Productive structure, composition of exports, technological capabilities an economic development: to what extent does it matter what countries export?*

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Introduction

In the literature on the determinants of economic development, one of the recurring topics is that of the relationship between the productive structure of a country, its international insertion mode and its level of economic development. Several analysts have wondered how underdeveloped countries should specialize (in terms of their productive structures) to become developed. On one hand, some economic schools, more akin to neoclassical thinking, have defended the Ricardian theory of comparative advantage, by which developing countries should specialize purely on what they "know best" -that is, in general, the export of raw materials (activity in which they would be more efficient than if they industrialize)- (for example, Viner, 1950, 1952; Johnson, 1960, 1965; Cooper y Massel, 1965; Lal, 1995; Bhagwati, 2005). On the other hand, industrialist theories have argued that a necessary condition for overcoming underdevelopment is industrialization, integration and diversification of the productive matrix, with the aim of increasing industrial exports at the expense of primary ones (Hirschman, 1961; Myrdal, 1957; Diamand, 1973; Chang, 2009; Fajnzylber, 1983; Azpiazu & Schorr, 2010). For this trend of economic thought, comparative advantages are never static but can be turned into dynamic advantages by consolidating an industrialization process that involves processes of learning and endogenous creation. Third, neoschumpeterian and neostructuralist approaches also emphasize the possibility of transforming static comparative advantages in dynamic ones, but with special emphasis on the creation of innovation rents (Dosi *et al*, 1989; Lall, 1984; Lundvall, 1992; Patel & Pavitt, 1995; Grossman & Helpman, 1992; Cimoli & Dosi, 1994; CEPAL, 2007; Katz, 2000, 2012; Bisang, 2011; Pérez, 2010; Ramos, 1998). This implies that, for them, there is a primacy of "*how* countries produce" over "*what* countries produce or export". Thus, although neoschumpeterians and neostructuralists recognize that manufacturing is where technological innovation occurs more frequently, they also argue that natural resources and services have high potential to promote economic development, as they can also be key areas of technology creation. A fourth stream, whose main exponents are Dani Rodrik and Ricardo Haussmann, argues that the key to economic development is that underdeveloped countries export products that advanced countries do export (mostly, manufacturing goods) (Haussmann *et al*, 2005, 2011). One of the main differences with the theories we have called "industrialists" is that, in this fourth stream, there is a lower concern for the analysis of the integration of the production structure in terms of the input-output matrix. Another difference between them is that, in Rodrik & Haussmann's approach, public policy recommendations are more market-friendly than in industrialists. While the latter proposed an aggressive state planning to challenge static comparative advantages through the use of instruments like import tariffs, subsidies to strategic sectors or the creation of public companies, Rodrik and Haussmann believe in a less interventionist state (e.g., their confidence in

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state planning is decidedly less), and a competitive exchange rate is considered a central element of industrial policy[1]. Finally, the resource curse theory asserts that specializing in raw materials (especially minerals and oil) generates macroeconomic patterns that are unfavorable for economic development as well as institutional frameworks conducive to authoritarianism, corruption and rent-seeking behavior. Naturally, all this assumes that societies with high endowments of natural resources have serious obstacles to overcome backwardness[2].

In this paper, we follow a neoschumpeterian-neostructuralistic framework, and we will hope to show empirical evidence that justifies our theoretical choice. We emphasize that neoschumpetarian-neostructuralistic theories do not challenge either industrialism nor Rodrik&Haussmann's thought, but rather complement them to qualify and specify some of its main assumptions. If we ask ourselves whether specializing in industrial goods is the key to development, our answer will be "not necessarily". As we will see, in countries that we call "assemblers" –like the Philippines, Mexico and Thailand, for instance-, the export basket is dominated by medium and high technology manufactures, and however they are far from being developed. Also, in countries we call "primarized innovators" -such as Norway, Australia and New Zealand, which are very developed nations-, integration in international trade is focused on commodities and resource-based manufactures. Although in these countries the composition of exports is very different to that of other developed countries (which itself largely export manufactured products), the way it is produced which is exported is very similar: whether they have export baskets focused on commodities or manufactured goods, developed countries share a great development of endogenous technological capabilities, which gives them a high potential to move the global technological frontier. By contrast, in "assembler" countries exports of manufactures are not accompanied by local technological capabilities, distinguishing them from developed countries that also export manufactured goods.

Thus, in this article we propose three goals. First, we analyze the relationship between the composition of exports of a country (*what* is exported), their endogenous technological capabilities (*how* it is produced) and economic development, using a large sample of cases while also a synchronous approach (a picture of the period 2000-2012). Secondly, we will establish a typology of cases derived from crossing our two independent variables (ie, composition of exports and endogenous technological capabilities). Finally, the synchronous approach mentioned in the first objective will be enriched with a long-term analysis (1965-2012), in order to understand what the national trajectories have been in terms of technological content of exports and endogenous technological capabilities.

In line with neoschumpeterian-neostructuralist frameworks, our hypothesis is that the existence of endogenous technological capabilities (*how* countries produce) plays a crucial role in economic development. But, at the same time, these capabilities can be constructed in several productive activities, such as engineering-intensive sectors (f.i., machinery and chemicals), resource-based sectors and even services. That is why we refuse to talk about a unique pattern of development and the idea of a "typology" makes sense. Nevertheless, we want to emphasize that practically all of

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[1] See for instance Rodrik (2004). It is worth noting that Rodrik & Haussmann's suggestions of economic and industrial policies are quite similar to those of neostructuralists. However, for the purposes of this paper, we differentiate between the latters (who often emphasise that natural resources have potential for innovation) and the formers (who tend to see exports of sophisticated manufactures the driver of long-term growth).

[2] See for instance Sachs & Warner, 1995; Auty, 1998, 2001; Auty & Gelb, 2001; Ross, 1999, 2001; Acosta, 2009, 2012; Gudynas, 2009, 2010.

these successful development patterns have in common a consolidated national innovation system, no matter what the predominant sectors in the productive structure and the export basket are.

This paper is structured as follows. Section 1 describes methodology and data used. Section 2 presents the results obtained for the synchronous approach based on an econometric test. Section 3 develops a typology of countries by the crossing of the two independent variables. Section 4 is the largest and shows how technological capabilities and export baskets have evolved in different countries since the mid-60s. Finally, Section 5 concludes.

I. Methodology and data

The methodological approach of this article is mainly quantitative. To characterize the composition of exports (*what* is exported) we will use an indicator of technological content of exports, which we will abbreviate as CCTX[3]. On the other hand, we will take gross domestic expenditure on research and development (GERD) as a percentage of GDP and the number of patents per capita as proxies of national technological capabilities (shortened to CT[4]).

The CCTX is a summary measure of a country's export basket, which will be decomposed according to the categories of technological content of goods created by Lall (2000). This divides internationally traded goods into six groups: primary products (PP)[5], resource-based manufactures (RBM)[6], low-tech manufactures (LTM), medium-tech manufactures (MTM), high-tech manufactures (HTM)[7] and others[8]. Thus, the CCTX will be 0% if the total exports of a country were PP, and 100% if they were all HTM. The intermediate categories were weighted as follows: RBM, 25%; LTM, 25% and MTM, 75%. The "others" group was excluded from the coefficient.

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[3] That is the abbreviation of “Coeficiente de Contenido Tecnológico de las Exportaciones” (Technological Content of Exports Coefficient).

[4] That is the abbreviation of “Capacidades tecnológicas” (Technological capabilities).

[5] For example, in this group are included goods such as cereals, oilseeds, rice, tobacco, unprepared fruit, unprepared meat, wool, cotton, cocoa, tea, coffee, timber, coal, ferrous metals, crude oil and natural gas.

[6] This category includes processed food (such as prepared fruit, prepared meat and vegetable oils), beverages, manufactured tobacco (cigars), wood products (pulp and paper, mainly), non-ferrous metals, processed oil, manufactured rubber, cement, gems, non-metallic minerals and many products of the basic chemical industry (Lall, 2000).

[7]The LTM category contains products associated with the textile-and-garments industry (such as yarn, apparel, footwear or leather) and also pottery, jewelry, furniture, toys, plastic products and basic metallic goods. The MTM group includes, among others, vehicles and their parts, engines, industrial machinery, ships, watches, pumps, boilers, synthetic fibers, much of the chemical products, plastics, tubes and pipes. The HTM encompasses office machines and data processing equipment, telecommunications equipment, televisions, transistors, power generating equipment, turbines, pharmaceutical products, aircrafts, precision and optical instruments and photo cameras, among others (Lall, 2010).

