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IDENTIFYING SMART STRATEGIES FOR ECONOMIC DIVERSIFICATION AND INCLUSIVE GROWTH IN DEVELOPING ECONOMIES. THE CASE OF PARAGUAY

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Identifying smart strategies for economic diversification and inclusive growth in developing economies. The case of Paraguay

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Abstract. A country's productive structure determines its future path of economic diversification, economic growth, and income inequality. In this article, we identify Paraguay's structural constraints and opportunities for economic diversification and inclusive growth. For this purpose, we advance methods from research on economic complexity and the product space to estimate how feasible and desirable are different types of new products and economic diversification strategies for Paraguay. To estimate the feasibility of different diversification opportunities, we measure the revealed comparative advantages and relatedness of 763 SITC products to Paraguay's current product structure. To estimate the desirability of each product, we measure the expected level of income, economic complexity, technology and income inequality associated with these products. Our results indicate that despite Paraguay's strong dependence on primary goods and resource-based manufactures, it has significant opportunities to diversify into more complex, high-income, and inclusive products. These opportunities include manufacturing products related to agricultural activities (such as machines for harvesting or food-processing) as well as chemical products (such as medicaments and vaccines). We present a scoreboard of feasible and desirable product options that helps to discuss different diversification strategies. Paraguay could for instance (1) only focus on the relatedness criteria; (2) further develop the products with intermediate capabilities; (3) promote diversification into related, higher income products; or (4) push towards complex and inclusive industries. Our results imply that only focusing on feasibility may lead developing countries like Paraguay further into an economic development trap, consisting in the focus on simple products and the large distance to high complexity and low inequality products. Instead promoting products that combine minimum standards regarding both feasibility and desirability criteria might be the best strategy for smart diversification and inclusive growth.

Keywords: Smart diversification, inclusive growth, product space, Paraguay

1 Introduction

Recent research has shown that the productive structure of a country determines its level of economic growth, future path of economic diversification, and income inequality (Hidalgo et al., 2007; Saviotti & Frenken, 2008; Hidalgo & Hausmann, 2009; Hausmann et al., 2014; Cristelli et al., 2015; Hartmann et al., 2016; Hartmann et al., 2017; Hidalgo & Hartmann, 2017; Gala, P., Camargo, J., & Freitas., 2017, Gala et al., 2017; Pinheiro et al., 2018a). Countries that export a varied set of complex products—such as cars or medical equipment—tend to have a significantly lower level of income inequality and a higher level of GDP per capita than countries that depend on few resource-exploiting products—such as soybeans, copper or crude petroleum (Hausmann et al., 2014; Hartmann et al., 2017). Paraguay is an example of a developing country that is strongly dependent of low value-added, mainly agro-based, products (González et al., 2018). Paraguay's main exports include products, such as soybeans (24% of the total exports), bovine meat (13% of the exports), and oilcakes (12% of the exports). Moreover, due to the Itaipu Dam's hydroelectric power plant, a significant share of Paraguay's export portfolio consists in electric current (24% of the exports). In contrast, among its main imports feature more complex manufacturing and chemical goods, such as cars (4.4% of its imports), TVs and radio transmitters (3.9%), or miscellaneous fertilizers (3.4%) (see Figure 1).

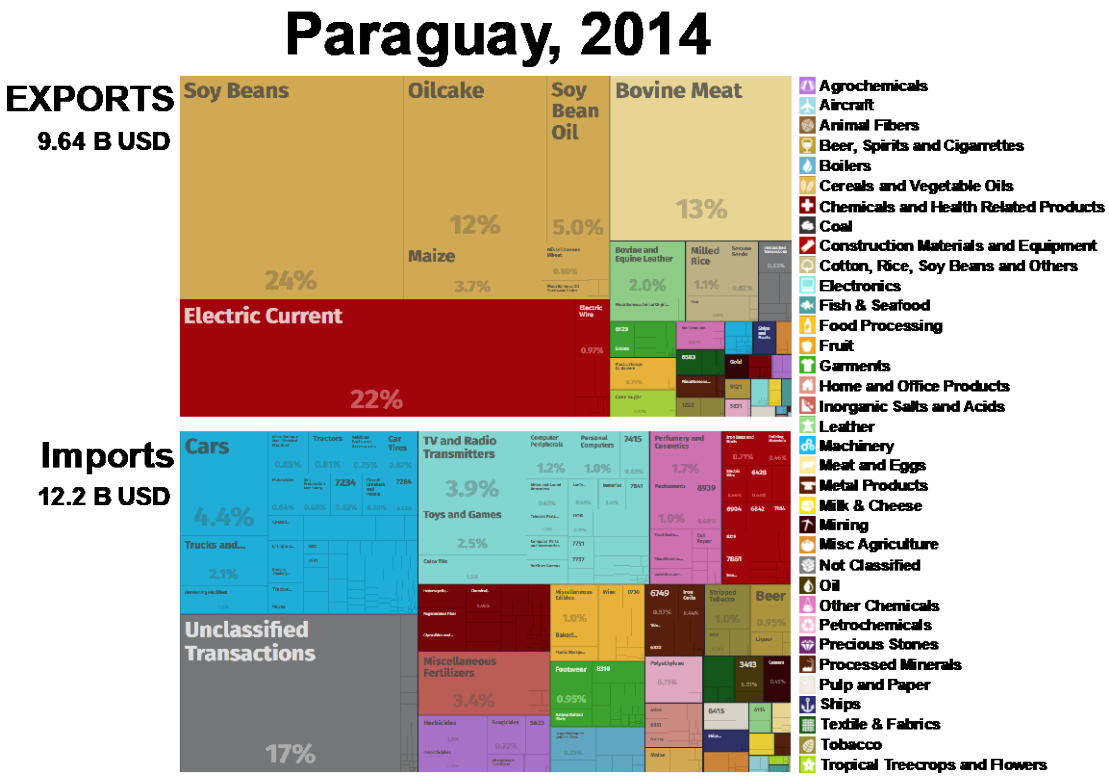

Figure 1. Exports and Imports of Paraguay in 2014 (gross in Billions of USD). Source: The Observatory of Economic Complexity, atlas.media.mit.edu.

The discrepancy between simple exports and complex imports reveals Paraguay's lack of technological sophistication and productive capabilities, and constrains Paraguay's ability to generate and distribute income. Consequently, Paraguay has a relatively low GDP per capita of 8.100 USD (Feenstra et al., 2015), and a high GINI income inequality coefficient of 45.53 (Solt, 2016) in 2014. (see Table 1). Additionally, estimations indicate that around 39.6% of the GDP and more than 50% of the employment of Paraguay belong to the informal sector in 2015 (Vargas, 2015; Pro Desarrollo, 2016). In order to achieve a higher GDP per cápita, create jobs in the formal economy, and reduce poverty and inequality, Paraguay needs to diversify its economy into more sophisticated products. Yet, one first step is being aware that diversification would be good for the economy. Another step is being able to identify the precise industries into which a country could and should move. This article introduces an analytical framework to identify feasible and desirable product options, and applies this framework to the case of Paraguay.

It must be noted that since the seminal contributions of development pioneers—such as Rosenstein-Rodan (1943), Raul Prebisch (1949) and Hans Singer (1950), —many theoretical and empirical contributions have shown that countries need to diversify and sophisticate their productive structure to achieve higher levels of economic development (Hirschman 1958; Furtado 1959; Fajnzylber, 1990; Passinetti, 1981, 1983; Saviotti, 1996; Weitzman, 1998; Imbs & Wacziarg, 2003; Saviotti & Pyka, 2004; Frenken & Boschma, 2007; Hidalgo et al., 2007; Frenken et al., 2007; Saviotti and Frenken, 2008; Felipe, 2009; Hausmann & Hidalgo, 2009; Hartmann & Pyka, 2013; Hausmann et al., 2014; Constantine, 2017; Pinheiro et al., 2018a). Without a diversified and sophisticated productive structure, it is hard for a country to achieve a high standard of living and create sophisticated and well-paid jobs (Hartmann, 2014; Hartmann et al., 2017; Gala et al., 2017). Income from natural resources or commodities may temporarily enable a country to generate or distribute income, but such a country is vulnerable to price fluctuations and external shocks. Moreover, its long-term economic development prospect is limited due to its lack of building blocks of knowledge in facilitating recombinant growth processes (Hartmann, 2014; Hausmann et al., 2014; Hidalgo, 2015). Consequently, many policy-makers, especially in developing and emerging economies, aim to promote economic diversification and sophistication of their economy.

The related question whether states or markets should be the key agents of structural transformations and economic development has been a hotly debated topic in science, politics, industry and the civil society. In the recent decades, a consensus has been emerging: a middle ground between emphasis on market forces and smart government intervention may be necessary to overcome both market and government failures (Rodrik, 2004). Incentives should be provided to facilitate self-discovery processes and the rise of new activities, such as technologies or products that are new to the domestic economy (Hausmann & Rodrik, 2003,

Hartmann, 2014). However, there should also be clear criteria for success and failure, as well as a built-in-sunset clause for the support of these new activities if they fail and do not become competitive (Rodrik, 2004).

Nonetheless this general understanding of the need for economic diversification and smart industrial policies is still insufficient for decision- and policymakers to actually identify the precise economic activities they should support. Fortunately, recent methods from network science and economic complexity research help to identify the most feasible new products for each country (Hidalgo et al., 2007; Hausmann et al., 2014). Moreover, these methods allow for an association of products to their expected level of income, complexity and inequality (Hidalgo & Hausmann, 2009; Hartmann et al., 2017; Hidalgo and Hartmann, 2017). In this article, we build upon these new empirical methods to identify which products are feasible and desirable for the case of Paraguay.

The remainder of this article is structured as follows. Section 2 reviews the recent literature on path-dependent economic transformations, economic complexity, and inclusive growth. Section 3 presents the data and methods. Section 4 analyzes the productive structure of Paraguay between 1970 and 2014, and identifies the feasibility and desirability of different new products. Moreover, four different diversification strategies are discussed: (1) a strategy that focuses on the diversification into the most related products; (2) a strategy that focuses on products that already have intermediate comparative advantages; (3) a strategy that puts emphasis on the diversification into related, complex, and high-income products; or (4) a strategy that puts minimum standards in all desirability and feasibility criteria, and thus additionally includes also considerations on the inequality and export size of related industries. Section 5 discusses the results and provides concluding remarks. In sum, our results indicate that despite Paraguay's strong dependence on agro-based activities, it has opportunities to further diversify their economy towards chemical products (such as medicaments, glycosides and vaccines) as well as to manufacturing products related to agricultural activities (such as machines for harvesting or food-processing).

2 Literature review on economic diversification and inclusive growth

In this section, we review the literature on (1) economic growth, productive structures, and income inequality, (2) the path-dependency of structural transformations, and (3) methods of identifying feasible and desirable opportunities for economic diversification.

2.1 Economic growth, productive structures, and income inequality

Decades ago, Simon Kuznets (1955) proposed an inverted-u-shaped relationship describing the connection between a country's level of income and its level of income inequality. Kuznets' curve suggested that income inequality would first rise and then fall as

country's income moves from low to high levels. Yet the inverted-u-shaped relationship fails to hold when several Latin American countries are removed from the sample. Indeed, the upward side of the Kuznets curve has vanished in recent decades, as inequality in low-income countries increased (Deininger and Squire, 1998; Palma, 2011). Moreover, several East-Asian economies have grown from low to middle income while reducing their income inequality (Stiglitz, 1996). These findings undermine the empirical robustness of Kuznets' curve and indicate that GDP per capita is an insufficient measure of economic development in terms of its ability to explain variations in income inequality (Kuznets, 1934; Kuznets, 1973; Leontief, 1951; Stiglitz, Sen & Fitoussi, 2009).

Recent studies have argued that income inequality and level of social welfare depends not only on a country's rate or stage of aggregated economic growth, but also on its type of growth, institutions and economic structure (Engerman & Sokoloff; 1997; Fields; 2002; Bourguignon, 2004; Ravallion, 2004; Sachs, 2005; Beinhocker, 2006; Collier 2007; Stiglitz, Sen & Fitoussi, 2009; Acemoglu & Robinson, 2012; Hartmann, 2014; Constantine & Khemraj, 2017; Hartmann et al., 2017). Hence, we should expect more nuanced measures of economic development, such as those focused on the types of products a country exports, to provide deeper insights on the connection between economic development and income inequality, beyond the limitations of aggregate measures of output, such as GDP (Engerman & Sokoloff, 1997; Hartmann et al., 2017; Hidalgo and Hartmann, 2017). One such measure is the Economic Complexity Index (ECI) which is a measure of knowledge intensity of an economy that is expressed in the type of products it makes (Hidalgo and Hausmann, 2009; Hausmann et al., 2014; Hidalgo, 2015). A country is considered complex if it exports not only a large number of different products but also highly complex products. Countries like Saudi Arabia, Chile, Paraguay, and Ghana rely heavily on a very limited number of simple and resource exploiting products, such as crude petroleum, copper, soybeans or cocoa beans, and therefore have a low ECI. Conversely, countries such as Japan, South Korea, and Germany export a high number of very complex products, such as microchips, medicaments, and sophisticated car parts, and therefore their ECI is very high. Table 1 shows that Paraguay ranks 89 out of 103 countries with respect to its level of economic complexity. It must be noted that not only Paraguay, but most countries of Latin America and the Caribbean (LAC) are significantly behind the most diversified and sophisticated economies like Japan, Switzerland or Germany.[1] Paraguay ranks

[1] The only outlier is Mexico, which ranks significantly higher than most LAC countries. However, this ranking position needs to be taken with reservations, since more than 70% of Mexico's exports are sent to the United States, suggesting that the apparent complexity of Mexico's economy is inflated due to its relationship with the U.S. Otherwise, we would expect a country with that level of productive sophistication to export to a larger number of destinations. Furthermore, in the case of Panama, the economic complexity index might be slightly overestimated as Panama has an important commercial free zone whose flows are usually mixed with the domestic ones (Ramos Martinez et al., 2015).

significantly lower than many of its neighbouring countries like Brazil, Uruguay, and Argentina, yet is higher ranked than Bolivia.

