industries	0.3570	164	1.7674	49	0.8280
10	Acondicionamiento de edificios	Construction	0.3550	258	1.1884	1204	0.8100
11	Silvicultura y actividades de servicio conexas	Agriculture	0.3665	127	0.9980	191	0.7480
12	Fabricación de prendas de vestir, excepto prendas	Manufacturing Industries	0.3770	92	0.4969	704	0.7455
13	Fabricación de vidrio y de productos de vidrio	Manufacturing Industries	0.3450	190	1.9207	60	0.7200
14	Fabricación de productos de homos de coque	Manufacturing Industries	0.3865	4	0.0524	0	0.6610
15	Elaboración de bebidas no alcohólicas; embotellado	Manufacturing Industries	0.3422	149	2.0827	84	0.6520
16	Reparación y mantenimiento de equipo de transporte	Manufacturing Industries	0.3387	248	1.6027	68	0.6417
17	Actividades de distribución de películas, video y	Commerce Activities	0.3108	525	1.6421	2089	0.6370
18	Venta al por mayor de maquinaria, equipo y materia	Commerce Activities	0.3176	348	2.3581	176	0.6360
19	Venta al por mayor a cambio de una retribución o p	Commerce Activities	0.3234	317	2.1673	319	0.6360
20	Forja, prensado, estampado y laminado de metal; pu	Manufacturing Industries	0.3483	108	1.8530	10	0.6340
21	Venta al por mayor de otros productos intermedios,	Commerce Activities	0.3293	230	2.2725	327	0.6200
22	Venta al por menor de otros productos en almacenes	Commerce Activities	0.3458	168	1.5417	1275	0.6170
23	Fabricación de productos de plástico, envases de p	Manufacturing Industries	0.3298	216	2.2626	151	0.6030
24	Venta al por mayor de metales y de minerales metal	Commerce Activities	0.3440	106	1.9486	15	0.5870
25	Extracción de minerales metalíferos no ferrosos, e	Mining and Oil Extraction	0.3423	196	1.4511	8	0.5850
26	Venta al por mayor de combustible sólido, líquido	Commerce Activities	0.3240	256	2.2820	177	0.5800
27	Comisión del Canal de Panamá	Logistics	0.3222	439	1.1639	44	0.5780
28	Elaboración de bebidas malleadas y malta	Manufacturing Industries	0.3261	221	2.2116	116	0.5450
29	Venta al por menor de aparatos, artículos y equipo	Commerce Activities	0.3184	340	1.9380	652	0.5450
30	Fabricación de sustancias químicas básicas, except	Manufacturing Industries	0.3362	115	2.1238	12	0.5210
31	Fabricación de productos primarios de hierro y de	Manufacturing Industries	0.3413	96	1.8914	27	0.5190
32	Elaboración de cacao y chocolate de productos de c	Manufacturing Industries	0.3537	55	1.2179	9	0.4980
33	Venta de vehículos automotores	Commerce Activities	0.3148	284	2.3396	643	0.4950
34	Fabricación de papel y cartón ondulado y de envase	Manufacturing Industries	0.3278	156	2.2989	13	0.4930
35	Otras actividades complementarias del transporte p	Logistics	0.3131	394	1.6956	113	0.4910
36	Fabricación de jabones y detergentes, preparados p	Manufacturing Industries	0.3304	144	2.1822	21	0.4890
37	Fabricación de otros productos minerales no metáli	Manufacturing Industries	0.3576	31	0.9198	0	0.4580
38	Actividades de envase y empaque	Real Estate and Other Business Activities	0.3293	132	2.1407	26	0.4460
39	Fabricación de otros productos de caucho	Manufacturing Industries	0.3593	30	0.7624	3	0.4450
40	Actividades de limpieza de edificios (fumigación)	Real Estate and Other Business Activities	0.3453	118	1.0649	455	0.4300
41	Extracción de sal	Mining and Oil Extraction	0.3589	28	0.6927	0	0.4210
42	Explotación de criaderos de peces y granjas piscic	Agriculture	0.3443	105	1.1799	50	0.4210
43	Fabricación de otros artículos de papel y cartón	Manufacturing Industries	0.3190	188	2.2824	45	0.4050
44	Otras actividades complementarias de transporte te	Logistics	0.3265	174	1.8399	108	0.3990
45	Fabricación de productos de la refinación del petr	Manufacturing Industries	0.3396	82	1.5444	6	0.3960
46	Fabricación de herramientas manuales	Manufacturing Industries	0.3437	65	1.3431	21	0.3890
47	Venta al por mayor de otros efectos personales y p	Commerce Activities	0.3125	226	2.3473	29	0.3770
48	Fabricación de otros productos químicos, n.e.p.; p	Manufacturing Industries	0.3269	108	2.1544	19	0.3770
49	Fabricación de pinturas, barnices y productos de r	Manufacturing Industries	0.3244	134	2.1418	31	0.3750
50	Venta de partes, piezas y accesorios de vehículos	Commerce Activities	0.3195	122	2.5479	42	0.3730