[8] Here Lall (2000) includes mainly transactions not classified and non-monetary gold. We have reclassified non-monetary gold as a primary product.

The criteria for weighting the intermediate categories lies in the R&D intensity in the manufacturing sectors of the United States, Japan and Germany in 2000[9]. Formally, the CCTX formula is:

where (PP_i / X_i) is the share of primary products in the export basket of country *i,* and so on with the other groups of manufactures.

On the other hand, measuring the technological capabilities of a country (which allows to approach the strength of its national innovation system) is not an easy task due to the lack of reliable indicators in a large number of countries (Archibugi et al, 2009). Beyond that, an important part of the literature[10] considers as "classic" indicators of technological capabilities the spending on research and development as a share of GDP and per capita approved patents in the United States Patent and Trademark Office (USPTO). In this paper we have followed this criterion.

Thus, the technological capabilities index (CT) ranges from 0 (null CT) to 1 (maximum CT). In turn, this index is composed of the scores obtained by countries in R&D as a share of GDP and per capita patents. In these two sub-indicators, the value "1" is taken by the country with the greatest figures in a given year (Israel in 2007, in the case of R&D and Taiwan in 2012 in the case of patents per capita). Is worth mentioning that for the construction of the CT index we have taken the natural logarithms of both sub-indicators in order to minimize the extreme values and to differentiate between the intermediate values. Without taking natural logarithms, the results would give us that France would be closer to Bolivia than to Israel in terms of technological capabilities.

The formula of the CT index is thus the following:

Here $R\&D_{ij}$ is the spending on R&D as a percentage of GDP of country *i* in year *j*, while $patpc_{ij}$ are patents per capita of country *i* in year *j*. The "+1" which was placed in each of the terms of the equation was to avoid negative numbers in the natural logarithm[11].

Two issues should be highlighted concerning our CT index. On the one hand, it is more related to the "per capita" technological capabilities of a country than to its absolute technological capabilities. That is the reason why a country like Russia is within the ideal type of the "intermediates", although

[9]We have taken the natural logarithms of the R&D intensity of MTM, LTM and RBM sectors and compared them with HTM sectors. Thus, it was found that MTM sectors are more similar to HTM than to RBM or even LTM. The database used for the sectorial R&D intensity was OCDEStat. For a further description of this weighting, see Schteingart (2014).

[10] See for example ECLAC, 2006, 2007, 2012 and Cimoli et al, 2005.

[11] For the calculation of the per capita US patents we have done the same criteria that Archibugi and Coco (2004). While the USPTO has a large bias in favor of US patents, we had to adjust the indicator in some way. What we did was to take the ratio of per capita patents between Japan and the United States at the European Patent Office (EPO). In formal terms the adjustment performed was the following: , where USA_{EPO} are the US per capita patents approved by the EPO, JPN_{EPO} the Japanese per capita patents also approved in that office and the Japanese per capita patents approved in the USPTO. Since EPO information is only available from 1994, we had to join the series of 1965-1994 and 1994-2012 from the variation in the number of US patents approved by the USPTO between 1965 and 1994.

it surely has a greater potential to push the technological frontier in certain areas[12] than other countries with a similar CT index, as for example Portugal. An index of absolute technological capabilities (which may be estimated, for example, using total expenditure on R&D and the total number of patents) can be very useful for understanding global geopolitics, but should be taken with caution when measuring its relationship with a country's average quality of life. While clearly geopolitics and economic development are intertwined, this relationship is mediated by multiple factors. On the other hand, it is clear that our indicator has many other limitations. One of these is that patents are not differentiated qualitatively, which can generate some distortions. In other words, the CT index does not distinguish between a patent in the field of food packaging and another one in the area of aerospace technology.

For its part, the dependent variable (used for the cross-section analysis of the period 2000-2012) is economic development, which was measured with the Human Development Index (HDI), which is in turn calculated by the United Nations Development Programme (UNDP). It is noteworthy that the HDI not only approaches the quality of life of a country by its GDP per capita, but also includes dimensions such as education and health.

To calculate the CCTX we used the COMTRADE database[13]. The details of expenditure on R&D as a percentage of GDP were taken mainly from the Statistical Office of UNESCO[14], while HDI indicators were taken from Human Development Report of UNDP. The patents granted in the US were taken from the USPTO and the population to calculate the indicator in per capita terms the World Bank. On the other hand is worth noting that CCTX and CT data for the synchronic analysis are based on the average of fourteen years between 2000 and 2012, to avoid results biased by specific national situations.

It is worth clarifying an issue. In the last part of this paper we will attempt to analyze historical trajectories in terms of CCTX and CT for several countries, in some cases since 1965. The database of the USPTO has information from this last year. However, when it comes to R&D data, in many countries the information is available much later. Thus, what was done to establish the CT index was this. First, we compared, for each country, the dynamics of these two indicators for the period that we do have information. After this, if the relationship between the two indicators was extremely narrow (as it occured in most developed countries) we inferred the expenditure on R&D as a share of GDP for the missing years from the values of patents per capita. When the relationship between expenditure on R&D and patents per capita was less linear (as in the case of Latin American or

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[12] For example in the defense industry.

[13] It should be clarified that the databases that use the SITC Version 2 (Lall used this one) go back to 1978. We had to use the SITC versión 1 to calculate the CCTX for the period 1965-1978. This forced us to make an ad hoc adjustment of Lall's classification. To check if our adjustment generated differences with Lall's categories we compared the result of the CCTX calculated with both versions of the SITC for the period 1978-2012, and we found that differences in the results were minimal.

[14] For the period 1981-1996 we used the OECD database (limited to its member countries) for R&D data. For the period before 1981 we have taken information from the US National Science Foundation, which has data about the USA, West Germany, Japan, France, Italy, Canada and the UK. For Norway, we employed data from the Nordic Institute for Studies in Innovation, Research and Education (NIFU) for the period prior to 1980, while for South Korea, we had to use data from the Ministry of Education, Science and Technology of Korea (MEST), for that period too. In the case of India, we have taken information from Mani (2008) to calculate R&D spending of the period prior to the 90s, while we used Wan's (2004) information to obtain Chinese data of the period 1985-1995.

former communist countries), efforts were made to impute (if that information was not available) expenditure on R&D from qualitative or quantitative research at micro and meso level. For example, for Argentina we have information of patents since 1965, but official data of spending on R&D is available since 1996. However, specialized literature (eg, Katz and Ablin, 1977; Katz, 2000a) noted that, although in terms of per capita patents there was virtually no change, between 1965 and 1974 it occured an incipient process of consolidation of technological and innovative capabilities through the increase in R&D, which would then be removed after the economic policy inaugurated in 1976 and especially during the 1980s recessive decade. Thus, although it does not allow us to guess with certainty the R&D numbers prior to 1996[15], this specialized literature will facilitate us to infer what the basic direction of Argentina trajectory was. The same can be inferred for countries like Brazil, Mexico and the former communists.

Finally, it should be noted that we were unable to find any number of expenditure on R&D for Qatar and Venezuela. However, due to its virtually null patents and the posible lack of concern for measuring R&D, we have inferred that it should be low. Thus, for these countries, we have imputed a R&D expenditure equivalent to 0.10% of GDP, which it also is consistent with figures from other oil countries with a similar level of development.

II."What is exported" and "how it is produced": what kind of relationship do they have with development?

One of the central questions of this paper can be reformulated as: "does what you export determine economic development"? To answer this, we estimated three different models of cross-section regression by the least squares method, in order to confirm whether our assumptions are (or not) statistically significant (see Table 1). The dependent variable in the three models is the HDI in 2012. In model 1, we have omitted the CT index and a control variable called "Institutional Quality"[16]. The sample of countries here was 167 (the 58 that we will use to build the typology that we will see below and the remaining 109, many of them small countries) and we tried to see if the CCTX (independent variable) was significant when controlled by population, export diversification (HH[17]) and a coefficient of export openness (exports to GDP). In this model, the CCTX was significant at 1%.

In model 2, we took the same sample of countries, adding the CT index and "Institutional Quality" as control variables. In this case, the CCTX lost statistical significance, reinforcing the targeted above hypotheses: the relationship between the composition of exports and economic development apparently disappears when technological capabilities are taken into account. Instead, both the CT index as the "Institutional Quality" variable were significant at 1%, with large coefficients in both cases (more on "Institutional Quality" than in CT).