2014 ECI RANKING AND ADDITIONAL COMPARATOR VARIABLES

Country	ECI (rank)	ECI (value)	GDP per capita	Gini	Population (Mil)
TOP 5 IN THE 2014 ECI RANKING					
Japan	1	2.24	35271	NA	126.8
Switzerland	2	1.95	61570	29.28	8.2
Korea	3	1.78	34585	NA	50.1
Germany	4	1.77	46190	28.96	80.6
Austria	5	1.60	45158	27.8	8.5
COUNTRIES WITH SIMILAR POPULATION SIZE LIKE PARAGUAY					
Hong Kong	13	1.27	45399	40.89	7.2
Bulgaria	41	0.27	16768	33.8	7.2
Slovenia	47	-0.01	7964	39.21	6.1
Jordan	50	-0.05	11741	40.04	7.4
LATIN AMERICA AND THE CARRIBEAN					
Mexico	22	0.91	15424	45.87	125.4
Brazil	56	-0.19	14674	44.89	206.1
Colombia	57	-0.21	12710	49.28	47.8
Uruguay	61	-0.35	19573	37.05	3.4
Dominican Republic	64	-0.36	12631	44.7	10.4
Argentina	71	-0.51	20007	38.96	43.0
Chile	72	-0.51	21125	46.29	17.8
Panama	74	-0.59	19792	46.28	3.9
Jamaica	80	-0.82	7198	NA	2.8
Peru	85	-0.91	10847	45.58	31.0
Nicaragua	86	-0.94	4495	43.16	6.0
Paraguay	89	-0.98	8169	45.53	6.6
Bolivia	92	-1.20	5799	44.14	10.6
Ecuador	96	-1.41	10922	42.65	15.9
Venezuela	98	-1.64	15118	37.04	30.7
BOTTOM 5 IN THE ECI RANKING					
Sudan	99	-1.74	3682	NA	50.3
Azerbaijan	100	-1.83	15799	NA	9.6
Nigeria	101	-1.93	5499	NA	177.5
Algeria	102	-1.98	12777	NA	38.9
Guinea	103	-2.23	1573	NA	12.3

Table 1. The position of Paraguay and comparator countries in the 2014 ECI ranking. Additional comparator variables, such as GDPpc, GINI, and population are added.

Several empirical studies have shown that countries exporting more sophisticated products tend to have higher levels of GDP and future economic growth prospects (Hausmann & Rodrik, 2003; Lall et al., 2006; Hausmann et al., 2006; Rodrik, 2006; Hidalgo & Hausmann, 2009; Felipe et al., 2012; Tacchela et al., 2012; Cristelli et al., 2013; Hausmann et al., 2014; Cristelli et al., 2015; Hidalgo, 2015). Moreover, Hartmann et al. (2017) showed that economic complexity is a significant, and negative predictor of income inequality on the country level. Virtually all economies that have a diversified and sophisticated productive structure tend to

have comparatively low levels of income inequality, whereas all economies that are strongly dependent on simple products tend to have high levels of income inequality.

Not surprisingly, Paraguay, as most other Latin American economies, exhibits a high level of income inequality and low level of economic complexity, whereas most European economies and many Asian economies such as Hong Kong, Singapore, and South Korea have significantly lower low levels of income inequality and higher levels of economic complexity. Hartmann et al., (2016) argue that while social policy programs had a positive impact on the reduction of income inequality in Latin America during the early 2000s, most Latin American economies continued to be dependent on simple and resource exploiting products. Consequently, once the commodity boom was over, several Latin American countries suffered from the recent global economic crisis while simultaneously developing an institutional crisis. Conversely, during the last decades, many Asian economies have successfully combined social and economic policies, diversifying into more complex products and promoting inclusive growth (Wade, 1990, Stiglitz, 1996, Hartmann et al., 2016).

But why do complex economies have lower levels of income inequality? Scholars from different disciplines have argued that income inequality depends on a variety of factors, from an economy's factor endowments, geography, and institutions, to its historical trajectories, changes in technology, and returns on capital (Engerman & Sokoloff; 1997; Fields, 2001; Beinhocker, 2006; Collier 2007; Davis, 2009; Acemoglu & Robinson, 2012; Brynjolfsson & Afee, 2012; Stiglitz, 2013; Autor, 2014; Piketty, 2017). Hartmann et al. (2016, 2017) argue that a likely explanation for the association between economic complexity and income inequality is that productive structures represent a high-resolution expression of a number of these factors, from institutions to education, which co-evolve with the mix of products that a country exports and with the inclusiveness of its economy. Because of this co-evolution, productive structures are not only associated with income and economic growth, but also with how income is distributed. For example, post-colonial economies that have specialized in a narrow set of resource-exploiting products tend to have more unequal distributions of political power, human capital, and wealth (Engerman & Sokoloff; 1997). Conversely, sophisticated products, like medical imaging devices or electronic components, are typically produced in diversified economies that require more inclusive institutions. Moreover, complex economies require a large network of skilled workers which have better remuneration and more bargaining power. Finally, diversified economies tend to be associated with a better distribution of political power (and lower levels of rent-seeking and political capture of economic benefits) than economies that are dependent on few resource-exploiting products. But how can we reveal the precise structural constraints and opportunities for economic diversification and inclusive growth of each country?

2.2 The path-dependency of structural transformations

Mounting evidence in economic geography and complexity research has shown that the structure of economic production and knowledge relatedness substantially determines an economy's future path of technological, industrial and occupational diversification (Hidalgo et al., 2007; Frenken & Boschma, 2007; Neffke et al., 2011, 2013; Guevara et al., 2016; Guevara, Hartmann, & Mendoza, 2016; Petralia et al., 2017; Balland et al., 2017; Pinheiro et al., 2018, Alshamsi et al., 2018). It has been shown that countries, regions and companies tend to move into related activities, i.e. activities that require similar knowledge and productive capabilities (ibid.). Conversely, it is hard to develop and enter into new activities that are unrelated with the current product portfolio (Frenken et al., 2007; Hidalgo et al., 2007, Zhu et al., 2017; Pinheiro et al., 2018, Alshamsi et al., 2018). For instance, an economy that currently produces cotton will probably find it much easier to diversify into the production of textiles than into the productions of cars or robots. Moreover, complex industries typically require a larger number of related activities to make them viable. The production of industrial robots may, for instance, require a large pool of companies supplying specialized inputs and services, as well as industrial consumers from which the producer of the robots can learn about needs and options of improving their products (Lundvall et al., 1988; Bezerra, 2013). The supply of specialized inputs and innovative consumers can partially be fulfilled by international partners, yet, the existence of related industries in the particular region or country is also an essential element in building up the technological and productive capabilities needed to become competitive in complex industries. This implies that each country or region faces unique development constraints and opportunities which are determined by its current productive structure.

But how can these constraints and opportunities be identified? New methods from complexity research have helped to reveal the region-specific constraints and predict the economic diversification opportunities of each region. In this regard, the product space was a seminal contribution to reveal the relatedness between products and to predict path-dependent economic transformations (Hidalgo et al., 2007). The product space is a network that relates products according to their relatedness in terms of knowledge necessary to successfully co-export them (see Figure 2). The product space takes into account that each product requires a specific set of capabilities that may either be similar or different to the capabilities needed in the production process of other products. The distance between products in the product space reveals that the closer a product is to another product, the more likely both of these products require a similar set of capabilities. Hence, closer products are more related, while farther away products in the product space are unrelated. New products can be more easily developed in a region when they are close to the products already being produced. This is because these products tend to require similar knowledge, technology, and skills that are already present in a

given region. In contrast, products that are further away in the product space require the region to develop a network of new productive capabilities, institutions, education, infrastructure, and so forth, that are necessary to produce these products in a competitive manner.

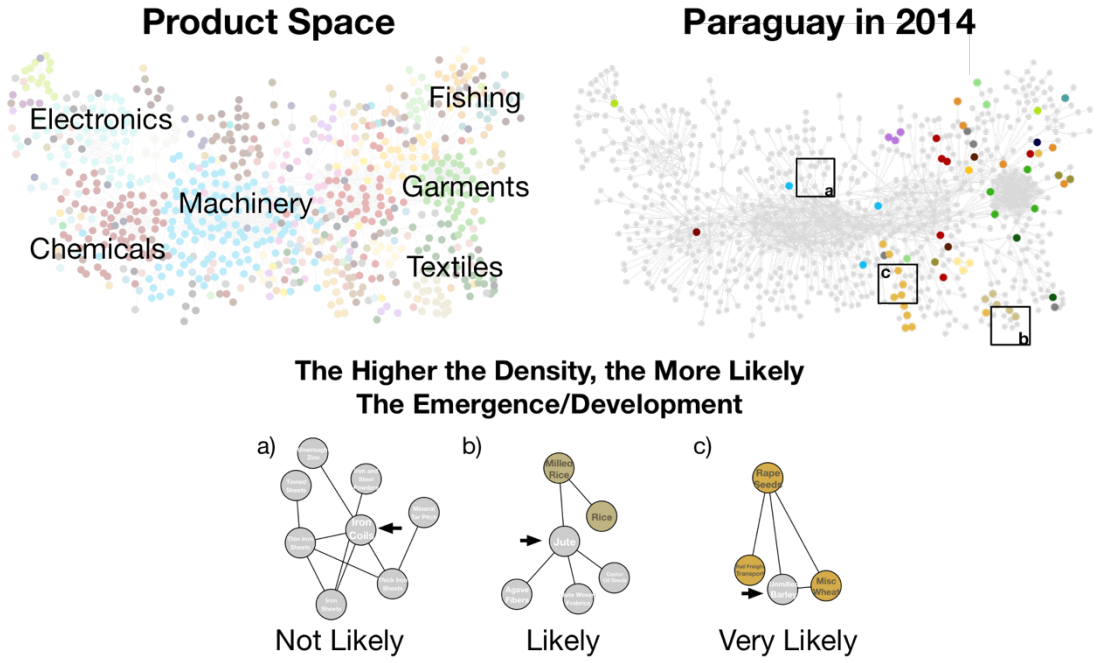

Figure 2. How the density / relatedness in the product space determines the emergence of new industries.

The product space captures the difficulty for simple economies (i.e. producing mainly simple agricultural or resource-based products) to move into more complex products in the center of the product space. Countries focusing on products in the periphery may face a development trap consisting in the large distance to more complex and connected products. But is it possible to move from agricultural products into unrelated complex products? Turkey is an example of a country that was able to transform its economy from primarily exporting simple agricultural products towards an economy with a significant share of more complex industries (Hartmann, 2016; Pyka et al., 2016). In the 1960s, Turkey mainly exported cotton, tobacco, and nuts. But then it started diversifying its productive structure and by 1990 it was already exporting a varied set of textile products. Finally, based on the advantages in the textile industry, Turkey further diversified and today it is exporting a varied set of manufactured goods such as cars, trucks and vehicle parts. Foreign companies and technologies, back-and-forth migration between Turkey and Germany, the rise of the Anatolian Tigers, and deliberate emphasis on the establishment of cutting-edge universities and research centers were significant factors in this transformation (Hartmann & Buchmann, 2016; Pyka et al., 2016).

Argentina, on the other hand, is an example of an agro-based economy that has been less successful in transforming their economy towards more complex products. In the 1960s, Argentina mainly exported bovine meat, wheat, and maize. Then it managed to diversify into

manufacturing industries, such as cars and vehicle parts. But then, the rate of diversification stagnated again and today, Argentina continues to being highly dependent on primary goods and agro-based manufactures.

Arguably, in the recent two centuries, virtually no economy has achieved a high standard of living, high levels of human development, and low levels of income inequality based solely on agricultural businesses. The rise of the bio-economy and emphasis on green growth certainly offers new opportunities for countries such as Paraguay which have a strong agricultural sector. Still, the diversification towards more complex manufactured products is a crucial challenge to being able to generate and distribute more income. This leads us to the next question: how can we identify new industries that are both feasible and desirable according to the current productive structure of a country?

2.3 Methods to identify feasible and desirable opportunities for economic diversification

Over the last decades, different approaches have been developed to identify and promote economic diversification opportunities. A significant part of the literature on economic growth and industrial policies in developing economies, has focused on the question whether state intervention or market forces are more appropriate to promote the economic diversification and sophistication processes. Here, we focus instead on the methods that allow for the identification of the feasibility and desirability of different industrial products in different countries.