5. Conclusions and policy recommendations

Panama has been one of the fastest growing economy in the world, doubling its income per capita between 2005 and 2015. Growth has been characterized by a large expansion of the construction sector, fueled by large public infrastructure projects and demands coming from the surge of a modern service sector. Logistics, transportation, financing intermediation, communications and trade, have flourished and fueled the demand for office buildings, warehouses, trade and port facility infrastructure.

It is unlikely that construction will keep on growing at the pace registered over the previous decade. On the one hand, large public infrastructure projects such as the Canal expansion or the Panama City metro, are unlikely to repeat, at least in size and nature. On the other hand, non-residential construction cannot grow persistently at a rate higher than the rest of the economy. Once the basic infrastructure required for the modern service sector is in place, construction will decelerate and lose weight within the Panamanian economy. The challenge lies in finding the new spearheads that will take over the growth lead once the construction boom recedes.

Our data-driven analysis aims at leveraging the capabilities and know-how that Panama has accumulated to identify opportunities for productive diversification at the national and sub-national level. New industries, such as processed foodstuffs or chemicals and plastics, rely on productive capacities already on the ground but also demand a step-up in skills. That is also the case of deepening and expanding already competitive service sectors, such as logistics, trade or even hotels and restaurants. Panama is not capital-constrained, and enjoys one of the most favorable business environments in the region. The challenge lies in attracting and fostering the productive capabilities demanded by these potential opportunities that are still missing. Some of them – in particular at the sub-national level – might be public goods, and their impact on potential diversification can be used as criteria to prioritize on their provision. Other might be plain know-how and skills currently unavailable, or not relatively abundant on the Panamanian economy.

The policies of recent years point out in that direction, and significant progress has been made. Authorities have made efforts to create a business ecosystem within its special economic zones, in particular *City of Knowledge* and *Panama-Pacific* (Hausmann, Santos and Obach, 2016). The Multinational Corporations Headquarters law (SEM, from its initials in Spanish) opened the way for large multinational companies to set foot in Panama, bringing new collective know-how and upgrading the country's skills. Large investments in education have been made, increasing average years of schooling, and bringing completion rates in primary, secondary and tertiary to the top of the region. Although these efforts are all aimed in the right direction, they might be insufficient, in particular when it comes to achieving the productive diversification opportunities we have outlined here.

Although the indicators of education from a quantitative standpoint have improved significantly, the quality - as assessed by standardized tests - is among the worst in Latin America. On top of that, Panama has instated many restrictions to the free flow of migrant labor. There is a long list of around thirty occupations that are restricted to immigrants by law. Even within the Special Economic Zones (SEZs), the transit of labor and knowledge in and out of the zones is highly restricted. Foreign workers enjoy their SEM visas as long as they remain within the multinational companies hosted in the SEZs. Once they are out of them, all the time they have spent working in Panama does not count for residence purposes. Citizenship from certain countries are still considered national security concerns (i.e. India, China). Out of the SEZs, a cap of 10% to the share of foreign workers in payroll exists. All these practices,

presumably aimed at protecting Panamanian workers, are preventing Panama from developing the skill base needed to diversify its economy.