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[15] In fact, Lopez (2002) estimates that R&D was 0.5% of GDP during the early 70s, which is a similar figure to that of the 90s.

[16] This indicator was an *ad hoc* construction based on three of the five variables published by the World Governance Index (WGI): a) rule of law; b) human rights and participation and c) peace and security.

[17] The abbreviation "HH" is because the indicator used to measure export diversification is the Herfindahl-Hirschman index.

In model 3, we tested the same variables than in model 2, but reducing the sample of observations to the 58 cases analyzed in this section and the following one. If there could be an overrepresentation of small countries in model 2 (since within the 167 observations, 90 corresponded to small countries –that is, less than 10 million people-, 55 to medium-sized countries –between 10 and 50 million- and only 23 to large ones –more than 50 million-), in model 3 there might be a bias in favor of large countries (within the 58 observations, 16 are small countries, while 23 are medium and 19 large ones). In fact, this bias turns the population variable significant at 1%. This occurs because only small countries with high exports could participate in the selected sample. Logically, this generates an overrepresentation of small countries with high exports per capita, which means probably a high GDP per capita and therefore a high HDI. Beyond this, the fact is that in model 3 the CT index remained significant at 1% while the "Institutional Quality" variable did not. As in model 2, the CCTX was not significant.

Table 1: Least-squares regression (coefficients and significance level)

Variable / Model	Model 1	Model 2	Model 3
Constant	0.593	0.334	0.721
CCTX	0.409***	0.048	0.03
HH	-0.141*	-0.098	-0.028
Population (ln)	-0.014	-0.004	-0.026***
CT		0.262***	0.199***
Exports / GDP	0.103**	0.090**	-0.021
Institutional Quality		0.427***	0.139
Adjusted R^2	0.388***	0.584***	0.737***

Source: author's own elaboration. CCTX = Technological content of exports coefficient; HH = Herfindahl-Hirschman index (export diversification); Population (ln) = natural logarithm of population; CT = technological capabilities index; * significant at 10%; **: significant at 5%; *** significant at 1%. In models 1 and 2, the sample comprised 167 countries, wheras in model 3 of the 58 typologized in Section 3.

In sum, the econometric test apparently confirmed that technological capabilities are closely linked[18] to economic development while, on the contrary, the CCTX (and note that also the HH index) are no longer significant when controlled for CT. Thus, rather than *what* countries export (as Rodrik & Haussmann argue), the key seems to be in *how* countries produce. From Rodrik & Huassmann's analysis one could think that it is better to export computers than minerals.

However, now imagine this situation: on the one hand, country A produces computers but without linkages with the rest of the productive matrix (that is, country A just assembles imported components that were technologically developed by other countries). On the other hand, country B exports minerals in which a sophisticated and locally developed know-how is used to improve sectorial productivity. Which country will have more chances to sustain a long-term growth that

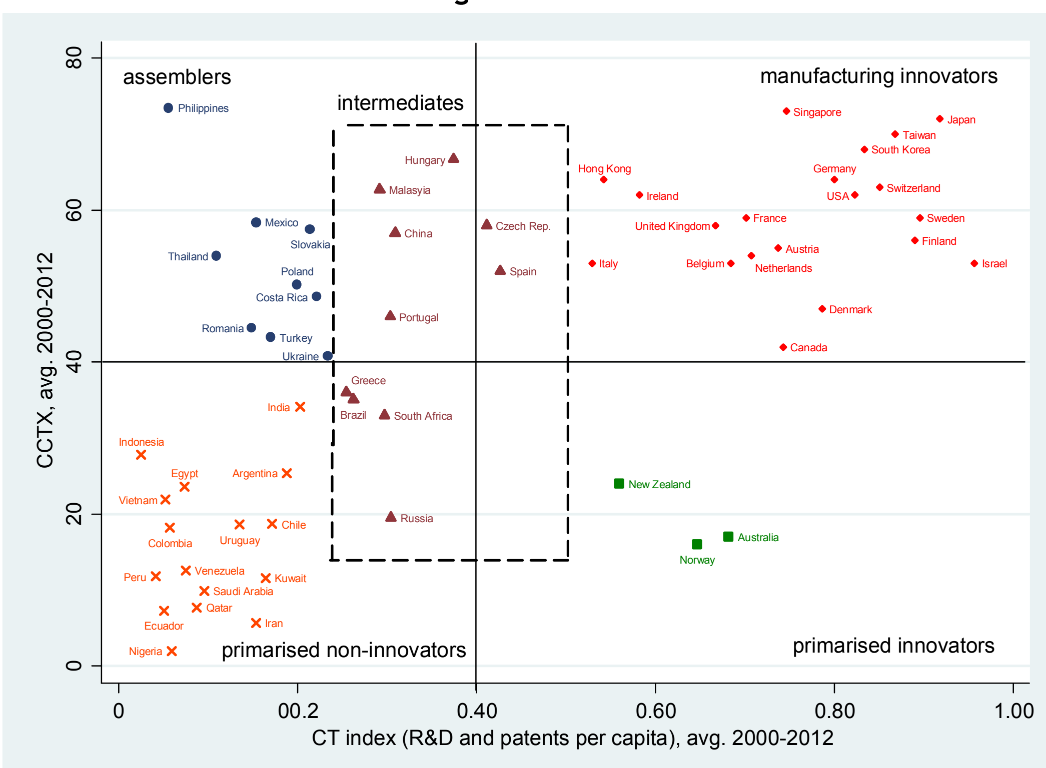
[18] We want to insist on one point: when we say that technological capabilities and economic development are "closely linked" we are not claiming that this is a causal relationship. Probably there is a mutual determination: higher economic growth -which is key to increasing IDH- simplify the conditions to generate endogenous technological capabilities, which in turn accelerate long-term growth. What is certain is that if these technological capabilities are not created, then economic growth will be short-lived and probably not enough to achieve economic development.

could foster economic development? Extrapolating the reasoning of Rodrik & Haussmann's papers above cited, it appears that A. As is expected, in our opinion it would be B.

II. Towards a typology of national development patterns

In this section we will try to analyze the relationship between our two independent variables (the CCTX and the CT index) in order to build a possible typology of countries. Figure 1 presents the crossing of these two variables, being thus defined four quadrants: upper-right quadrant represents those countries with a high CT index and a high CCTX. We will call them "manufacturing innovators". In the bottom-right quadrant, we can find those countries that have a high CT index but a low CCTX. We call them "primarised innovators". Upper-left quadrant covers those countries with a high CCTX but low technological capabilities ("assemblers"), while in the bottom-left one we can see those countries that have a low CT index and a low CCTX. We call these ones "primarised non-innovators". Finally, the central zone of Figure 1 covers heterogeneous countries in their CCTXs, but with intermediate CT indexes. This sets a fifth ideal type: the "intermediate".

Figure 1: Technological capabilities index (CT) and Technological content of exports coefficient (CCTX), avg. 2000-2012



Source: author's own elaboration on the base of COMTRADE, UNESCO, USPTO and World Bank data.

On the one hand, the "manufacturing innovators" are countries that export mainly MTM and HTM and where probably most of the technology incorporated therein is produced locally (because their CT indexes are high). Hence the label we put them, and the corresponding differentiation from the "assemblers" of the upper-left quadrant. It is worth noting that every country in the upper-right quadrant are developed (the HDI is always higher than in the countries in the left half of the graph).

Countries that are part of this quadrant are Israel, Finland, Sweden, Japan, Taiwan, South Korea, Switzerland, United States, Germany, Denmark, United Kingdom, France, Austria, Netherlands, Belgium, Singapore, Canada, Italy, Ireland, Hong Kong, Spain and Czech Republic. However, it should be noted that the latter two are clearly closer to intermediate values with regard to technological capabilities (and this is why we have grouped them within the ideal type of the "intermediates"), while Canada and Denmark have an export basket a bit more "primarized" than the rest.

Second, in the upper-left quadrant we can find countries that export mostly MTM and HTM, but with reduced endogenous technological capabilities. In other words, the bulk of technological knowledge incorporated in the exported manufactures is not produced domestically. It is for this reason that we have called them "assemblers". It should be highlighted that all these countries have experienced structural changes in the last four decades, during which large transnational companies have relocated the lowest value-added stages of their production processes to lower their costs (mainly, labor ones)[19]. Within this quadrant are the Philippines, Thailand, Mexico, Costa Rica, Slovakia, Poland, Turkey, Romania, Ukraine, Hungary, Malaysia, Portugal and China. It should be noted, however, that these last four countries have rather intermediate technological capabilities (China has been moving rapidly "eastwards" in the last twenty years, as we would see in the following section). For this reason, we have grouped these four countries within the "intermediates". Also, note that, in fact, Ukraine is halfway between the upper-left and bottom-left quadrants.