In this regard, Lin and Monga (2011) suggested that developing countries should learn from dynamic growing countries that have a similar endowment structure, but whose income per capita is about 100% higher than their own. Then, these developing countries should identify the tradable industries that have exhibited strong growth in those countries for the last 20 years, as the potential targets of industries for upgrading or diversification. This also connects to the focus by Hausmann et al. (2006) and Rodrik (2006) that countries should move towards products that are typically produced in countries with higher income levels.

More recent analysis using methods from network analysis argue that not only income, but also the knowledge relatedness and the complexity of the products should be a crucial information for the identification of growth opportunities of countries (Hidalgo & Hausmann, 2009; Hausmann et al., 2014). Countries should aim at moving into the most complex industries which are close to their current productive capabilities. The purpose of this strategy is to step by step improving the level of economic complexity and open up opportunities to further diversify into more complex parts of the product space. This also relates to previous work highlighting the need to move into more knowledge-based and technology intensive products for long-run economic development (Lall, 2000; Lall et al., 2006).

Finally, Hartmann et al. (2017) introduced a measure called the Product Gini Index (PGI) that links products to the average level of income inequality of the countries exporting them. The PGIs helps to identify the structural constraints of income inequality related to different productive portfolios (Hartmann et al., 2016; Hartmann et al., 2019), and to identify productive sectors that are likely to reduce a country's income inequality.

In this article, we combine several desirability and feasibility criteria discussed in the literature. This includes as feasibility criteria the existence of nascent or intermediate revealed comparative advantages in products (Balassa, 1965), as well as the relatedness of the productive structure to potential new products (Hidalgo et al., 2007). As desirability criteria, we consider the different estimated characteristics of products, such as income (Hausmann et al., 2006, Lin & Monga, 2011), the technology content and complexity of products (Lall et al., 2006; Hidalgo & Hausmann, 2009) and the level of inequality associated to different products (Hartmann et al., 2017) (see also Figure 5). A combination of different feasibility and desirability allows for the simulation and discussion of different diversification strategies, considering also the respective preferences of the respective society, policy- and decision-makers. Previous research on the diversification opportunities of Paraguay has used the distance in the products space in combination with expert interview (González et al., 2018). Here we present a data-driven empirical analysis framework that can be replicated to other countries and also considers feasibility criteria, such as density and the level of RCA, as well as desirability indicators, such as the expected export size when achieving an RCA or the inequality associated to productive portfolios.

3 Data and Methods

We use data on world trade, economic complexity, and income inequality to compare the structural constraints of LAC and HPAE. Data on GDP per capita at current PPPs (in mil. 2011US$) comes from the Penn World Tables V9.0 (Feenstra et al., 2015). Data on income inequality comes from the Galbraith et al., 2014 (GINI EHII dataset). Due to the sparseness of the Gini data, we interpolate the missing years using linear splines. Moreover, we consider only the countries for which the Economic Complexity Index is available. The data on world trade, compiled by Feenstra et al. (2005), combines exports data from 1962 to 2000 with data from the U.N. Comtrade from the period between 2001 and 2012. The values for the Economic Complexity Index come from MIT's Observatory of Economic Complexity (atlas.media.mit.edu) (Simoes & Hidalgo 2011). We use the Economic Complexity Index (ECI) as an indicator for the know-how and productive capabilities of LAC and HPAE countries. ECI measures the sophistication of a country's productive structure, combining information on the diversity and ubiquity of the products a country's exports (Hidalgo and Hausmann 2009). The intuition behind ECI is that sophisticated economies are diverse and

export products produced by few other economies. ECI can be interpreted as a measure of a country's productive capabilities that are embodied in its institutions and people. Further information about the calculation of ECI can be found in Hidalgo and Hausmann (2009). Additionally, we follow the classification of Lall (2000) to identify primary goods and resource-based manufactures (see also Table A1 in the appendix).In order to reveal the structural transformation processes of countries, we make use of the product space, which is a network that estimates the relatedness between products traded in the global economy (Hidalgo et al., 2007; Hausmann et al., 2014). For this purpose, we first measure the revealed comparative advantages of countries (Balassa, 1965), then the co-location of products in countries as a measure of the relatedness between products (Hidalgo et al., 2007) and finally calculate the density of products with revealed comparative advantages (Hidalgo et al., 2007; Pinheiro et al., 2018) in the vicinity of a particular product in Paraguay's product space.

The Revealed Comparative Advantages (RCA) allow us to link countries to their significant exports (the products they export more than what we expect based on a country's total exports and a product's global market). Formally we compute the RCA as a matrix R_{cp} that is defined as

$$\mathrm{R_{cp}} = \left(\frac{X_{cp}}{\sum_{cp'} X_{cp'}}\right) \Big/ \left(\frac{\sum_{c'p} X_{c'p}}{\sum_{c'p'} X_{c'p'}}\right) \tag{1}$$

where X_{cp} is a matrix summarizing the exports of country c in product p. The Product Space estimates the proximity between pairs of products by looking at the probability they are co-exported. Formally, the proximity between products p and p' ($\phi_{pp'}$) is the minimum of the conditional probability that a country has a Revealed Comparative Advantage (RCA) in both products:

$$\phi_{pp'} = \frac{\sum_c M_{cp} M_{cp'}}{\max(k_p, k_{p'})} \tag{2}$$

where M_{cp} is equal to one when country c has $\mathrm{R_{cp}} > 1$ over product p, and 0 otherwise.

We then use this proximity to estimate the relatedness between the products that a country exports and each of the products it does not export. The resulting quantity is commonly referred to as the density, ω_{cp}, of product p in country c and is computed as

$$\omega_{cp} = \frac{\sum_{p'} M_{cp'} \phi_{pp'}}{\sum_{p'} \phi_{pp'}} \tag{3}$$

Higher density products are products that are more related/similar to the export capacities of a country, whereas lower density products correspond to unrelated/farther away products.

Moreover, we make use of the Product Gini Index (Hartmann et al., 2017; Hartmann et al., 2019) to reveal the relationship between a country's mix of products and its structural constraints on inequality reduction (Hartmann et al., 2016), PRODYs to capture the association between products and income (Rodrik, 2006; Hausmann et al., 2006) and PCIs to measure the complexity of products (Hidalgo & Hausmann, 2009; Hausmann et al., 2014). These measures are inspired by Lall's work on the sophistication of exports (e.g. Lall, 2000; Lall et al., 2006) and are all calculated in a similar manner.

For instance, the Product Gini Index (PGI) is a measure that relates each product to its typical level of income inequality. Formally, the PGI is defined as the average level of income inequality of a product's exporters, weighted by the importance of each product in a country's export basket. Formally, we define the *PGI* (Product Gini Index) for a product p as:

$$PGI_p = \frac{1}{N_p} \sum_c M_{cp} s_{cp} Gini_c \tag{4}$$

where $Gini_c$ is the Gini coefficient of country c, M_{cp} *is* 1 if country c exports product p with revealed comparative advantage and 0 otherwise, s_{cp} is the share of country c's exports represented by product p. N_p is a normalizing factor that ensures PGIs are the weighted average of the Ginis. N_p and s_{cp} are calculated as:

$$N_p = \sum_c M_{cp} s_{cp} \tag{5}$$

$$S_{cp} = \frac{X_{cp}}{\sum_{p'} X_{cp'}} \tag{6}$$

where X_{cp} *is* the total export of product p by country c.

Finally, to simulate the effect of different diversification strategies on income inequality, income, and complexity, we calculate the simple average of the Product Ginis (PGI), Product Income (Prody) and Product Complexity (PCI) of the current and the potential future export portfolio. Prodys associate products to the typical level of income in the exporter countries. The average Prodys of a countries allow for the estimation of the Expy, an indicator that estimates the income associated with the export portfolio of a country (Hausmann et al., 2006). PCIs estimate the complexity, and thus difficulty, to achieve revealed comparative advantages in products; the average of the PCI values provide the Economic Complexity Index (Hidalgo and Hausmann, 2009; Hausmann et al., 2014).

4 Results

In this section, we analyze the structural economic transformation from the 1970s to 2014, benchmark the evolution of ECI, EXPY and XGINI of Paraguay, and identify different

opportunities and strategies for future economic diversification and inclusive growth in Paraguay.

4.1 The structural economic transformation of Paraguay since the 1970s

In the introduction, we highlighted the strong dependency of Paraguay's export on agro-based products. Here, we analyze the structural transformation in the last decades. Paraguay's productive structure has undergone a slight diversification since 1970 (see Figure 3). Several large infrastructure projects—such as the Itaipu hydro electrical dam—as well as the rise of soybean and cotton prices led to very high economic growth rates over 10% at the end of the 1970s. Yet, in the 1980s and 1990s Paraguay could not maintain these growth dynamics and the process of economic diversification began to stagnate. Since the year 2000, Paraguay's economy shows relatively high growth rates, among other factors, due to a commodities boom and rising global demand in products such as soybeans. However, this GDP growth has not been matched by the qualitative transformation of the economy towards products with a higher level of complexity (*i.e.* PCIs and ECI) and lower levels of inequality (PGIs and XGINI) related to them. Paraguay continues to primarily export simple products and import complex products.

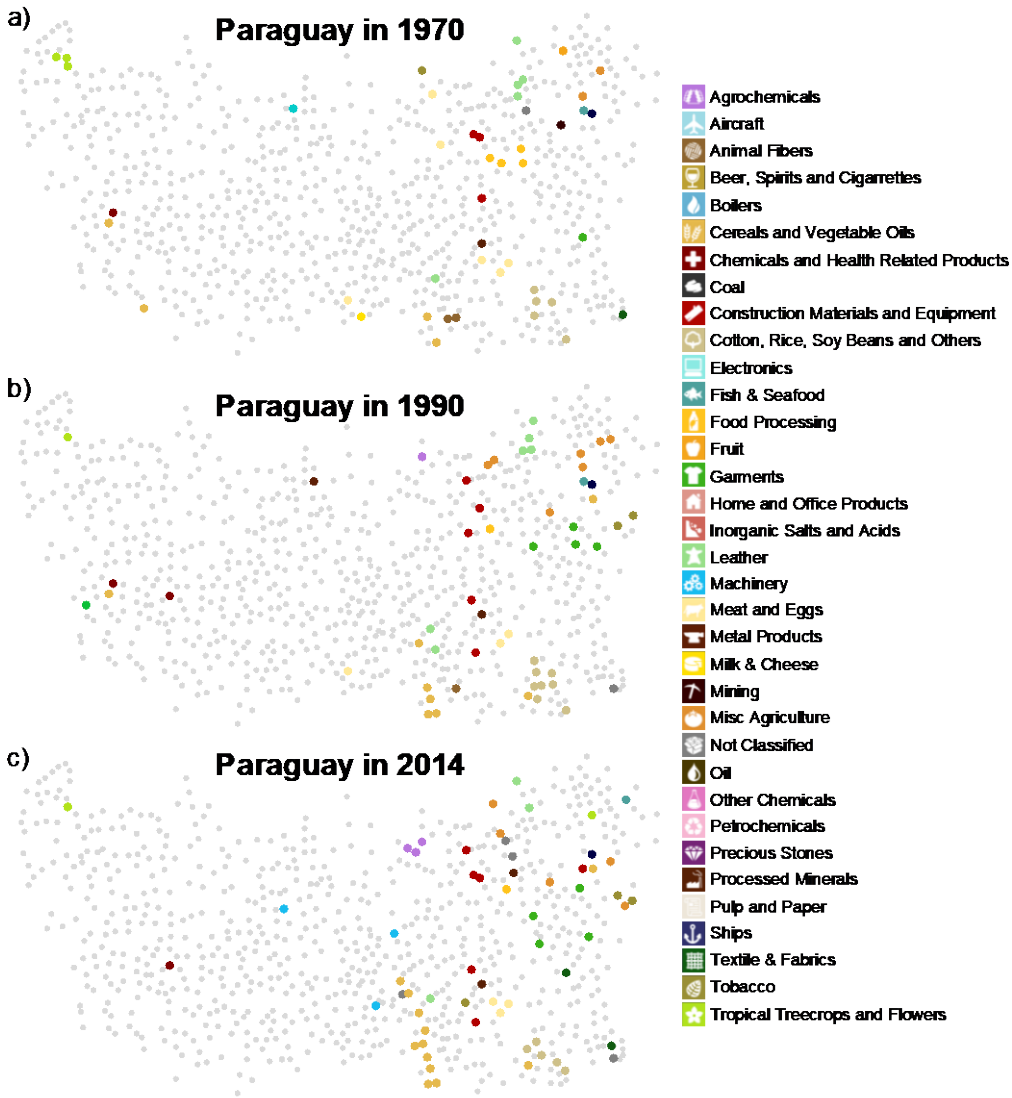

Figure 3. The evolution of the product space. Paraguay's productive structure in 1970, 1990, and 2014. Source: The Observatory of Economic Complexity: atlas.media.mit.edu

4.2 The evolution of Paraguay's ECI, EXPY, XGINI

In 2014, Paraguay only occupied the 89th position among 193 countries in the economic complexity ranking (See Figure 4). Paraguay exported or re-exported 590 out of 763 SITC products (=77%), yet it had only 66 product categories with revealed comparative advantages (RCAs) (=8%). Among Paraguay's top ten export products in terms of the total values were electricity and agricultural products (such as soybeans and bovine meat). Among the top ten imports featured cars, trucks, and TVs (see Figure 1). The products in which Paraguay had the highest level of reveal comparative advantages in 2014 were electric current, soybeans, and fuel wood.