According to our assessments, these policies restricting the flow of migrants are not helping the Panamanians. As registered by censuses, the inflow of high-skilled migrants has helped Panamanians in their industry-region to make higher salaries. This is a clear signal that the skills brought by immigrants are complementary, not substitutes, to those of Panamanians (Hausmann, Santos and Obach, 2016). At the same time, they indicate that immigrants, whether coming through the SEM Law or not, have raised the constraint bar up to a point and help Panama grow at a faster pace. But high-returns to migrants of similar education, experience, and gender than their Panamanian counterparts are pointing out to skill-scarcity in Panama, which in turn hinders prospects of productive diversification and growth.

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Appendix II: Technical Appendix

In this appendix, we describe the methods utilized for calculating the economic complexity metrics used in this study. The analysis is based on two separate groups of metrics: those based on exports of goods (HS Rev. 3, at 4 digits, based on customs data from ANA for years 2013-2014), and those based in employment of all industries producing either goods or services (Panama-adapted ISIC classification, Rev. 3, 4 digits, based on Population Census data for 2000 and 2010).

In the explanation that follows, the methods as executed on the exports from Panamanian exports are described. However, precisions will be made whenever the procedures followed on employment data by industry differ mathematically from those executed on export data. In the equations below, the sub-index c indicates countries, provinces or districts, and the sub-index p indicates products or industries, depending on the case. While no sub-index for years is shown in order to simplify notation, all calculations are applied for each year separately.

Calculation of Revealed Comparative Advantages:

Exports by product, year and countries are organized in matrix form:

$$X_{cp}$$

From this matrix, country and product aggregates can be constructed:

$$\begin{aligned} X_c &= \sum_p X_{cp} \\ X_p &= \sum_c X_{cp} \\ X &= \sum_c \sum_p X_{cp} \end{aligned}$$

Building on these metrics, the Revealed Comparative Advantage (RCA) for each country/product combination can be developed:

$$RCA_{cp} = \frac{X_{cp}/X_p}{X_c/X}$$

In terms of province or district specific employment in different industries, the location quotient is basically the same mathematical expression. However, it must be noted that calculations on employment data by industry use the Panamanian

totals as benchmark (Xp in this case is the total employment in Panama on industry p , and X is the total employment across industries).

Diversity and Ubiquity Calculations

The RCA matrix is transformed in a binary matrix depending on whether a particular value is larger than 1 or not.

$$M_{cp} = \begin{cases} 1 & RCA_{cp} \geq 1 \\ 0 & RCA_{cp} < 1 \end{cases}$$

This matrix indicates the products (or industries) that are relatively large in each country, province and district. From this matrix, the basic Diversity indicator at the locality level, and Ubiquity at the product (or industry) level can be built. These account for the number of products with relatively large exports for each locality, and the count of the places that export a given product with a relatively high intensity.

$$k_{c,0} = \sum_p M_{cp} \quad k_{p,0} = \sum_c M_{cp}$$

In the case of employment, the same metrics are also calculated from a location-occupation and an industry-occupation perspective – that is, an M_{cp} matrix that captures whether an occupation is relatively large for a given location, and another that measures the same concept for every given industry. The respective occupation diversities at the location and industry levels are also calculated.

Economic Complexity Metrics by product and localities

One metric of the complexity of a location is its diversity weighed by the relative ubiquity of the products (or industries) in which it displays a relative comparative advantage levels larger than one. Similarly, the complexity of a product or industry can be measured by its ubiquity weighed by the diversity of the localities that are competitive in such product or industry. The matrix-algebra method that extends this iterative exercise of correcting diversity with ubiquity and vice-versa, *ad infinitum*, is called the *method of reflections*. Its use allows the development of the following metrics:

$$\begin{aligned}
k_{c,n} &= \frac{1}{k_{c,0}} \sum_p M_{cp} \frac{1}{k_{p,0}} \sum_{c'} M_{c'p} k_{c',n-2} \\
&= \sum_{c'} k_{c',n-2} \sum_p \frac{M_{c'p} M_{cp}}{k_{c,0} k_{p,0}} \\
&= \sum_{c'} k_{c',n-2} \tilde{M}_{c,c'}^C
\end{aligned}$$

Where:

$$\tilde{M}_{c,c'}^C \equiv \sum_p \frac{M_{c'p} M_{cp}}{k_{c,0} k_{p,0}}$$

Using vector notation, this can be expressed in the following way:

$$\vec{k}_n = \tilde{\mathbf{M}}^C \times \vec{k}_{n-2}$$

When $n \rightarrow \infty$, we obtain the following expression:

$$\tilde{\mathbf{M}}^C \times \vec{k} = \lambda \vec{k}$$

Where $\vec{k}$ is an eigenvector of $\tilde{\mathbf{M}}^C$.