Third, in the bottom-left quadrant are those countries that, despite having a primarized international integration (low CCTX), have an elevated CT index; that is why we have called them "primarized innovators". Norway, Australia and New Zealand are the only countries in this quadrant. It is worth noting that in 2014 Norway and Australia had the highest HDI in the world, while New Zealand was in the seventh place in the ranking (just behind Switzerland, United States, Germany and Netherlands).

In the case of Norway, the low CCTX is due to the high weight of primary products (PP) and resource-based manufactures (RBM), which together accounted for 85% of total exports between 2000 and 2012. This fact is mainly explained by oil products, which represented 61% of total exports in the same period. In Australia, PP and RBM explained 81% of the total exports of that period. The commodities that best explain this phenomenon are iron (19% of Australian exports), coal (14%), non-ferrous metals (8%), oil (6%), gold (6%), meat (4%), gas (4%) and cereals (3 %), among others. In New Zealand, PP and RBM accounted for 75% of total exports between the same period. This is explained mostly by the agrifood complex, which represented about half of New Zealand's exports.

Despite this international integration centered mainly on PP and RBM, Norway, Australia and New Zealand have developed strong technological capabilities, which allowed them to take advantage of this type of integration in the world market (ECLAC, 2006, 2007, 2012). For example, according to Stoeckel (1999), in 1995-96 20% of Australia's expenditure on R&D was implemented in areas linked to mining. By the late 90s, Australia led the world market for mining software, with about 65% of world exports. On the other hand, despite its small size, New Zealand is an important global player

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[19] See, for instance, Usui (2011), Wignaraja (2011), Reyes-Macasaquit (2011), Paus & Gallagher (2006), Koopman *et al* (2008), Jürgens & Krzywdzinski (2009) and Kohpaiboon (2010), among others.

in the dairy industry (especially in the milk powder sector). For its part, since the late nineteenth century Norway has developed sophisticated knowledge in geology, marine and forest biology, meteorology and oceanography (Ville and Wicken, 2012). Since the last quarter of the twentieth century, Norway has developed expertise in the area of offshore oil. It should be mentioned that this sector has become the main engine of its economy since then.

Fourth, in the bottom-left quadrant are those countries that are not innovative and also have a primarized export basket. This group includes countries such as Argentina, Nigeria, Iran, Ecuador, Peru, Venezuela, Colombia, Uruguay, Chile, Saudi Arabia, Kuwait, Indonesia, Egypt, Vietnam, India, Russia, Brazil, South Africa and Greece. It should be said, however, that these latter four countries are in the intermediate ranges of the CT index and, except Russia, also in the CCTX. That is why we have grouped them in the “intermediates” category. India also has an export basket with an intermediate CCTX, albeit with a lower CT index. Argentina and Chile, although being “primarised non-innovators”, have a CT index slightly higher than the countries on the far left of the graph.

Lastly, as was mentioned above, we have created a fifth ideal-type: the “intermediates”. Although being very heterogeneous with regard to the technological content of exports (with countries like China and Hungary exporting mainly MTM and HTM and others like Russia exporting commodities), the “intermediates” share a noticeable development of technological capabilities. Apart from the countries recently mentioned, Spain, Czech Republic, Malaysia, Portugal, Greece, Brazil and South Africa belong to this group.

IV. The diachronic approach: national paths since the 60s

In this section, we will introduce dynamics in the scheme described above. In other words, we will try to visualize how the CCTX and CT index have evolved in 43 of the 58 countries typologized in the latter section since the mid sixties[20]. This 43 countries will be divided into nine groups, based on a criterion that combines historical, geographical and populational issues:

-Group A is composed by large traditional manufacturing powers (US, Japan, Germany, France, UK and Italy);

-In Group B we have traditional manufacturing European countries, which are small in terms of population (Switzerland, Austria, Belgium and Netherlands);

-Group C comprises Scandinavian countries (Norway, Denmark, Sweden[21] and Finland);

-Group D is composed by English-speaking settler countries in which resource-based sectors are an essential part of the economy (Australia, New Zealand and Canada[22]);

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[20] The reason for the time period chosen lies mostly in the availability of statistical data: as mentioned, COMTRADE database goes back to 1962, while the USPTO until 1965.

[21] In fact, the strong industrial heritage of Sweden could be a reason to include it in the previous group. Here we have chosen a strictly geographical criterion.

[22] As we will see, Canada has a stronger manufacturing basis than the other two (and that is why its CCTX is nowadays higher) but unlike other "manufacturing innovators", it also has huge natural resource endowments, which have historically been of central importance in its economy.

-In Group E we have late-developed European countries, which have not experimented communist governments (Spain, Portugal, Ireland, Greece and Israel[23])

-Group F covers late-developed Asian countries (South Korea, Taiwan, Hong Kong and Singapore);

-Group G includes emerging Asian countries (China, India, Malaysia, Thailand, Vietnam, Indonesia, Turkey and the Philippines);

-Group H is made up of former communist European countries (Russia, Czech Republic, Hungary, Poland, Ukraine, Romania and Slovakia)

- Finally, in Group I we have three big Latin American countries (Argentina, Brazil and Mexico).

We have excluded many "primarised non-innovators" from the diachronic analysis (Iran, Egypt, Venezuela, Bolivia, Peru, Colombia, Chile, Ecuador, Uruguay, Nigeria, Qatar, Saudi Arabia and Kuwait). That is because they have not shown significant signs of structural change (in terms of the CT index and the CCTX) since the mid- 60s. In other words, during this period, these thirteen countries have remained confined to the bottom-left corner of our scheme[24].

IV.1. The large traditional manufacturing powers

In this subsection we will focus on six major economic powers that have developed profound industrialization proccesses since the nineteenth century (or even before). Historically, these countries have been in the quadrant of the "manufacturing innovators", as can bee seen in Figures 2 and 3. Within this group we have the USA, Germany, France, the UK, Italy and Japan. While these last two developed their economies much later than the first four, the roots of their spectacular industrial expansion of the Second Postwar occurred since the late nineteenth century. That is why we have grouped them into this category.

Figure 2 shows the evolution of the CCTX and the CT index in the USA, Japan and Germany[25] since 1965. In this year, the USA was the country with the largest CT index in the world, both in absolute[26] and per capita terms. Although US hegemony with respect to absolute technological capabilities remains enormous, in per capita terms it has been slightly surpassed by other countries. Such is the case of Japan and Germany, whose CT indexes were significantly lower than

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[23] Although not being part of the European Union, Israel shares with these four countries the fact of having been a late- developer that has not been through a communist regime. Also, despite being located in Asia, its cultural and geopolitical ties are much stronger with Europe. This is the reason why we have classified it as "European", although not being strictly the case.

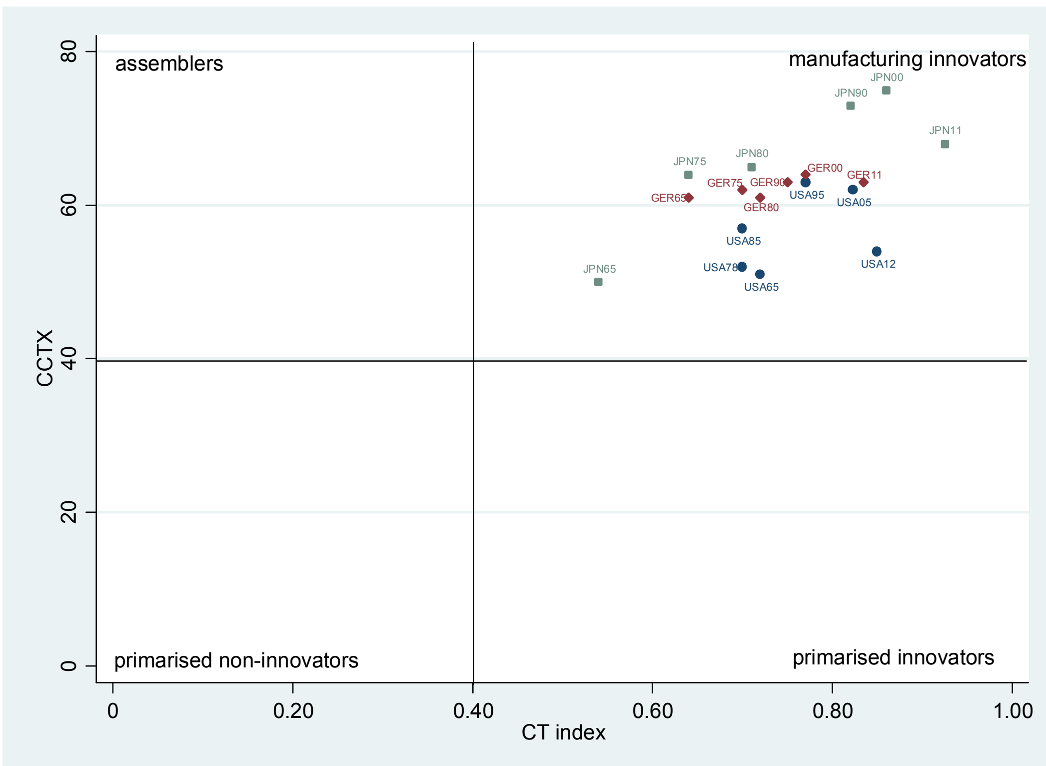
[24] While South Africa has shown greater signs of structural change, especially when it comes to CCTX, we have excluded it from the diachronic analysis because COMTRADE data has a very important component of "transactions not classified". Thus, we would lose accuracy in the analysis. By its part, Costa Rica experimented a considerable shift in its export basket since the mid-90s. We preferred to exclude it from the group I because we wanted to describe big Latin American countries' development paths.