Partly due to the concentration of Paraguay's productive structure on simple and resource-exploiting products, Paraguay has a very low-ranking position in terms GDP per capita, ECI, exports, Gini and XGINI. In 2014, the average complexity of the products (=ECI) which

Paraguay exports was -0.98, the level of income of countries exporting these products (=EXPY) was -1.04, and the level of inequality of countries exporting these products (XGINI) was 41.74. Only a few products exported by Paraguay tend to be produced by countries with low to intermediate levels of inequality. Moreover, Paraguay's comparative advantages are quite distant from the parts of the product space, where more complex and inclusive products are located.

Only with respect to its EXPY (estimating the average income associated with an export basket) Paraguay had a middle-ranking position in comparison to all countries in our dataset between 1970 and 2014. While its GDP grew at the end of the 1970s, Paraguay moved towards products that are associated with higher levels of income inequality (XGINIs) and lower levels of complexity (ECI) and income (EXPY). Arguably, the bonanza of ITAIPU caused a relative deterioration in terms of Paraguay's focus on complex and inclusive products. From 1993-1998, the EXPY value, and thus the production of products related to higher incomes rebounded, yet, the average inequality values related to Paraguay's product basket remained very high and the average complexity low (compared to all other countries in the dataset).

Figure 4. The global ranking position of Paraguay with respect to GDPpc, Economic Complexity, total exports, EXPY, GINI and XGINI.

Comparison with economies that are spatially close or have a similar population size

When comparing Paraguay's productive structure with countries that are spatially close, such as Argentina, Brazil or Uruguay, it is noteworthy to identify that Paraguay might suffer from regional constraints in the development of its productive structure, yet could also learn from its neighbors (See Figure A1 in the appendix). All of these countries exhibit a similar productive structure, with Argentina and Brazil having additional RCAs in manufactured and chemical products, such as harvesting machinery, medicine or fertilizers. It is noteworthy that these latter products also form part of Paraguay's diversification opportunities. (see also section 4.2 and 4.3). Moreover, we can observe that a country's population size alone or being landlocked are not good indicators for economic diversification and complexity (See Table A2 in the appendix). There are major differences between less complex economies such Paraguay and

Nicaragua, and more complex economies such as Slovenia, Bulgaria or Hong Kong. Regarding the latter, we can observe that these countries have been able to develop strong presence in particular areas of the product space (i.e. Bulgaria in garments and Hong Kong in electronics). Finally, Paraguay not only has a low number of products with Reveal Comparative Advantages ≥ 1, but also has a very low number of potentially new products for which it has a high density of related products with RCAs ≥ 1 (see Table A3 in the appendix). Yet, as the following sections shows, if we slightly relax the density threshold and/or introduce the existences of intermediate RCAs, further options can be considered.

4.3 The economic diversification opportunities of Paraguay

Next, we identify which new products are feasible and desirable in the case of Paraguay. To that end, we consider two feasibility criteria for the development of comparative advantages of new products: (1) the density of products with an RCAs ≥1 and (2) the existence of nascent or intermediate RCAs. The ability to jump to a new product decreases as the distance increases in the product space. The more unrelated is a product, the less likely is it for a country to develop it (Hidalgo et al., 2007). Therefore, a minimum feasibility level sets the baseline scenario of options that Paraguay is likely to achieve, based on its current productive portfolio. Nonetheless, within the range of feasible options, there may also be products that are more or less desirable to achieve different socioeconomic goals. We calculate five different desirability criteria for the product options, consisting in (1) the (minimum) additional exports of a product in order for Paraguay to achieve RCA higher or equal to 1 in that product; (2) the product's expected income (PRODY); (3) the product's complexity (PCI); (4) a binary variable if the respective product are primary or agro-based goods or a more technology intensive product; and (5) the income equality related to the product (PGI). Information about the calculation of the PGI, PCI, and PRODYs can be found in the methods section. For the association between the relatedness and the PRODY, PCI, PRODY and RCA see Figure A2 in the appendix.

These calculations allow us to reveal a scoreboard of economic diversification opportunities, considering both feasibility constraints imposed by the current productive capabilities, as well as desirability criteria emphasizing different socioeconomic variables (see Figure 5). The desirability fields of the scoreboard of economic diversification are colored in black or white depending on whether products fulfill the respective minimum desirability values. The respective threshold values of the desirability criteria in Figure 5 are defined as follows: (1) the expected export value in the case of achieving an RCA above 1 is higher than 1 million USD, in order to focus on products that have a minimum direct impact on the income creation of the country; (2) a PRODY above 16200 USD, which is double the current GDP value; thus in line with the Lin and Monga (2011) proposition of entering products that are typically produced in countries with a GDP level that is 100% higher; (3) the product is not a primary or agro-based

product, in order to identify more technology intensive products, in line with Lall (2000); (4) a positive product complexity value, in line with the idea of Hidalgo and Hausmann (2009) that countries should focus on complex products; and finally (5) a PGI value below 0.405 to consider products that are related to products which are typically produced by countries that have a significantly lower level of income inequality than Paraguay. This way we can consider 2 feasibility and 5 desirability criteria to simulate and discuss different diversification strategies, highlighting either one or more of these criteria.

Figure 5 The scoreboard of Paraguay's export diversification constraints and opportunities. The scoreboards visualizes the feasibility and desirability of 87 product options for which Paraguay has RCAs greater than 0.1 and lower than 1. Each row depicts a product, each column indicates a feasibility and desirability criteria.

It must be noted that it is beyond the scope of this paper to discuss the benefits of concentrating effort on few sectors (with a very high feasibility and desirability) or spreading the effort and money to larger number of sectors. Moreover, each society and economy may provide different weighting to the desirability criteria. Regardless, we suggest that establishing minimum standards regarding both feasibility and desirability criteria may help the democratic process of deciding a country's industrial policies. The exclusion of product options that do not reach a minimum feasibility level or do not reach minimum desirability levels can significantly reduce the number of product options that the industrial policies needs to evaluate. Industries that are very far away from the current productive capabilities, or industries with little benefit for income creation but high levels of income inequality arguably should not be priorities for the industrial policies of countries. Thus, establishing minimum standards may help to identify feasible, desirable, and politically viable economic diversification strategies.

4.4 Benchmarking different economic diversification strategies

The scoreboard of economic diversification opportunities allows us to identify the feasibility and desirability of product options and to develop different diversification strategies. In this article, we discuss the following four (out of many) possible diversification strategies:

S1. Focus on relatedness, and thus natural advantages, alone

S2. Promote products with intermediate RCAs

S3. Diversification into related higher income products

S4. Diversification into more complex and inclusive products

The strategies S1 and S2 only focus on feasibility criteria, while the strategies S3 and S4 also include desirability criteria. The following table summarizes the criteria and thresholds we used to identify the top twenty products of each strategy.

	S1	S2	S3	S4
Exports	-	-	> 1 M	> 1 M
RCA	-	≥ 0.50	> 0.05	> 0.05
Relatedness	≥ 0.11	-	> 0.05	> 0.05
PCI	-	-	-	> 0.00
PRODY	-	-	≥ 29725	≥ 16200
PGI	-	-	-	< 0.405
Agrobased	Yes	Yes	Yes	No

Table 2. Criteria and thresholds to identify the top twenty products in the four diversification strategies

We do not analyze strategies that only focus on desirability criteria, because these strategies are not very likely to be successful. Indeed, the economic complexity and relatedness literature has shown that countries typically cannot randomly jump into the economic activities they desire, but tend to follow path-dependent transformation processes (Hidalgo et al., 2007).

Therefore, we suggest here that choosing the most desirable of the feasible options may be the smartest strategy for countries to pursuit.

Focus on relatedness and natural advantages alone

We start with a strategy that only focuses on relatedness. The top twenty most feasible options for Paraguay, in terms of relatedness, are a varied set of simple agricultural products (see Table 3).

id	Description	Relatedness	RCA	Exports[2]	Prody	PCI	PGI
2681	**Greasy Wool**	**0.124**	0.000	0	28988	-1.789	0.416
573	**Bananas**	**0.124**	0.809	11529955	11666	-2.131	0.459
4242	**Palm Oil**	**0.122**	0.000	0	8999	-2.256	0.449
612	**Refined Sugars**	**0.121**	0.011	234216	14127	-1.087	0.427
2632	**Cotton Linters**	**0.121**	0.718	125100	3702	-2.070	0.498
9710	**Gold**	**0.120**	0.205	91222039	11063	-1.850	0.471
616	**Honey**	**0.119**	0.000	577	16466	-1.058	0.438
6545	**Jute Woven Fabrics**	**0.119**	0.004	680	5278	-2.072	0.516
542	**Legumes**	**0.119**	0.306	3773126	9261	-1.838	0.488
711	**Coffee**	**0.116**	0.000	7611	7346	-1.633	0.474
1212	**Stripped Tobacco**	**0.115**	0.652	8980522	3006	-1.454	0.496
6851	**Unwrought Lead**	**0.115**	0.288	2520878	19561	-1.202	0.431
459	**Misc Unmilled Cereals**	**0.115**	0.424	1723956	10591	-1.389	0.489
112	**Sheep and Goat Meat**	**0.115**	0.000	0	26487	-1.476	0.415
577	**Nuts**	**0.114**	0.026	791107	7156	-1.968	0.473
2223	**Cotton Seeds**	**0.113**	0.357	205682	15284	-1.849	0.443
741	**Tea**	**0.113**	0.026	238643	5825	-2.141	0.461
6612	**Cement**	**0.113**	0.000	205	11660	-1.118	0.462
5541	**Soaps**	**0.112**	0.731	7740190	8613	-1.400	0.478
579	**Miscellaneous Fruit**	**0.112**	0.056	2518909	15875	-1.415	0.450
571	**Oranges**	**0.112**	0.086	1195070	14737	-1.437	0.478
470	**Non-Wheat Cereal Flour**	**0.112**	0.048	103153	8651	-1.100	0.488

Table 3. The most related products, in which Paraguay has RCAs below 1.

For a developing country like Paraguay, which aims at improving their productive structure and promoting inclusive growth, it is arguably not the best strategy to only focus on feasibility. Paraguay would then further focus on the export of some of the least complex and most ubiquitous products in the world, such as fruits, legumes, or nuts, and its productive structure would further move to the periphery of the product space (See also Figure 6).

If the economic agents of a country, comprised of companies, government, science and the civil society, put their efforts only in the easiest possible options, then that country runs the risk

[2] Average exports between 2012 and 2014

of staying or moving into a development trap where it becomes even harder to move into industries that allow for that country to generate and distribute more income. Paraguay would also move further into a development trap from which it is difficult to shift the economy towards more complex and inclusive type of products (see Figure 7). Thus, focusing on feasibility alone, is arguably the easiest, though probably the worst diversification strategy.

A glimpse on the product space of Paraguay indicates that the workforce and companies of Paraguay have indeed mastered and specialized in several more complex, inclusive and income generating products than the most feasible options outlined in this strategy. Thus, in the next strategy we focus on the products in which Paraguay already has intermediate levels of RCA.

Upgrading intermediate capabilities

The second strategy would move Paraguay's productive competences into products in which it already possesses intermediate RCA levels (see also Figure 6). Being able to produce and sell significant quantities of a product and thus achieving an intermediate RCA demonstrates the factual feasibility of this product in the respective country. A country may decide to further promote its existing, but still underperforming, products to achieve international competitiveness and reputation in these products. Table 4 shows that Paraguay has already intermediate advantages (0.5 < RCA <1) in a set of resource-based manufactures and textiles.

id	Description	RCA	Relatedness	Exports[3]	Prody	PCI	PGI
5232	**Metallic Salts**	**0.947**	0.093	18361009	13053	-0.418	0.461
585	**Fruit or Vegetable Juices**	**0.893**	0.109	21528388	14210	-1.044	0.441
6415	**Miscellaneous Paper**	**0.856**	0.070	33841549	29319	0.670	0.382
7731	**Electric Wire**	**0.837**	0.095	134333311	11653	-0.097	0.446
586	**Temporarily Preserved Fruit**	**0.835**	0.102	5057433	17214	-0.535	0.444
573	**Bananas**	**0.809**	0.124	11529955	11666	-2.131	0.459
5541	**Soaps**	**0.731**	0.112	7740190	8613	-1.400	0.478
6531	**Synthetic Woven Fabrics**	**0.721**	0.059	28404215	17823	-0.025	0.446
2632	**Cotton Linters**	**0.718**	0.121	125100	3702	-2.070	0.498
5411	**Vitamins**	**0.714**	0.076	5393062	33833	-0.030	0.398
8463	**Synthetic Knitted Undergarments**	**0.674**	0.105	24256882	11263	-0.966	0.437
2239	**Oil Seeds Flour**	**0.658**	0.087	1967049	14134	-1.083	0.470
1212	**Stripped Tobacco**	**0.652**	0.115	8980522	3006	-1.454	0.496
7219	**Misc. Agricultural Machinery**	**0.626**	0.075	6952979	32990	0.645	0.374
6515	**Retail Yarn of More Than 85% Synthetic Fiber**	**0.621**	0.080	339877	10237	-0.539	0.453
6522	**Finished Cotton Fabrics**	**0.580**	0.085	22959353	10667	-1.028	0.481
980	**Miscellaneous Edibles**	**0.563**	0.097	51765543	21111	-0.307	0.412
5121	**Acyclic Alcohols**	**0.514**	0.100	29171280	21192	-1.082	0.470
1223	**Tobacco Substitutes**	**0.510**	0.095	4004789	17104	-0.498	0.431
5823	**Polyesters**	**0.505**	0.076	31859585	26729	0.347	0.420

Table 4. Products in which Paraguay has intermediate levels of Revealed Comparative Advantages.