The second largest eigenvector of $\tilde{\mathbf{M}}^C$ in the international trade data accounts for the Economic Complexity Index (ECI) at the country level, and the second largest eigenvector of $\tilde{\mathbf{M}}^P$ accounts for the Product Complexity Index (PCI). The ECI of a country is mathematically equivalent to the average of the PCIs of those products (or sectors) in which a location has an RCA larger than 1.

In the case of employment, the calculation of the ECI at the province or district level follows the same logic, just applied to the M_{cp} , diversity and ubiquity values from the location-occupation perspective. Following the criteria used in <http://dataviva.info>, the complexity of different economic activities is simply measured as its occupational diversity from an industry-occupation perspective.

Technological proximity between products (or industries), and distance from a location to a product or sector

In the exports module, technological proximities between products are calculated on international trade data at the country level. The technological proximity between two products is calculated as the conditional probability that a country exports a product with an RCA larger than 1, given that it does so with the other product –this kind of conditional probability is called the “co-location” proximity metric. To guarantee symmetry in the resulting proximity matrix, the ubiquity of the most ubiquitous product in each pair of products is considered the fixed denominator for the conditional probability – that is, the metric is always the minimum conditional probability between each pair or products.

$$\Phi_{p,p'} = \frac{\sum_c M_{cp} M_{cp'}}{\max(\sum_c M_{cp}, \sum_c M_{cp'})} = \frac{\sum_c M_{cp} M_{cp'}}{\max(k_{p,0}, k_{p',0})}$$

For the employment module, different approaches were developed and tested in section 3 of this study. The technological proximity approach followed to develop the industry diversification opportunities section is Occupation similarity alternative. The mechanics of calculating this matrix are exactly those described above for the export co-location proximities, applied on the relevant industry-occupation matrix. That is, the proximity metric between pairs or industries used for all complexity calculations at the province and district levels are based on the minimum conditional probability for an occupation to be demanded with an RCA larger than 1 by an industry, given that it is so demanded by the other industry.

Feasibility and opportunity metrics

Building on the proximity metric between pairs of products, the density of a country around a product or industry is the sum of the proximities between the products that such country exports with RCA >1 and each given product.

$$d_{cp} = \frac{\sum_{p'} M_{cp'} \Phi_{p,p'}}{\sum_{p'} \Phi_{p,p'}}$$

The distance from a country to a product is measured as the unit minus the density value for that country-product cell.

$$\text{distance}_{cp} = 1 - d_{cp}$$

The Complexity Outlook Index (COI) of a locality is the sum of the densities for the products in which a location has RCA lower than 1, multiplied by their PCIs.

$$COI_c = \sum_p d_{cp}(1 - M_{cp})PCI_p$$

Hence, places “closer” to producing a larger number of more complex products show higher COI values.

Finally, the Complexity Outlook Gain (COG) of a product in a location is the COI gain that a locality would observe by adding a given product to its export mix. This metric takes into account both the immediate gain of adding the product and the indirect gain of becoming “closer” to other products with RCA lower than 1.

$$COG_{cp} = \left[\sum_{p'} \frac{\Phi_{p,p'}}{\sum_{p''} \Phi_{p'',p'}} (1 - M_{cp'}) PCI_{p'} \right] - d_{cp} PCI_p$$

These metrics are calculated in exactly the same fashion for the employment module at the province and district levels, just using with the relevant industry proximities and complexity metrics described above.

For more information

For a more detailed discussion on the conceptual basis of the Economic Complexity Metrics, and to find further relevant technical literature, we invite you to visit the Atlas of Economic Complexity (<http://atlas.cid.harvard.edu>) and to download the book of the Atlas of Economic Complexity (<http://atlas.cid.harvard.edu/book>).