[25] For the period 1965-1990, data are for West Germany.

[26] When we say "in absolute terms", we mean the total expenditure on R&D and the total number of approved patents.

the US in the mid-60s and today are similar (in the case of Germany) or even higher (in Japan). Also, it should be noted the spectacular growth of the Japanese CT index, especially until the '90s. It is also interesting to remark that since the mid-60s these three countries have remained in the upper-right quadrant. Also noticeable is that, while between 1965 and 2000, Germany and the United States remained their CCTX relatively stable, Japan increased it from 50% to 75%. This is due not only to a growing specialization in MTM and HTM at the exponse of LTM, but also because its scarce natural resource endowments. In fact, PP and RBM have had a practically insignificant share in Japan's export basket. By contrast, in Germany and the USA, these products still represented around 20% of exports in 2000.

Figure 2: The paths of the United States, Japan and Germany (1965-2012)



Source: author's own elaboration on the base of COMTRADE, UNESCO, USPTO, NSF, OECD and World Bank data.

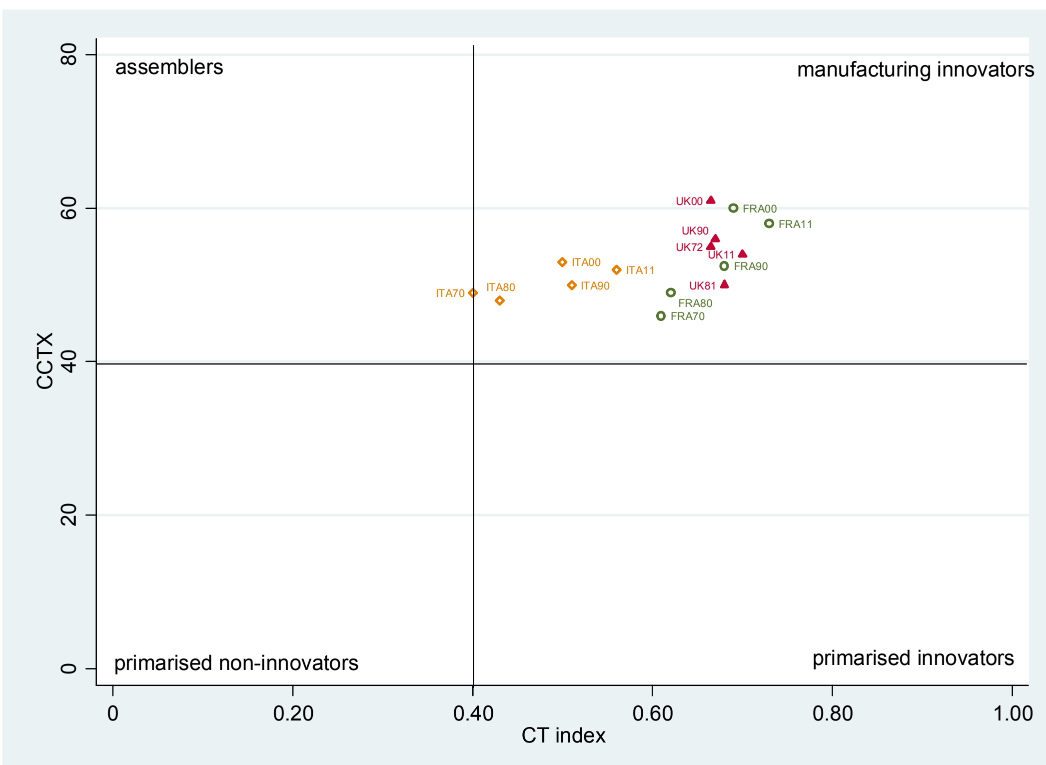
In Figure 3 we can see the paths of the United Kingdom, France and Italy since the early 70s. On the one hand, in the UK, the CT index remained virtually stagnant over the past four decades, despite this country was the first manufacturing power in the world. It is striking that their technological capabilities are now almost largely the same as forty years ago. This is due to the neutral effect generated by a slight growth of patents per capita and a significant decline in expenditure on R&D as share of GDP. According to Becker and Pain (2003), this latter fact is due to a combination of a low growth of industrial output since the '90s, with a reduction in government funding to private industry. The authors also argue that Britain's currency real appreciation might explain the shrinking of the R&D.

However, after having been the industrial power with less economic dynamism during the Second Postwar, between the late 80s and 2008 UK grew faster than countries like Germany, France or Italy.

At first glance, this seems contradictory with the stagnation in the CT index. This proves that the relationship between the CT index and economic growth is far from unidirectional and much less linear. Maybe, the shift from an industrial economy to a services economy (with a strong importance of financial sectors) has involved a better economic performance for almost twenty years, in a global context in which the finances have been highly dynamic. At this point, it is worth noting that in 2012 British exports of services accounted for 37% of its total exports, a figure which is considerably higher than in other industrial powers (29% in the US, 27 % in France, 18% in Italy, 16% in Japan and 15% in Germany). For this reason, UK is currently the world's second largest exporter of services, only behind the United States. In particular, services that could be defined as hi-tech (communications, finance, insurance, IT and other business services) are extremely important in Great Britain, accounting for 27% of its total exports of goods and services. In regard to CCTX, UK experienced a little loss in the 70s, which was then offset by an increase in the 80s and 90s. In 2011, the British CCTX was similar to that of the early 70s.

For its part, France shows a moderate dynamism in its CT index, similar to the United States (in both countries this coefficient rose 0.13 points since the early 70s), higher than the UK (whose CT index grew just 0.04 points) but lower than those of Germany (whose CT index expanded 0.18 points) and Japan (where it rose 0.35 points). It is worth noting that the French CCTX experienced a clear upward trend between 1970 and 2000, going from 46% to 60% (since then it fell slightly to 57%). This is due to a higher share of MTM and HTM in its exports, at the expense of PP, RBM and LTM.

Figure 3: The paths of United Kingdom, France and Italy (1970-2011)



Source: author's own elaboration on the base of COMTRADE, UNESCO, USPTO, NSF, OECD and World Bank data.

Finally, note that within the Group A, Italy have historically had a lower CT index than the others. However, it is also interesting to see its path since 1970. If until 1990 Italy tended to narrow the gap that separated it from Germany, USA, France and UK, since then it has stalled, losing ground compared to them. Italian GDP per capita followed a similar trajectory: while it grew faster than these four countries until 1990, it has been stagnant since then. Between 1970 and 1990, the Italian CT index rose 0.11 points (from 0.40 to 0.51), while in Germany it did it in 0.08, in France in 0.07, in the USA in 0.04 and in the UK in just 0.01 (Japan expanded the distance that separated it from Italy, while its CT index rose 0.23 points in those twenty years). However, between 1990 and 2000 Italy had a slight decline in its CT index, and since then it raised again, although at a rate similar to that of Japan, USA, Germany and France.