[3] Average exports between 2012 and 2014

It must be noted that several, but not all, of the best products in this strategy have higher levels of income (i.e. PRODYS) associated with these products in comparison with the products of the first strategy. Therefore, this strategy of further upgrading intermediate capabilities is arguably a better strategy than only focusing on the most related options. Yet, not all of these feasible products in which Paraguay may have the ability to gain revealed comparative advantages (RCA >= 1) are necessarily the most desirable options in terms of the income, complexity and inequality related to these options. For this purpose, we combine in the next two strategies feasibility with desirability considerations.

Diversification into related higher-income products

The third strategy aims to focus on the diversification into feasible products that offer a high expected level on income associated with the respective new products. Thus, this strategy searches for a trade-off between feasibility and desirability in term of income. For this purpose, we identify the top twenty products which have a minimum level of feasibility (0.05 < RCA < 1, and Relatedness > 0.05) and a high level of income associated with them (Prody > 29725) (see Table 5).

id	Description	Relatedness	RCA	Prody	Exports[4]	PCI	PGI
3413	**Liquified Petroleum Gases**	**0.103**	**0.124**	**53356**	34778799	-2.315	0.488
5416	**Glycosides and Vaccines**	**0.060**	**0.075**	**46247**	13553265	1.335	0.351
5148	**Other Nitrogen Function Comp.**	**0.058**	**0.066**	**42613**	3198579	1.555	0.368
5839	**Misc. Polymerization Products**	**0.051**	**0.068**	**42494**	7063438	1.607	0.385
5831	**Polyethylene**	**0.086**	**0.341**	**39454**	37868038	0.090	0.417
7188	**Miscellaneous Engines**	**0.062**	**0.178**	**36110**	5515600	1.260	0.363
7272	**Misc. Food-Processing Machinery**	**0.069**	**0.179**	**35240**	3826567	0.831	0.363
0488	**Malt Extract**	**0.087**	**0.051**	**35125**	1415632	-0.039	0.391
0113	**Pig Meat**	**0.078**	**0.405**	**34898**	19070839	0.518	0.377
5139	**Oxygen-Function Acids**	**0.080**	**0.442**	**34109**	4964519	0.192	0.390
7441	**Factory Trucks**	**0.059**	**0.068**	**33834**	2160149	1.248	0.365
5411	**Vitamins**	**0.076**	**0.714**	**33833**	5393062	-0.030	0.398
5922	**Glues**	**0.084**	**0.374**	**33279**	12476311	0.366	0.398
7219	**Misc. Agricultural Machinery**	**0.075**	**0.626**	**32990**	6952979	0.645	0.374
8942	**Toys and Games**	**0.057**	**0.107**	**32736**	10121822	0.942	0.373
5111	**Acyclic Hydrocarbons**	**0.064**	**0.077**	**32729**	2994700	0.387	0.403
5417	**Medicaments**	**0.086**	**0.260**	**32509**	134054143	0.381	0.385
6572	**Bonded Fiber Fabrics**	**0.060**	**0.281**	**31042**	5920578	1.065	0.386
0230	**Butter**	**0.097**	**0.392**	**30768**	4684123	-0.346	0.401
7211	**Soil Preparation Machinery**	**0.089**	**0.277**	**29726**	3542140	0.426	0.380

Table 5 - Best options based on Prody, RCA and relatedness

This strategy is in line with work emphasizing the income related to products (e.g. Rodrik, 2006; Hausmann et al., 2006; Lin & Monga, 2011). This strategy does not yet deliberately consider the likely effect on income inequality and complexity of the economy. It must be noted

[4] Average exports between 2012 and 2014

that many, but not all, of the high-income products are also complex and inclusive. Some high-income products (such as petroleum) can even lead to a development trap and hamper efforts to build up knowledge in more complex parts of the product space.

Diversification into complex and inclusive products

The fourth strategy aims to strategically move beyond primary and resource-based manufactures towards more complex and inclusive products. For this purpose, we identify products that achieve a minimum standard in all feasibility (Relatedness > 0.05 and 0.05 <= RCA < 1) and desirability criteria. For this most progressive strategy we do not consider primary products or agro-based manufactures (see Table S1 in the appendix). Moreover, we only consider products with a certain minimum standard with respect to complexity (PCI > 0), inequality (PGI < 0.405), income (Prody > 16200), and the export size of this product (1 million USD). This strategy reveals that Paraguay has opportunities for economic diversification in a set of chemical products (such as medicaments and vaccines) as well as in the production of manufactures and machinery related to agricultural and textile industries (such as harvesting machines) (see Table 6).

id	Description	Relatedness	RCA	Exports	Prody	PCI	PGI
5417	**Medicaments**	**0.086**	**0.260**	**134054143**	**32509**	**0.381**	**0.385**
8720	**Medical Instruments**	**0.075**	**0.193**	**27564407**	**26175**	**0.592**	**0.400**
8211	**Chairs and Couches**	**0.087**	**0.216**	**22294017**	**17227**	**0.251**	**0.398**
5416	**Glycosides and Vaccines**	**0.060**	**0.075**	**13553265**	**46247**	**1.335**	**0.351**
8942	**Toys and Games**	**0.057**	**0.107**	**10121822**	**32736**	**0.942**	**0.373**
5839	**Misc. Polymerization Products**	**0.051**	**0.068**	**7063438**	**42494**	**1.607**	**0.385**
7219	**Misc. Agricultural Machinery**	**0.075**	**0.626**	**6952979**	**32990**	**0.645**	**0.374**
6572	**Bonded Fiber Fabrics**	**0.060**	**0.281**	**5920578**	**31042**	**1.065**	**0.386**
7212	**Harvesting Machines**	**0.079**	**0.176**	**5650084**	**29451**	**0.783**	**0.385**
5335	**Glazes**	**0.070**	**0.278**	**5523116**	**27260**	**0.917**	**0.387**
7188	**Miscellaneous Engines**	**0.062**	**0.178**	**5515600**	**36110**	**1.260**	**0.363**
5139	**Oxygen-Function Acids**	**0.080**	**0.442**	**4964519**	**34109**	**0.192**	**0.390**
7272	**Misc. Food-Processing Machinery**	**0.069**	**0.179**	**3826567**	**35240**	**0.831**	**0.363**
7211	**Soil Preparation Machinery**	**0.089**	**0.277**	**3542140**	**29726**	**0.426**	**0.380**
7822	**Special Purpose Trucks and Vans**	**0.067**	**0.152**	**3243138**	**29163**	**0.031**	**0.391**
7754	**Shavers and Hair Clippers**	**0.050**	**0.468**	**2332444**	**29627**	**1.331**	**0.361**
7441	**Factory Trucks**	**0.059**	**0.068**	**2160149**	**33834**	**1.248**	**0.365**
7621	**Vehicles Stereos**	**0.053**	**0.137**	**2148037**	**21349**	**0.713**	**0.404**
6996	**Misc. Articles of Base Metals**	**0.089**	**0.089**	**1963509**	**21858**	**0.224**	**0.399**
8921	**Printed Books and Maps**	**0.082**	**0.068**	**1866781**	**23659**	**0.272**	**0.392**
7169	**Misc. Rotating Electric Plant Parts**	**0.074**	**0.061**	**1799693**	**26729**	**0.940**	**0.378**

Table 6. Products with minimum standards in all categories, and excluding primary and agro-based manufactures

This is arguably both the most risky and progressive strategy. It would push the product space of Paraguay into the more complex and inclusive parts of the product space (See Figure 6).

Yet, it also implies the need to have more skilled labor, promote the establishment of knowledge-based companies in Paraguay, and establish a learning society in which industry, government, science and the civil society interact and learn from each other. Nonetheless, the identified industries are within the possibility space of Paraguay. In-depth case studies in these industries are necessary to identify which training and education programs, additional infrastructures and FDI attraction programs may be appropriate to move into or upgrade the presence in these industries. As a caveat, it must also be noted that deliberate emphasis on linking less educated and poor segments of the society to these potential new growth sectors may also be necessary, to prevent further increases of structural heterogeneity within the society.

Estimating the development directions and effects of the four diversification strategies

Here we assess the implications of each of the strategies by, firstly, looking at how the product space of Paraguay would change and, secondly, by evaluating how this change would impact the average Prody, PGI and PCI of the new product basket of Paraguay. For the sake of simplicity, we assume that Paraguay is able to achieve Relative Comparative Advantages (RCAs) in the identified products of each respective strategy. Moreover, we estimate the impact that developing such products would have in the EXPY, XGINI, and ECI (see Hausmann et al., 2006; Hartmann et al., 2016, and Hidalgo & Hausmann, 2009) by doing a simple average of the PRODY, PGI and PCI of the productive structure of Paraguay after developing such products[5].

[5] The simple average of the PRODY, PGI and PCI is strongly correlated with the EXPY, XGINI and ECI respectively. Hence, its analysis holds the same qualitative value.

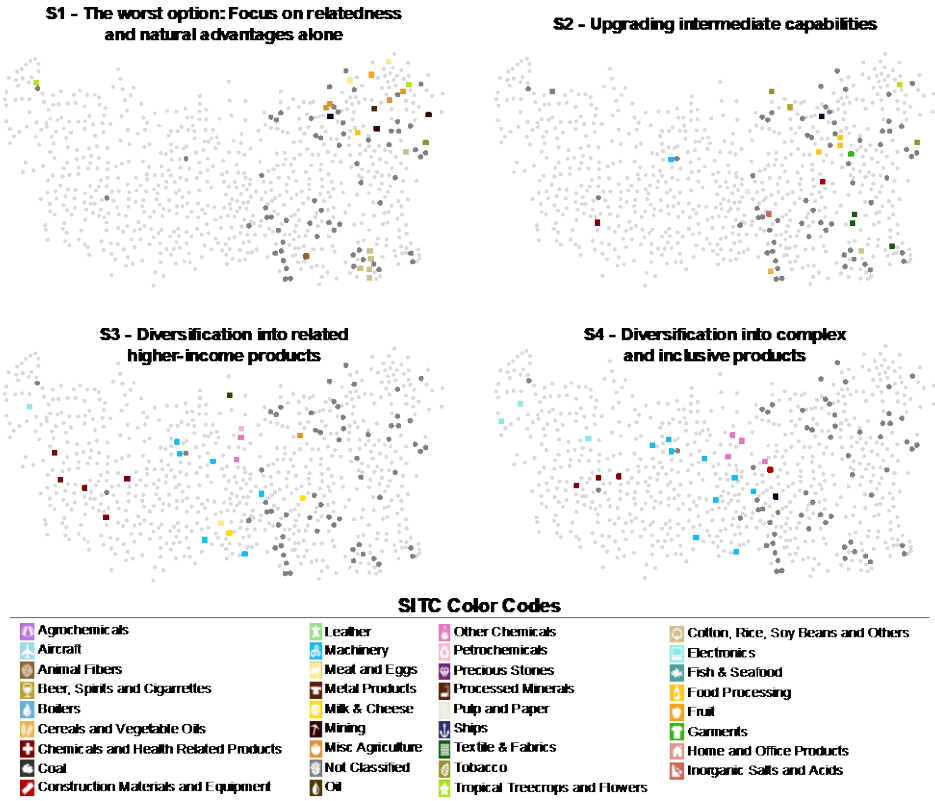

Figure 6. How a successful implementation of the strategies S1-4 might change Paraguay's productive structure respectively. Source: atlas.media.mit.edu and own calculations

Strategy 1 would further push the productive structure of Paraguay into the periphery of the product space, in this case towards simple agricultural products (in the top right quadrant of the product space, see Figure 6). This is the worst strategy as it would decrease the average income (Prody) and complexity (PCI), and increase the inequality (PGI) of the products that Paraguay produces (See Figure 7).

Strategy 2 would only slightly change the current productive structure of Paraguay, the average income associated with Paraguay's products would slightly increase, the average complexity would stagnate, and the inequality associated with the products would stagnate or very slightly increase (see Figure 6 and Figure 7).

Strategy 3 would increase the expect income associated with Paraguay's products, the average inequality would stagnate or very slightly decrease, the average complexity would decrease, but also new areas of the product space would be reached which can have positive effects on the long-run diversification and sophistication of Paraguay's economy (see Figure 6 and Figure 7).

Strategy 4 would significantly increase the level of income, complexity and equality associated with the product portfolio of Paraguay. Moreover, it would bring Paraguay further towards more complex and inclusive sectors (see Figure 6 and Figure 7). This would be the most beneficial, but arguably also difficult strategy.

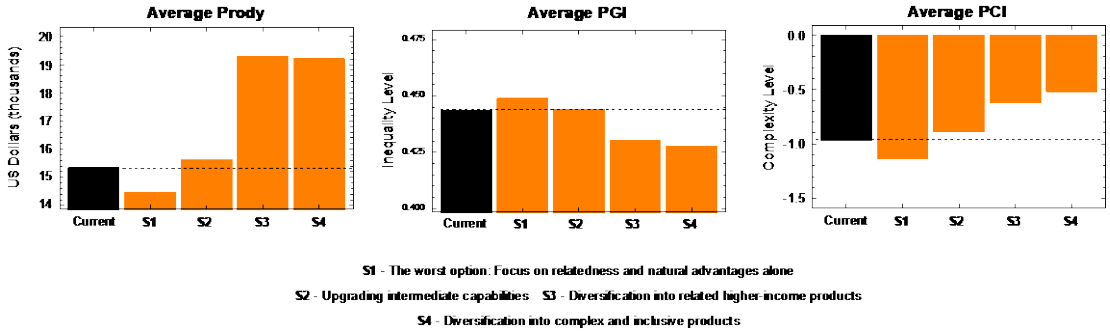

Figure 7. How a successful implementation of the strategies S1-4 would change the average PRODY, PGI and PCI of Paraguay

5 Discussion

In this article, we developed an analytical framework to identify smart strategies for economic diversification and inclusive growth, and applied this framework to the case of Paraguay. This framework is a significant advance, because it helps to reveal each country's feasible opportunities to diversify its productive structures, while also considering the weight that each country puts on different socioeconomic goals. In consequence, it may help to facilitate a democratic debate about the minimum standards that each country assigns to different socioeconomic goals (Sen, 1999). At same time our analysis not omit the structural constraints imposed by the productive structure and capabilities of each country. Additionally, the analytical framework helps to estimate the likely development directions and effects of different diversification strategies.

We discussed four (out of many) possible diversification strategies for the case of Paraguay: the first strategy focuses only on the diversification into the most related products. The second strategy focuses on products that have already intermediate RCAs. The third strategy focuses on related products that are associated with high levels of income of the countries exporting them. Finally, the fourth strategy establishes minimum standards regarding all feasibility and desirability criteria, including income, complexity, technology and equality. The worst strategy in terms of the expected level of income, complexity and equality would be solely focusing on feasibility criteria. This strategy would move Paraguay's productive structure further towards simple agricultural products and thus parts of the product space from which it very difficult to move into more complex and high-value added products. Arguably the best strategy, would be promoting the economic diversification towards several manufacturing products (like harvesting machines) and chemical products (like cosmetics and medicaments). This strategy, if successfully implemented, could help to improve the average level of expected income, complexity and equality.

However, several limitations of our study need to be taken into account. Firstly, the productive structure is a significant factor, but it is not the only factor explaining income, complexity and

income inequality (Hartmann et al., 2016; Hartmann et al., 2017). Other important factors such as institutions, demand structures, geography, technological change, and innovation capabilities need to be taken into account and studied in more detail (Sachs, 2005; Collier, 2007; Acemoglu & Robinson, 2012; Bezerra, 2013; Romero & Britto, 2016; Romero & McCombie, 2016, Brynjollfson & McAfee, 2012; Frey & Osborne, 2017).

Secondly, the analysis in this article is based on export data which is a decent, yet imperfect, proxy for the productive structure and capabilities of a country. Services or the large informal economy of Paraguay are not included in our analysis. Moreover, we use export data according to the Standard Industrial Trade Classification (SITC) which allows for the analysis of a relatively long periods of time, yet the results could be triangulated with BACI dataset that considers customs and tariffs issues (Gaulier, G., & Zignago, S., 2010).

Thirdly, potential negative effects of industries, such as negative environmental or employment effects, need to be carefully evaluated and may require additional institutional consideration and appropriate regulations. For this purpose, qualitative methods such as expert interviews, multi-criteria mapping or scenario building could complement the results of quantitative analysis presented here (González et al., 2018; Coburn & Stirling, 2017).

From a policy perspective, our analysis provides valuable information about which precise export products may be feasible and desirable for Paraguay. This is an important step forward from the understanding that economic diversification may be useful towards effective policy measures. Yet to successfully venture into the identified industries, a smart combination of industrial, innovation and social policies and interactive learning between different segments of the society is necessary. For instance, cluster policies and the establishment of technology parks can help to promote the interactive learning between science and industry. It is important to note, though, is that mere emphasis on picking winners may lead to further structural heterogeneity and inequality within developing countries. Thus, deliberate emphasis on creating linkages between new industries, cluster and the local economy is necessary. Moreover, research on innovation systems in developing countries has shown that in unequal and economically less advanced countries, a simultaneous policy emphasis on human development and innovation may be necessary to establish prolific systems of competence building and innovation, and successfully venture into new industries (Johnson et al., 2004; Lundvall et al., 2011; Hartmann, 2014). Moreover, the cases of high performing East-Asian economies have shown that successful technological upgrading and economic sophistication may require a smart combination of industrial and social policies (Stiglitz, 1996; Ranis et al., 2000; Amsden, 2010; Hartmann, 2014; Hartmann et al., 2016, Hartmann et al., 2017). This includes a smart mix of policy incentives in new industries as well as investing in the education of the required skills and research in these industries.

Finally, in regions with very little previous knowledge in more advanced industries, new sources of knowledge and unrelated variety growth may be necessary to start recombinant growth process and overcome a potential economic development trap. In this regard, a smart strategy of promoting back- and forth knowledge migration, commuting entrepreneurs and international innovation network with regions and countries that have technological capabilities in the feasible and desirable industries (Hartmann & Buchmann, 2016; Pyka et al, 2016; Bahar & Rapoport, 2016). Thereby, deliberate incentives for commuting entrepreneurs to create knowledge based linkages or even multinational companies between their home and host region may help to reduce the negative effects of brain drain. All these measures together may help to establish prolific innovations system and facilitate the economic diversification and sophistication of the country.

Despite all limitations and necessary additional steps, our analytical framework provides relevant information on the structural constraints and opportunities for smart and inclusive diversification of economies. Revealing structural opportunities for smart and inclusive growth is especially relevant for economies whose productive structure is strongly dependent on primary goods and resource-based manufactures, as it is in the case of Paraguay. Our results indicate that despite the fact that Paraguay is strongly dependent on primary and agro-based products, it also has significant opportunities to diversify into more complex, inclusive, and high-income products. This includes chemical products (such as medicaments, glycosides and vaccines) and manufacturing products related to agricultural activities (such as machines for harvesting or food-processing).

Finally, our analytical framework implies that instead of maximizing single goals, establishing minimum standards regarding both different feasibility and desirability criteria of new products may be a smart strategy to identify prolific diversification opportunities and to promote inclusive growth.

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6 References

Acemoglu, D., & Robinson, J. (2012). Why Nations Fail: The Origins of Power, Prosperity, and Poverty. New York: Crown.

Alshamsi, A., Pinheiro, F. L., & Hidalgo, C. A. (2018). Optimal diversification strategies in the networks of related products and of related research areas. Nature communications, 9(1), 1328.

Amsden, A. 2010. 'Say's Law, Poverty Persistence, and Employment Neglect'. Journal of Human Development and Capabilities, 11(1): 57–66.

Asociación PRO Desarrollo Paraguay. (2016). Economía Subterránea: el Caso Paraguayo, 4ª. Edicion, Asunción

Bahar, D., & Rapoport, H. (2016). Migration, knowledge diffusion and the comparative advantage of nations.

Bahar, D., & Santos, M. A. (2016). Natural Resources and Export Concentration: On the Most Likely Casualties of Dutch Disease (No. 68). Center for International Development at Harvard University.

Balassa, B. (1965). Trade Liberalisation and "Revealed" Comparative Advantage1. The Manchester School, 33(2), 99–123.

Balland, P. A., Boschma, R. A., Crespo, J., & Rigby, D. L. (2017). Smart Specialization policy in the EU: Relatedness, Knowledge Complexity and Regional Diversification.

Bezerra, M. (2013). Gargalos ao desenvolvimento das atividades intensivas em conhecimento em regioes perifericas: os APLs de software da Paraiba e Pernambuco. Tese de Doutorado, Instituto de Economia – Universidade Federal do Rio de Janeiro, 2013.

Bourguignon, F. (2004). The Poverty-growth-inequality triangle (Indian Council for Research on International Economic Relations, New Delhi Working Paper No. 125). Indian Council for Research on International Economic Relations, New Delhi, India.

Brynjolfsson, E., & McAfee, A. (2012). Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy. Lexington, MA: Digital Frontier Press.

Coburn, J., & Stirling, A. (2016). Multicriteria mapping manual-version 2.0.

Collier, P. (2007). The Bottom Billion: Why the Poorest Countries are Failing and What Can Be Done About It. New York: Oxford Univ. Press.

Constantine, C. (2017). Economic structures, institutions and economic performance. Journal of Economic Structures, 6(1), 2.

Constantine, C., & Khemraj, T. (2017). Geography, Economic Structures and Institutions: A Synthesis.

Cristelli, M., Gabrielli, A., Tacchella, A., Caldarelli, G., & Pietronero, L. (2013). Measuring the intangibles: A metrics for the economic complexity of countries and products. PLoS One, 8(8), e70726.

Cristelli, M., Tacchella, A., & Pietronero, L. (2015). The heterogeneous dynamics of economic complexity. PloS one, 10(2), e0117174.

Davis, G. F. (2009). Managed by the Markets: How Finance Re-Shaped America. Oxford: Oxford Univ. Press.

Deininger, K., & Squire, L. (1998). New ways of looking at old issues: inequality and growth. Journal of Development Economics, 57(2), 259–287.

Engerman, S. L., & Sokoloff, K. L. (1997). Factor endowments, institutions, and differential paths of growth among new world economies. In S. H. Haber (Ed.), How Latin America Fell Behind: Essays on the Economic Histories of Brazil and Mexico, 1800-1914 (pp. 260–304). California: Stanford Univ. Press.

Fajnzylber, F. (1990). Industrialization in Latin America: from the 'Black Box' to the 'Empty Box': a Comparison of Contemporary Industrialization Patterns. Cuadernos de la CEPAL, No. 60, 1990-08,

Feenstra, R.C., Inklaar, R., & M.P. Timmer (2015). The Next Generation of the Penn World Table, American Economic Review, 105(10), 3150-3182, available for download at www.ggdc.net/pwt

Felipe, J. (2009). Inclusive Growth, Full Employment and Structural Change: Implications and Policies for Developing Asia. London: Anthem Press.

Fields, G. S. (2001). Distribution and Development: a new look at the developing world, Russell Sage Foundation. New York, and The MIT Press, Cambridge, Massachusetts, and London.

Frenken, K., & Boschma, R. (2007). A theoretical framework for evolutionary economic geography: industrial dynamics and urban growth as a branching process, Journal of Economic Geography, 7(5): 635–649

Frenken, K., Oort, F. V., & Verburg, T. (2007). Related variety, unrelated variety and regional economic growth. Regional Studies, 41(5), 685–697.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: how susceptible are jobs to computerisation? Technological Forecasting and Social Change, 114, 254-280

Furtado, Celso. 1959. "Formação Econômica Do Brasil." RJ: Fundo de Cultura

Gala, P., Camargo, J., & Freitas, E. (2017). The Economic Commission for Latin America and the Caribbean (ECLAC) was right: scale-free complex networks and core-periphery patterns in world trade. Cambridge Journal of Economics.

Gala, P., Camargo, J., Magacho, G., & Rocha, I. (2017). Sophisticated jobs matter for economic development: an empirical analysis based on input-output matrices and economic complexity.

Galbraith, J. K., Halbach, Béatrice, Malinowska, A., Shams, Amin, & Zhang, W. (2014). UTIP Global Inequality Data Sets 1963-2008: Updates, Revisions and Quality Checks (Working Paper No. 68). University of Texas at Austin. Retrieved from http://utip.gov.utexas.edu/papers/UTIP_68.pdf

Gaulier, G., & Zignago, S. (2010). Baci: international trade database at the product-level (the 1994-2007 version).

González, A., Ortigoza, E., Llamosas, C., Blanco, G., & Amarilla, R. (2018). Multi-criteria analysis of economic complexity transition in emerging economies: The case of Paraguay. Socio-Economic Planning Sciences.