Italian CCTX shows a relatively stable path, with a score of around 50% over the whole period. One point should be remarked: within developed countries, Italy is the one with the highest share of LTM in total exports (it avergaed 28% between 2000 and 2011), then followed by Czech Republic (22%) and Austria (20%). However, Italy has developed a strong product differentiation in its LTM. This implies that its export prices are much higher than LTM exported by Asian countries (which nowadays concentrate most of the world exports of such goods). For example, Italy is a big global player in sectors like textiles, clothing, footwear, leather, glassware, jewelry or furniture, among others. During the last two decades, China has become a leader in many of these areas, relegating Italy from the first place. However, when comparing the unit price of these goods, we will see that in Italy are geometrically higher, demonstrating the existence of significant innovation activities[27]. In any case, the quality and brand differentiation in Italian low-tech manufactures is not enough to compensate its relative weakness in the CT index[28].

IV.2. The small traditional manufacturing countries

In this section we will focus on four European countries that have managed to build a diversified industrial economy since the nineteenth century: Belgium, Netherlands, Switzerland and Austria. These are countries with small populations (between 8 million -Switzerland and Austria- and 16 million -Netherlands-) and even smaller surfaces, which leads to high population densities.

Figure 4 shows the paths of these four countries since the late 60s. Firstly, it should be noted that they were widely developed nations around 1970. Secondly, they also had relatively high technological capabilities. Thirdly, countries have gone in a “northeastern” direction, that is, toward a higher CCTX and a stronger CT index. However, it is interesting to note some peculiarities.

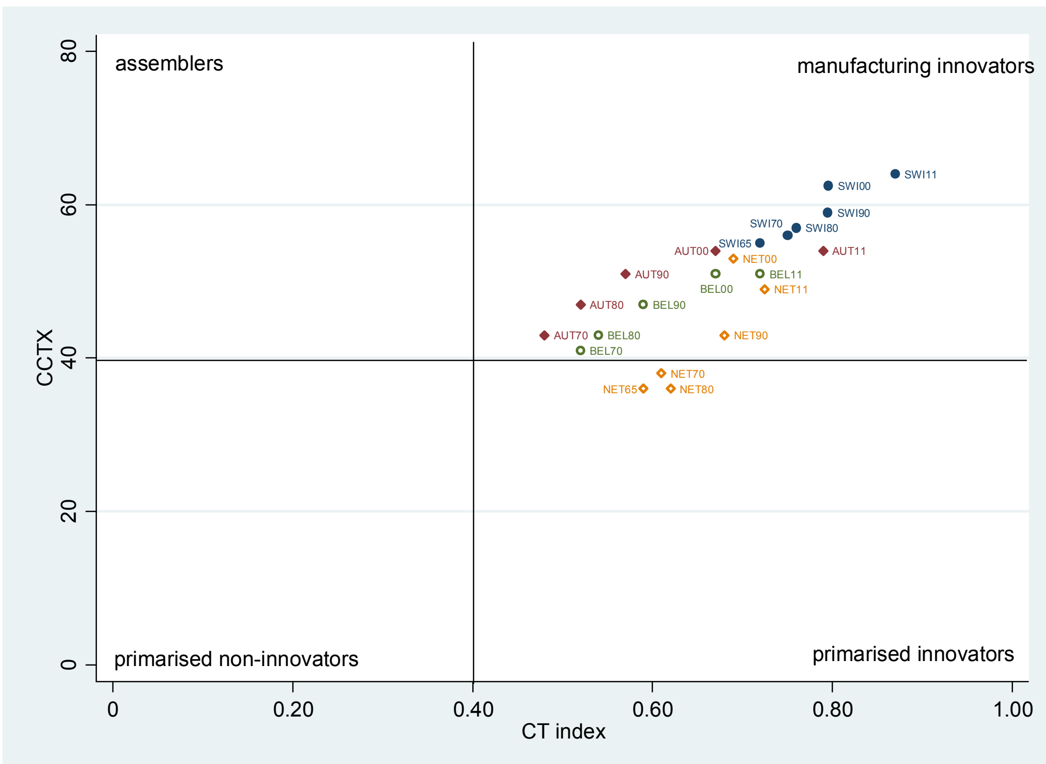
In first place, it should be remarked the phenomenal growth of Austria’s CT index, which increased by 0.31 points (0.48 to 0.79) between 1970 and 2011. Thus, Austria shifted from being the country with the lowest CT index of this subgroup to the second one, only behind Switzerland (it is worth noting that something similar happened with GDP per capita). For its part, Belgium also increased its

[27] For example, in 2012 the price per unit exported in the footwear sector was $ 46 in Italy, while just $4.4 in China.

[28] What we have recently pointed out can also be extended to RBM. In particular, Italy has become highly prestigious in activities such as processed foods and beverages, as well as countries like France, Germany or the UK.

CT index at a relatively fast rate (0.20 between 1970 and 2011), although not as much as Austria or Japan. By contrast, Switzerland and Netherlands (which by 1970 exceeded Austria and Belgium both in terms of GDP per capita or CT index) experienced a moderate increase in their CT index (0.12), with periods of stagnation (the 70s and the 90s in both cases). Thus, in regard to the CT index, both Switzerland and Netherlands lost ground against Austria and Belgium. Although Switzerland still remains the country with the highest CT index in this group, the distance to the others has narrowed considerably over the whole period. For its part, in the last decade Netherlands has left the second place that held in 1970 at the hands of Austria, and currently it has a CT index similar to that of Belgium. It is also noteworthy that in terms of GDP per capita, the gap that separated Netherlands and especially Switzerland from Belgium and Austria has virtually disappeared since the late 60s. Finally, it can be seen that in the last fifty years there has been a clear upward trend in the CCTX of these four countries.

Figure 4: The paths of Austria, Belgium, Netherlands and Switzerland (1965-2011)



Source: author's own elaboration on the base of COMTRADE, UNESCO, USPTO, NSF, OECD and World Bank data.

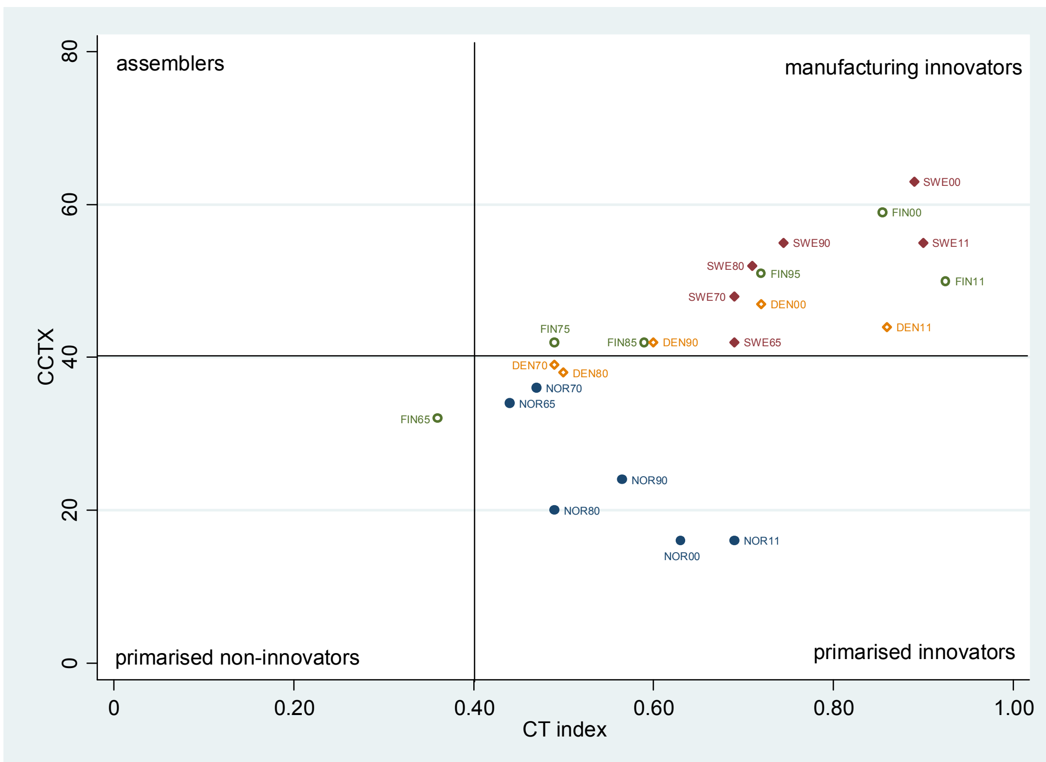
IV.3. The Scandinavian countries

The experiences of the Nordic countries as well as those of Australia, New Zealand and Canada (described in the next subsection) are particularly interesting because in all of them natural resources have historically been central levers of economic development (Ramos, 1999; Blomstrom & Meller, 1990; Maloney, 2002).