Guevara, M., Hartmann D., & Mendoza, M. (2016): "diverse": Diversity Measures for Complex Socioeconomic Systems, The R Journal, 8(2), 60-78

Guevara, M., Hartmann, D., Aristaran, M., Mendoza, M., & Hidalgo, C. (2016): The Research Space: using the career paths of scholars to predict the evolution of the research output of individuals, institutions, and nations, Scientometrics, 103.9, 1695-1709

Hartmann, D. (2014): Economic Complexity and Human Development. How Economic Diversification and Social Networks Affect Human Agency and Welfare. Routledge Studies in Development Economics, Routledge: London and New York

Hartmann, D. (2016). The economic diversification and innovation system of Turkey from a global comparative perspective, in Pyka, A., Kustepeli, Y. & Hartmann, D. (2016, eds.). International Innovation Networks and Knowledge Migration – The German-Turkish nexus, Routledge Lisbon Civic Forum Studies in Innovation

Hartmann, D., Bezerra, M., Lodolo, B. & Pinheiro, F.L. (2019). International Trade, Development Traps, and the Core-Periphery Structure of Income Inequality. Available at SSRN: https://ssrn.com/abstract=3312097 or http://dx.doi.org/10.2139/ssrn.3312097

Hartmann, D., & Buchmann, T. (2016). The comparative technological advantages and international patent network of Turkey and Germany, in Pyka, A., Kustepeli, Y. and Hartmann, D. (2016, eds.). International Innovation Networks and Knowledge Migration – The German-Turkish nexus, Routledge Lisbon Civic Forum Studies in Innovation

Hartmann, D., Guevara, M., Jara-Figueroa, C., Aristarán, M., & Hidalgo, C. A. (2017): Linking Economic Complexity, Institutions and Income Inequality, World Development, Vol. 93, 75-93

Hartmann, D., Jara-Figueroa, C., Guevara, M., Simoes, A., & Hidalgo, C.A. (2016). The structural constraints of income inequality in Latin America, Integration & Trade Journal, No. 40, Inter-American Development Bank

Hartmann, D., & Pyka, A. (2013). Innovation, economic diversification and human development. FZID discussion papers, 65

Hausmann, R., Hidalgo, C. A., Bustos, S., Coscia, M., Simoes, A., & Yildirim, M. A. (2014). The Atlas of Economic Complexity: Mapping Paths to Prosperity. MIT Press.

Hausmann, R., Hwang, J., & Rodrik, D. (2006). What you export matters. Journal of Economic Growth, 12(1), 1–25.

Hidalgo, C., & Hartmann, D. (2017). Economic Complexity, Institutions and Income Inequality, OECD

Hidalgo, C. A., & Hausmann, R. (2009). The building blocks of economic complexity. Proceedings of the National Academy of Sciences, 106(26), 10570–10575. http://doi.org/10.1073/pnas.0900943106

Hidalgo, C. A., Klinger, B., Barabási, A. L., & Hausmann, R. (2007). The product space conditions the development of nations. Science, 317(5837), 482-487.

Hirschman, A. O. (1958). The Strategy of Economic Development (Vol. 10). New Haven: Yale Univ. Press.

Imbs, J., & Wacziarg, R. (2003). Stages of diversification. The American Economic Review, 93(1), 63–86.

Johnson, B., Edquist, C., & Lundvall, B. Å. (2004). Economic development and the national system of innovation approach. Georgia Institute of Technology.

Kuznets, S. (1934). National Income, 1929-1932. In National Income, 1929-1932 (pp. 1–12). NBER.

Kuznets, S. (1973). Modern economic growth: findings and reflections. The American Economic Review, 63(3), 247–258.

Lall, S. (2000). The Technological structure and performance of developing country manufactured exports, 1985-98. Oxford development studies, 28(3), 337-369.

Lall, S., Weiss, J., & Zhang, J. (2006). The ‘‘sophistication” of exports: A new trade measure. World Development, 34(2), 222–237.

Leontief, W. W. (1951). Input-output economics. Scientific American, 185(4), 15–21.

Lin, J., & Monga, C. (2011). Growth Identification and Facilitation: The Role of the State in the Dynamics of Structural Change’. Development Policy Review, 29 (3): 264–90.

Lundvall, B. A., Dosi, G., & Freeman, C. (1988). Innovation as an interactive process: from user-producer interaction to the national system of innovation. 1988, 349-369.

Lundvall, B. Å., Joseph, K. J., Chaminade, C., & Vang, J. (Eds.). (2011). Handbook of innovation systems and developing countries: building domestic capabilities in a global setting. Edward Elgar Publishing.

Neffke, F., & Henning, M. (2013). Skill relatedness and firm diversification. Strategic Management Journal, 34(3), 297-316.

Neffke, F., Henning, M., & Boschma, R. (2011). How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. Economic Geography, 87(3), 237-265.

Palma, J. G. (2011). Homogeneous middles vs. heterogeneous tails, and the end of the "Inverted-U": It's all about the share of the rich. Development and Change, 42(1), 87–153.

Petralia, S., Balland, P. A., & Morrison, A. (2017). Climbing the ladder of technological development. Research Policy, 46(5), 956-969.

Piketty, T. (2017). Capital in the twenty-first century. Harvard University Press.

Pinheiro, F. L., Alshamsi, A., Hartmann, D., Boschma, R., & Hidalgo, C. (2018). Shooting Low or High: Do Countries Benefit from Entering Unrelated Activities?. arXiv preprint arXiv:1801.05352.

Prebisch, R. 1949. The Economic Development of Latin America and Its Principal Problems. UN.

Pyka, A., Kustepeli, Y., & Hartmann, D. (2016, eds.): International Innovation Networks and Knowledge Migration – The German-Turkish nexus, Routledge Lisbon Civic Forum Studies in Innovation, Routledge: London and New York

Ramos Martínez, A., Michalczewsky, K., Iannuzzi, P., & Gayá, R. (2015). Metodología de registro de comercio exterior de bienes y regímenes especiales de comercio: Centroamérica y República Dominicana. Inter-American Development Bank

Ranis, G., Stewart, F., & Ramirez, A. (2000). Economic Growth and Human Development'. World Development, 28 (2): 197–219.

Ravallion, M. (2004). Pro-Poor Growth: A Primer (Policy Research Working Paper No. ID 610283). World Bank.

Rodrik, D. (2004). Industrial policy for the twenty-first century.

Rodrik, D. (2006). What's so special about China's exports? China & World Economy, 14(5), 1–19.

Romero, J. P., & Britto, G. (2017). Increasing returns to scale, technological catch-up and research intensity: endogenising the Verdoorn coefficient. Cambridge Journal of Economics, 41(2), 391-412.

Romero, J. P., & McCombie, J. S. (2016). Differences in increasing returns between technological sectors: A panel data investigation using the EU KLEMS database. Journal of Economic Studies, 43(5), 863-878.

Rosenstein-Rodan, P. N. (1943). Problems of industrialisation of eastern and south-eastern Europe. The Economic Journal, 53(210/211), 202–211.

Sachs, J. (2005). The End of Poverty: How We Can Make it Happen in Our Lifetime. New York: Penguin Books Limited.

Saviotti, P. P. (1996). Technological Evolution, Variety and the Economy. Cheltenham, UK: Edward Elgar.

Saviotti, P. P., & Pyka, A. (2004). Economic Development by the Creation of New Sectors. Journal of Evolutionary Economics, 14(1): 1–35.

Saviotti, P. P., & Frenken, K. (2008). Export variety and the economic performance of countries. Journal of Evolutionary Economics, 18(2), 201–218.

Sen, A. (1999). The possibility of social choice. The American Economic Review, 89(3), 349-378.

Simoes, A. J. G., & Hidalgo, C. A. (2011). The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development. In Scalable Integration of Analytics and Visualization.

Singer, H. W. (1950). The distribution of gains between investing and borrowing countries. The American Economic Review, 40(2), 473–485.

Solt, Frederick. (2016). "The Standardized World Income Inequality Database." Social Science Quarterly 97(5):1267-1281.

Stiglitz, J. E. (1996). Some lessons from the East Asian miracle. The World Bank Research Observer, 11(2), 151–177. http://doi.org/10.1093/wbro/11.2.151

Stiglitz, J. E. (2013). The Price of Inequality: How Today's Divided Society Endangers Our Future (1 edition). New York: W. W. Norton.

Stiglitz, J., Sen, A. K., & Fitoussi, J.-P. (2009, December). The measurement of economic performance and social progress revisited: reflections and overview. Retrieved from https://hal-sciencespo.archives-ouvertes.fr/hal-01069384/document

Tacchella, A., Cristelli, M., Caldarelli, G., Gabrielli, A., & Pietronero, L. (2012). A new metrics for countries' fitness and products' complexity. Scientific reports, 2, 723.

Vargas, J. P. M. (2015). Informality in Paraguay: Macro-Micro Evidence and Policy Implications, IMF Working Papers, WP/15/245

Wade, R. (1990). Governing the market: Economic theory and the role of government in East Asian industrialization. Princeton University Press.

Weitzman, M. L. (1998). Recombinant Growth. Quarterly Journal of Economics, 113:331–60.

Zhu, S., He, C., & Zhou, Y. (2017). How to jump further and catch up? Path-breaking in an uneven industry space. Journal of Economic Geography, 17(3), 521–545.

Appendix A

List of Primary Goods and Resource Based Manufactures

Primary Products		**Resource Based: Agro-Based**	
001	LIVE ANIMALS FOR FOOD	012	MEAT DRIED,SALTED,SMOKED
011	MEAT FRESH, CHILLED, FROZEN	014	MEAT PREPD,PRSVD,NES ETC
022	MILK AND CREAM	023	BUTTER
025	EGGS, BIRDS, FRESH,PRESERVED	024	CHEESE AND CURD
034	FISH, FRESH, CHILLED, FROZEN	035	FISH SALTED,DRIED,SMOKED
036	SHELL FISH FRESH, FROZEN	037	FISH ETC PREPD,PRSVD NES
041	WHEAT ETC UNMILLED	046	WHEAT ETC MEAL OR FLOUR
042	RICE	047	OTHER CEREAL MEALS,FLOUR
043	BARLEY UNMILLED	048	CEREAL ETC
044	MAIZE UNMILLED	056	VEGTBLES ETC PRSVD,PREPD
045	CEREALS NES UNMILLED	058	FRUIT PRESERVED,PREPARED
054	VEG ETC FRSH,SMPLY PRSVD	061	SUGAR AND HONEY
057	FRUIT, NUTS, FRESH, DRIED	062	SUGAR CANDY NON-CHOCLATE
071	COFFEE AND SUBSTITUTES	073	CHOCOLATE AND PRODUCTS
072	COCOA	098	EDIBLE PRODCTS,PREPS NES
074	TEA AND MATE	111	NON-ALCOHL BEVERAGES NES
075	SPICES	112	ALCOHOLIC BEVERAGES
081	FEEDING STUFF FOR ANIMLS	122	TOBACCO,MANUFACTURED
091	MARGARINE AND SHORTENING	233	RUBBER,SYNTHTIC,RECLAIMD
121	TOBACCO UNMNFCTRD,REFUSE	247	OTH WOOD ROUGH,SQUARED
211	HIDES,SKINS,EXC FURS,RAW	248	WOOD SHAPED,SLEEPERS
212	FURSKINS,RAW	251	PULP AND WASTE PAPER
222	SEEDS FOR SOFT FIXED OIL	264	JUTE,OTH TEX BAST FIBRES
223	SEEDS FOR OTH FIXED OILS	265	VEG FIBRE,EXCL COTN,JUTE
232	NATURAL RUBBER,GUMS	269	WASTE OF TEXTILE FABRICS
244	CORK,NATURAL,RAW,WASTE	423	FIXED VEG OILS,SOFT
245	FUEL WOOD NES, CHARCOAL	424	FIXED VEG OIL NONSOFT
246	PULPWOOD,CHIPS,WOODWASTE	431	PROCESD ANML VEG OIL,ETC
261	SILK	621	MATERIALS OF RUBBER
263	COTTON	625	RUBBER TYRES, TUBES ETC
268	WOOL(EXC TOPS),ANML HAIR	628	RUBBER ARTICLES NES
271	FERTILIZERS,CRUDE	633	CORK MANUFACTURES
273	STONE,SAND AND GRAVEL	634	VENEERS,PLYWOOD,ETC
274	SULPHUR,UNRSTD IRN PYRTE	635	WOOD MANUFACTURES NES
277	NATURAL ABRASIVES NES	641	PAPER AND PAPERBOARD

278	OTHER CRUDE MINERALS		
291	CRUDE ANIMAL MTRIALS NES	**Resource Based: Other**	
292	CRUDE VEG MATERIALS NES	281	IRON ORE,CONCENTRATES
322	COAL,LIGNITE AND PEAT	282	IRON AND STEEL SCRAP
333	CRUDE PETROLEUM	286	URANIUM,THORIUM ORE,CONC
341	GAS,NATURAL AND MANUFCTD	287	BASE METAL ORES,CONC NES
681	SILVER,PLATINUM,ETC	288	NONFERR METAL SCRAP NES
682	COPPER EXC CEMENT COPPER	289	PREC MTAL ORES,WASTE NES
683	NICKEL	323	BRIQUETS,COKE,SEMI-COKE
684	ALUMINIUM	334	PETROLEUM PRODUCTS,REFIN
685	LEAD	335	RESIDUAL PETRLM PROD NES
686	ZINC	411	ANIMAL OILS AND FATS
687	TIN	511	HYDROCARBONS NES,DERIVS
		514	NITROGEN-FNCTN COMPOUNDS
9710	GOLD	515	ORG-INORG COMPOUNDS ETC
		516	OTHER ORGANICCHEMICALS
		522	INORG ELEMNTS,OXIDES,ETC
		523	OTHR INORGCHEMICALS
		531	SYNT DYE,NATINDGO,LAKES
		532	DYES NES,TANNINGPROD
		551	ESSENTL OILS,PERFUME,ETC
		592	STARCH,INULIN,GLUTEN,ETC
		661	LIME,CEMENT,BLDG PRODS
		662	CLAY,REFRACTORY BLDGP
		663	MINERAL MANUFCTURESNES
		664	GLASS
		667	PEARL,PREC-,SEMI-P STONE
		688	URANIUM,THORIUM,ALLOYS
		689	NON-FER BASEMETALS

Table A1. Primary Goods and Resource Based Manufactures according to Lall (2000) and Bahar and Santos (2015), we added gold 9710 as primary good

Paraguay's productive portfolio in comparison with neighboring countries and countries with a similar population size

Country	ECI	EXPY	XGINI	Population (Millions)
Paraguay	-0.98	-1.04	41.74	6.55
Argentina	-0.51	-0.82	40.36	42.98
Bolivia	-1.19	-1.51	41.46	10.56
Brazil	-0.19	-1.20	40.35	206.08
Uruguay	-0.34	-0.94	40.05	3.41
Hong Kong	1.26	0.38	39.73	7.22
Bulgaria	0.27	-0.33	37.85	7.20
Slovenia	-0.01	-0.66	40.36	6.10
Nicaragua	-0.94	-1.11	41.64	6.01

Table A2. ECI, EXPY, XGINI and population of Paraguay and comparative countries which are either spatially close or have a similar population size

Paraguay has a low number of products (61 out 763) in which it has reveal comparative advantages (See Table A3). Moreover, it has a very low number of products (6) for which it has already a dense network of related products with RCAs (i.e. with a density greater than 0.12).