Figure 5 shows that since the mid-60s, the Scandinavian countries have rapidly increased their CT indexes. Moreover, in these four countries, the growth rate of this index was higher than in the countries analyzed so far (except Austria and Japan). However, it is possible to distinguish different rates between countries and between sub-periods.

Finland is a special case: in 1965 was, by far, the Scandinavian country with the lowest CT index (and also lower than in all the cases analyzed so far in this section) index. This was because at that time the modernization process was more unfinished than in the rest of the developed world. However, in 2011 the picture was radically different: Finland had become one of the world leaders in innovation. Between 1965 and 2011, the Finnish CT index rose 0.57 points, from 0.36 to 0.93, which represents one of the most dynamic paths of the world. Finnish GDP per capita followed a similar pattern: while in the mid-60s Finland was significantly poorer than Denmark and Sweden, currently it has converged with them. It should be noted that the Finnish CT index growth was sustained throughout the period, which did not occur in the other Scandinavian countries.

Figure 5: The paths of the Scandinavian countries (1965-2011)



Source: author's own elaboration on the base of COMTRADE, USPTO, Nordic Institute for Studies in Innovation, Research and Education (NIFU), OECD and World Bank data.

For its part, Denmark's CT index also experienced strong growth (0.37 points), although it may be noted that in the 70s stagnation prevailed. In spite of "primarizing" its exports, Norway also significantly increased its CT index, albeit at a slower pace than Denmark and Finland (0.25 points). Having had in the 60s a CT index that was similar to the Danish and higher than the Finnish one, Norway has currently fallen behind its Scandinavian neighbors. Despite this, it is worth mentioning two issues: first, the relative lag of Norway's CT index becomes meaningless when compared with other countries in the world, as we have seen in Section 3. Second, though having a lower CT index, Norway currently has a higher GDP per capita and a higher HDI than its Scandinavian neighbors.

Probably, the proper management of oil revenues (which in Norway are huge) since the 70s has influenced this. Finally, Sweden is the country that has shown a slower growth in the CT index compared to the other Nordic countries (0.21 points). However, it should be remarked that Swedish advantage respect to the CT index was very high in the 60s. Thus, like Denmark and Finland, Sweden is nowadays one of the most innovative countries.

The paths of the Scandinavian CCTXs were uneven. On the one hand, Norway experienced a marked reprimarization of its exports, which happened mostly in the 70s, due to the discovery of oil in the North Sea in 1971. However, as noted, the fall of the Norwegian CCTX was accompanied by an increase in the CT index.

Meanwhile, in 1965 Finland had an international insertion rather focused on natural resources, with its CCTX just over 30 points. This was due to the enormous weight of the forestry sector, which accounted for 63% of Finnish exports (15% because of timber and 48% because ofpulp and paper). However, since then, Finland's CCTX has experienced an upward trend, only partially reversed in recent years. The Finnish transition to the group of "manufacturing innovators" is embodied in the fact that the machinery and equipment sector accounted for 45% of Finnish exports in 2005, while in 1965 they had done it in only a 12%. The counterpart of this is the decline of forestry, which accounted for just 17% of exports in 2005. Within the machinery and equipment sector, telecommunications equipment have excelled, explaining about 20% of Finnish exports between 1998 and 2007. Almost all of these sectorial exports was due to a single company, Nokia, who also represented 30% of Finnish expenditure on R&D and 25% of economic growth in those ten years. Also, it explained 27% of Finland's patent applications in 2011[29]. Since the international economic crisis triggered in 2008 and increased competition from other similar companies as Apple or Samsung, Nokia ceased to be one of the engines of the Finnish growth. In fact, in 2012, telecommunications equipment only represented 3% of the country's export basket. The latter explains why the Finnish CCTX has fallen in recent years.

The trajectory of the Swedish CCTX has many elements which are similar to that of Finland. First, both countries share an upward path of the CCTX between 1965 and 2000 and then show a significant drop. Second, forestry and telecommunications sectors have also been crucial in the Swedish export basket. Similarly to Finland, Swedish exports of telecommunications equipment came to represent 16% of exports in 2000 before falling to 6% in 2011[30]. It should be highlighted that the bulk of Swedish exports of telecommunications equipment was made by the company Ericsson[31], whose relevance in Sweden's economy was lower than that of Nokia in Finland. Despite these similarities between these two countries, it should be noted that the Swedish CCTX has been always somewhat higher than the Finnish one. This is because Sweden industrialized and diversified its productive structure much earlier.

For its part, the Danish CCTX has been rather stable between 1970 and 2011, with figures of around 40% (except in 2000, when reached 48%). However, it is noteworthy that, until the second post-war

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[29] Source: "The Nokia effect", The Economist, 8/25/2012. Available in: http://www.economist.com/node/21560867

[30] Is this retraction which accounts for much of the fall of the Swedish CCTX in the first decade of the new millennium.

[31] Source: http://www.swedishtradehistory.com/Relations/From-raw-materials-to-environmental-technology/

period, the Danish CCTX was much lower, because its exports were dominated mainly by PP and RBM (mostly meat and dairy products). During the second post-war period, machinery sectors gained share in the export basket, and this explains why Denmark's CCTX was relatively high by the 70s.

Before closing this subsection, we would like to expand on one problematic issue. By 1970, Norway was a country whose GDP per capita was 20% lower than that of Denmark and Sweden, and slightly higher than the Finnish. Despite having helped to primarise its exports, the discovery of oil in the North Sea in 1971 did not involve the emergence of Dutch disease in Norway. Furthermore, henceforth, Norway grew faster than its neighbors, thus becoming one of the richest countries in the world (the most affluent in Scandinavia) and the world leader in HDI. Thus, why here the discovery of oil refuted the idea that natural resources can be a "curse"?

Larsen (2004) establishes various factors that might have an impact on this point. First, he shows that Norwegian wages increased in line with productivity gains in manufacturing. This was a major difference with other experiences of commodity booms, where the new dynamic sector became the reference of wages and prices in the economy, which eventually affected the competitiveness of other activities. This was posible because Norway has had one of the most concentrated systems of wage negotiations in the world. The legacy of this was that trade unions and employers could understand the harmful effects of an excessive currency appreciation, which could be reached if wages in the oil sector rose disproportionately.

Another feature highlighted by Larsen (2004) is that Norwegian oil extraction has been off-shore, unlike most oil countries where this has been in-land. This difference is important because offshore extraction requires more sophisticated technological knowledge and more costly investments. Moreover, the author notes that off-shore extraction allows a sector such as oil to generate spillovers to the rest of the productive structure, which is very rare. Also, the Norwegian state encouraged R&D activities and human capital formation in order to avoid using skilled foreign labor in offshore oil activities. In short, the hydrocarbon sector has become a main driver of Norway's national innovation system. Without this fact we cannot understand why the CT index increased considerably since the '70s, nor why Norway turned the natural resource curse into a blessing[32].

IV.4. The English-speaking settler countries with a strong weight of the resource-based sectors

The countries in this group (Canada, Australia and New Zealand) share together various features: first, the three were former British colonies and, even after their independence, they remained linked to the British Crown under the Commonwealth. Secondly, they are highly developed countries. Third, as in the Nordic countries, they have used their natural resources to establish its path of economic development (although, as we shall see, Canada has built a larger industrial base than the other two). Fourth, historically they have always had very favorable geopolitical frameworks, without which their processes of economic development would have been more difficult[33].

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[32] Larsen (2004) points out other factors that may have contributed to Norway's success. Among them, he mentions the existence of strong institutions, the implementation of public policies towards female labor participation, and the creation of a countercyclical Petroleum Fund, which has also avoided xcessive currency appreciation by exporting capitals.