Country	Exports Volume [Average value 2012-2014] Billions USD	# of RCAs	Number of close products (with a density greater than 0.12)
Paraguay	8.8	61	6
Argentina	75.3	139	582
Bolivia	12.3	51	2
Brazil	237	131	613
Uruguay	8.98	98	375
Hong Kong	517	140	608
Bulgaria	28.5	206	550
Slovenia	5.367	129	590
Nicaragua	4.71	86	223

Table A3. Total exports, number of RCAs, and number of products with a density greater than 0.12 of Paraguay and comparator countries.

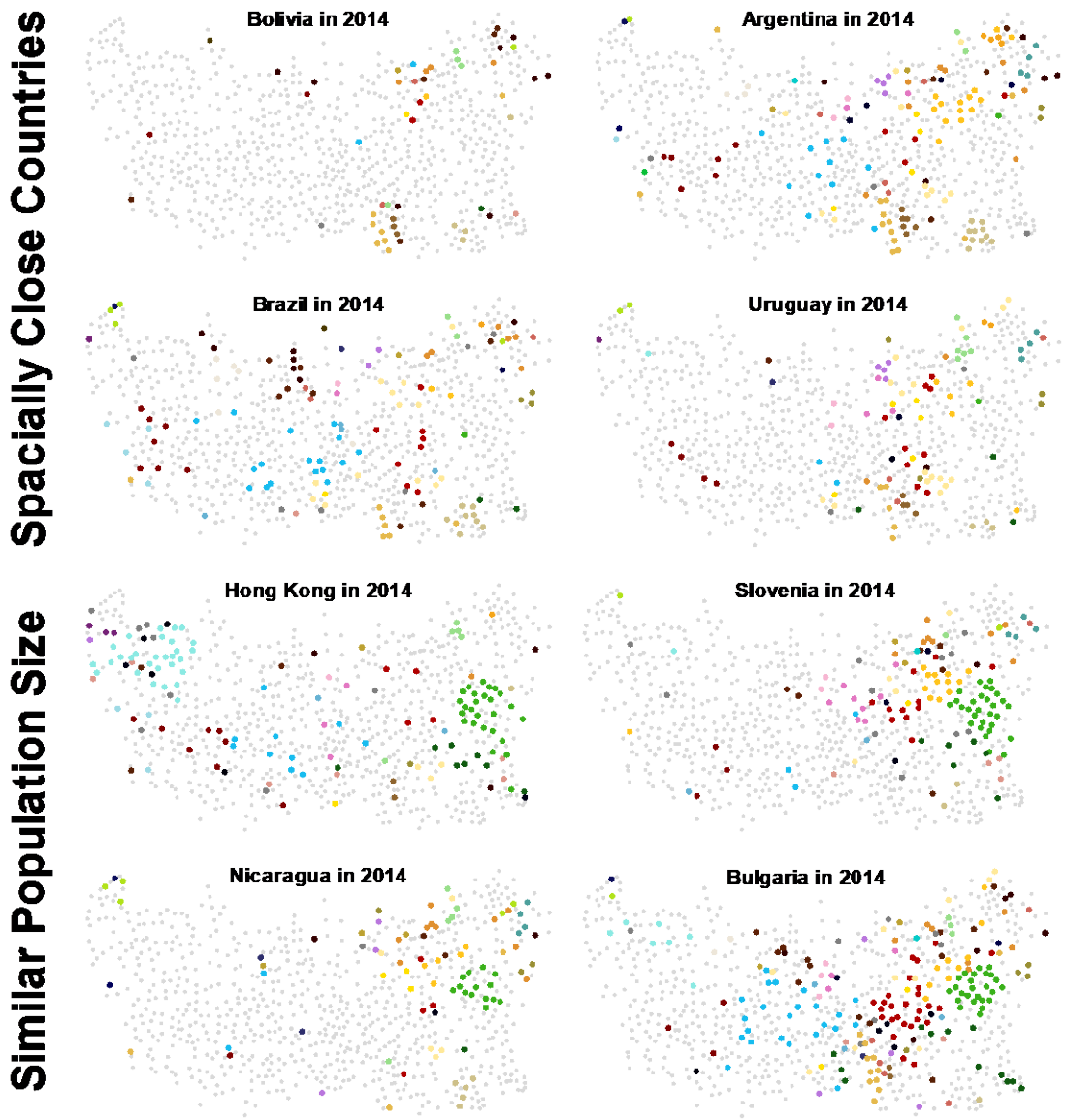

Figure A1. The product space of spatially close countries and countries with a similar population size. Source: atlas.media.mit.edu

The association between density and PCI, PGI, PRODY and RCA

Figure A3 illustrates the association between the relatedness (i.e. the proxy for productive capabilities to produce these products in competitive manner) and a) the Product Complexity, b) Product Gini Index, c) Prody and d) current revealed comparative advantage of Paraguay in this product. This provides us with a large set of different options into which Paraguay could diversify in the future.

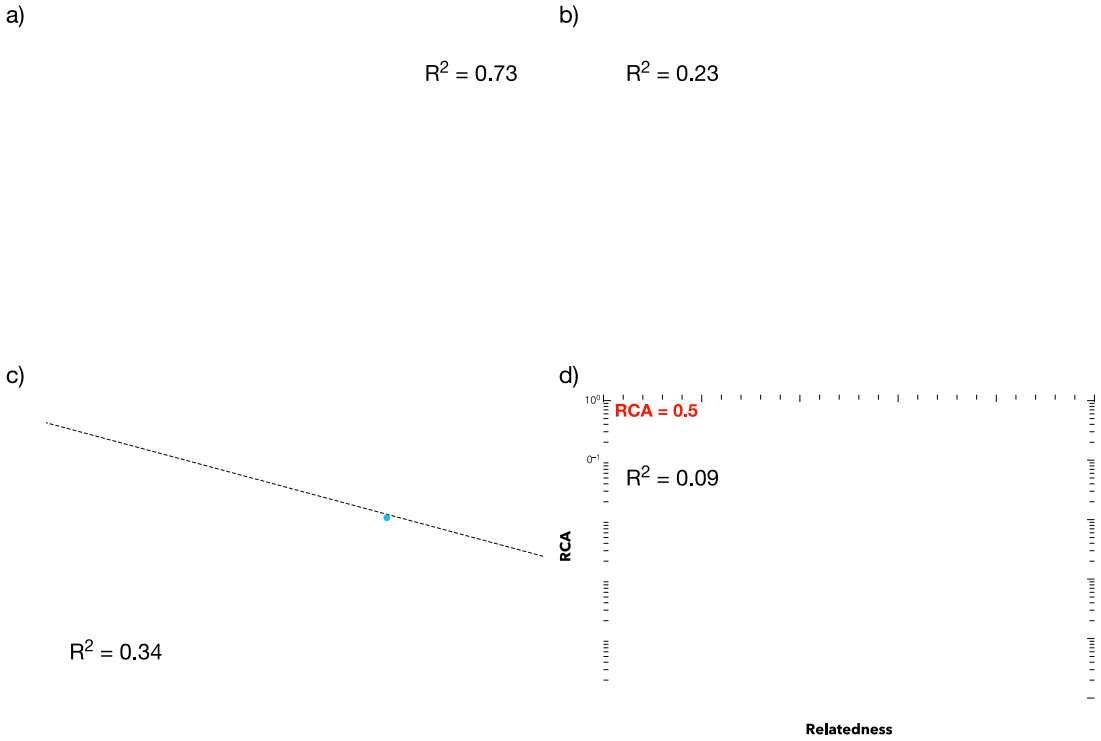

Figure A2. The strategic opportunity space of Paraguay. Product relatedness and different development goals, such as a) product complexity, b) product inequality, c) product income, and d) product competitiveness

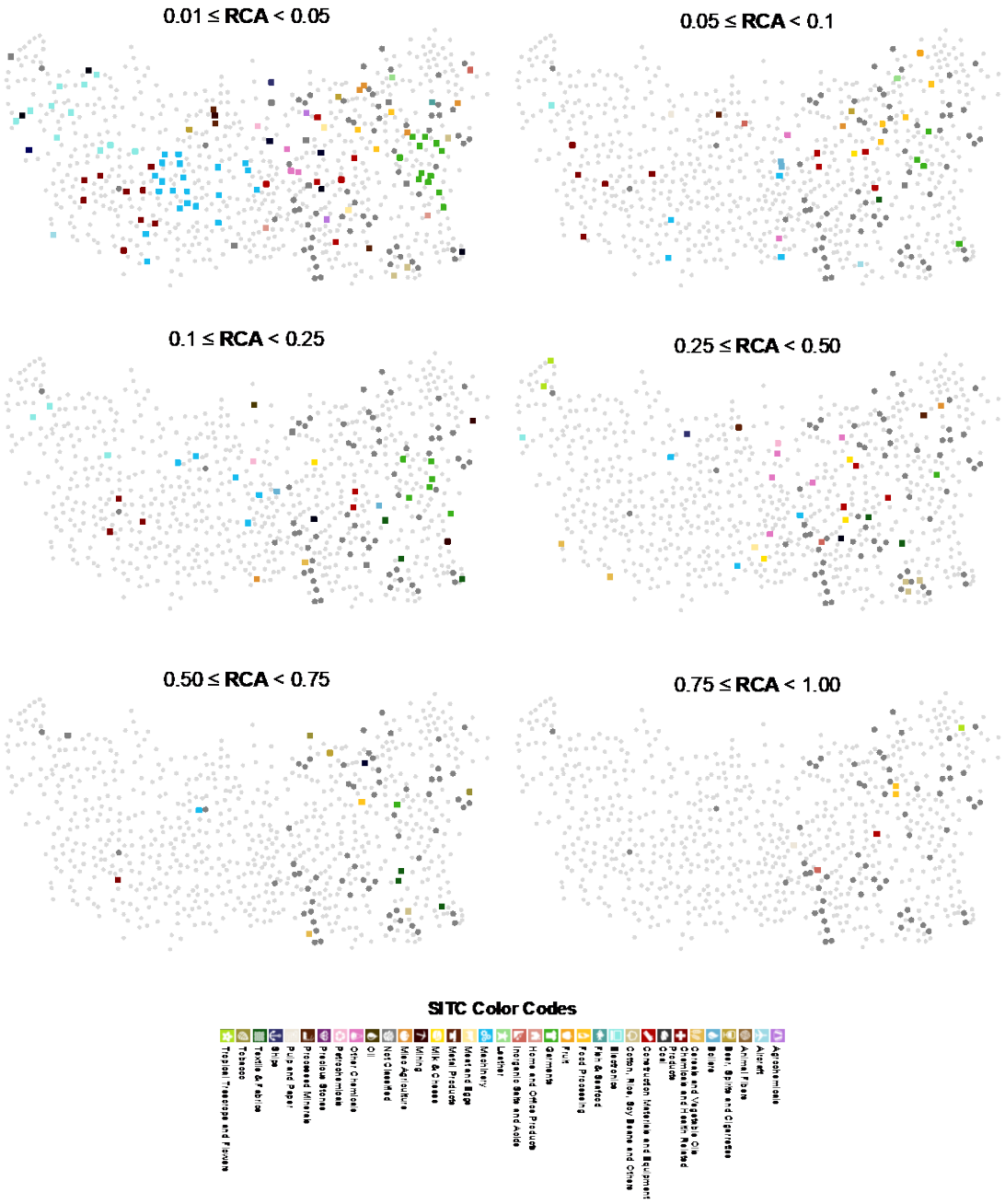

Figure A4. Location of the products identified in Figures 5.1 and 5.2 in the Product Space. Colored squares correspond to the listed product at a level of RCA, dark gray disks to the products in which Paraguay has Relative Comparative Advantages. Source: atlas.media.mit.edu and own calculations of the authors.

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