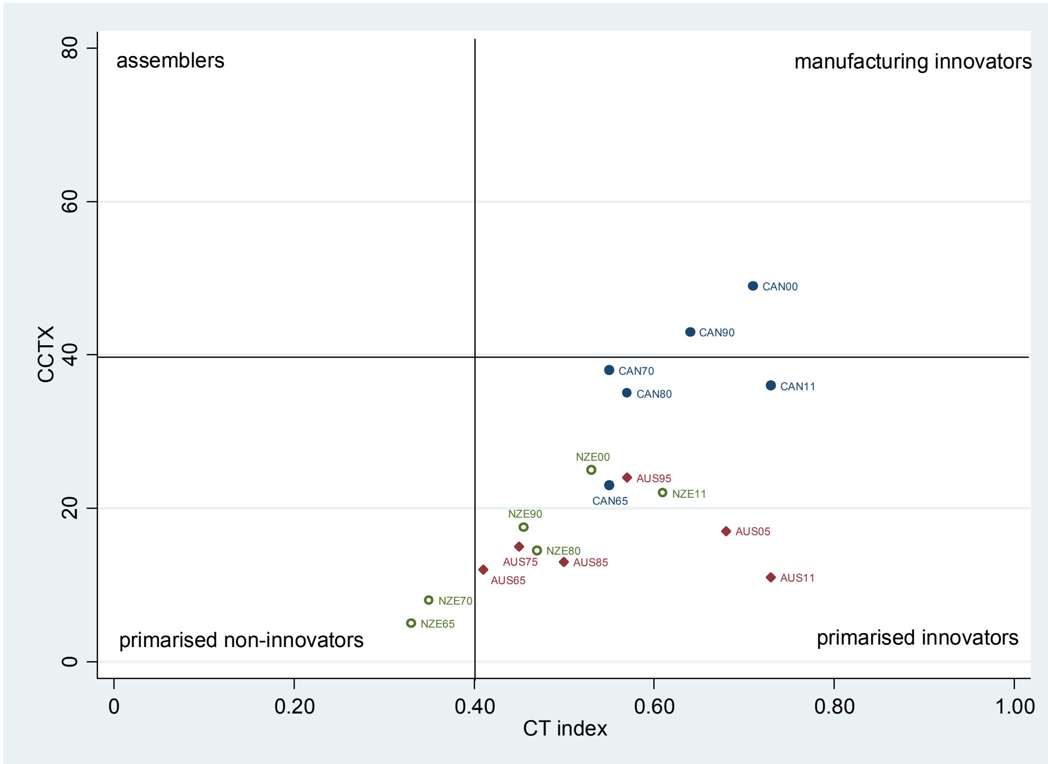
[33] For example, since the end of WWII, Australia has had a chronical deficit in its current account which was generally financed with American capitals.

Figure 6 shows that in the mid-60s these three countries had a relatively high CT index, being higher in Canada than in Australia and New Zealand. It can also be noted that since then the CT index has risen in the three countries, although with dissimilar rhythms. On the one hand, Australia has rapidly increased its CT index, reaching Canada, who also rose it, but more moderately. New Zealand, which has historically had a lower CT index than those of Australia and Canada, has narrowed the gap with the latter, but increased it with the former[34]. Thus, Australia and New Zealand also decreased the gap with traditional powers such as the USA, Germany or France, while Canada kept them. Currently, the distance in the CT index between these three countries and countries like the US and Germany is noticeable but not too wide.

Figure 6 also illustrates that none of these three countries has significantly altered its CCTX since the early 70s. Perhaps New Zealand has experienced the highest growth (its CCTX increased from 5% to 22% between 1965 and 2011), but which is explained mostly by a lower share of PP in total exports, in favor of RBM, and not by a significant growth of MTM and HTM. The Australian CCTX is now almost the same to that of 1965 (11% in 2011 vs. 12% in the mid-60s), while the same occurs in Canada (36% in 2011 vs. 38% in 1970). However, it should be noted the sharp increase in Canada's CCTX between 1965 and 1970. This was due to the implementation of an automobile trade agreement between the USA and Canada in 1965, which involved trade liberalization between these two countries in the segment of automobiles and autoparts. Consequently, between 1965 and 1970, the automotive sector (mainly composed of MTM) increased much its importance in Canadian exports. For its part, also note how the change in relative prices in favor of commodities which occurred during the last decade affected the CCTX of these countries, particularly in Canada and Australia.

Figure 6: The paths of Australia, New Zealand and Canada (1965-2011)

[34] For the period 1965-2011, the CT index has risen 0.30 points in Australia, 0.26 in New Zealand and 0.18 in Canada.



Source: author's own elaboration on the base of COMTRADE, USPTO, NSF, OECD and World Bank data.

In these three countries, manufacturing plays a less important role in the productive structure than in most of the other developed countries. This is not only proved by a lower CCTX, but also by the contribution of manufacturing to total business enterprise expenditure on R&D. In Australia, manufacturing only accounted for 37.5% of it in 2005, while in New Zealand and Canada these figures were 52.1% and 59.4%, respectively. By contrast, in countries like Germany, Japan, South Korea and France, these numbers exceed 85%, according to OECDStat. This suggests that in Australia, New Zealand and Canada, both primary sectors and services linked with resource-based activities play a prominent role in R&D.

Finally, above we have noted that Canada has a larger industrial base than Australia and New Zealand. This is not only due to a higher CCTX. Other indicators that could sustain this assumption are, for example, the share of manufacturing in the total business enterprise R&D (as we have seen in the last paragraph, in Canada is higher than in the other two). If we decompose this indicator by manufacturing sectors we will see that the gap between Canada and Australia and New Zealand is significant. For example, according to OECDStat, in 1999, engineering-intensive sectors[35] accounted for 57,3% of total business R&D in Canada, while in Australia and New Zealand these figures were 32,2% and 26,4% respectively. In Germany and Japan, these numbers were higher than 80% in the same year.

IV.5. Late-developed European countries (without communist legacy)

[35] That is, machinery and equipment, transport equipment and chemicals.

This subsection describes the development paths of five countries of the European periphery who did not have a communist past: Spain, Portugal, Ireland, Greece and Israel. Although not strictly European, we have considered the latter as such, because for cultural and geopolitical reasons.

It is noteworthy that, according to Maddison (2009), in the mid-50s these countries had a GDP per capita considerably lower than those analyzed until now (except Japan). However, during the second post-war period they experimented a strong process of convergence with the developed world (mainly, the US). Since then, these countries have had an heterogeneous performance: while Portugal, Greece and Israel barely stagnated their process of catch-up, Ireland accelerated it between the late 80s and 2007. Spain also continued its process of convergence between the mid-80s and 2007, but at a lower pace than Ireland. In 2007, before the outbreak of the international economic crisis, Ireland ranked 5th in the HDI world ranking (just below Norway, Australia, Iceland and Canada), Spain 15th (in the same level that the USA, Austria or Denmark), Greece 25th (just below Germany and the UK), Israel 27th (just below Greece and South Korea) and Portugal 34th (at the level of Czech Republic and Qatar). Within this group, Israel is by far the country that has least suffered the international crisis: in 2013, it climbed to the 19th place of the HDI world ranking, while Ireland fell to the 11th, Spain to the 27th, Greece to the 29th and Portugal to the 41th. Obviously there are multiple factors that can explain this Israeli anomaly, but we believe that one of them might lie in its particular development path experienced.

Figure 7 presents the development paths of these five countries since the mid-60s. We can observe several interesting issues: in the late 60s, the five had a relatively low CCTX (around 20-25 points), which was because none of them had experienced a profound process of industrialization based in manufacturing. However, it should be noted a detail: Israel (who then had the largest GDP per capita within the group) had a much greater CT index than the rest. In fact, it was the only country in this group that was in the bottom-right quadrant of our scheme. In those years, 70% of Israeli exports were PP and RBM (mainly, diamonds, fruit and vegetables). Despite not having an outstanding manufacturing sector, Israeli productive structure was quite technicized. Particularly, its agricultural sector was not only modernized but was also the center of important innovations that were made both within the *kibbutzim*[36] and Israeli universities (Senor and Singer, 2009). Israel is located in a region with low natural resources endowments due to arid climate and salinization of soils. Thus, it is not surprising that the most important innovations after the founding of the State in 1948 were linked to desert agriculture, water management, drip irrigation and desalination. All this contributed to diversify and raise productivity in Israel's agricultural sector.

Since 1970, Israel has been moving to the "northeast" of our scheme. Thus, in recent years it has become one of the countries with the highest CT index of the world. In fact, nowadays Israel is the world leader in R&D expenditures as a percentage of GDP. Even more, within the five countries of this group, Israel is the one who has most risen its CT index, despite starting from a higher level. Its CT index increased from 0.51 in 1965 to 0.99 in 2011 (0.48 points increase), while in Ireland it grew 0.38 points (from 0.31 to 0.69), in Spain 0.34 (from 0.18 to 0.52), in Portugal 0.32 (from 0.11 to 0.43) and in Greece 0.22 (from 0.11 to 0.33). Such is the magnitude of the Israeli innovative performance

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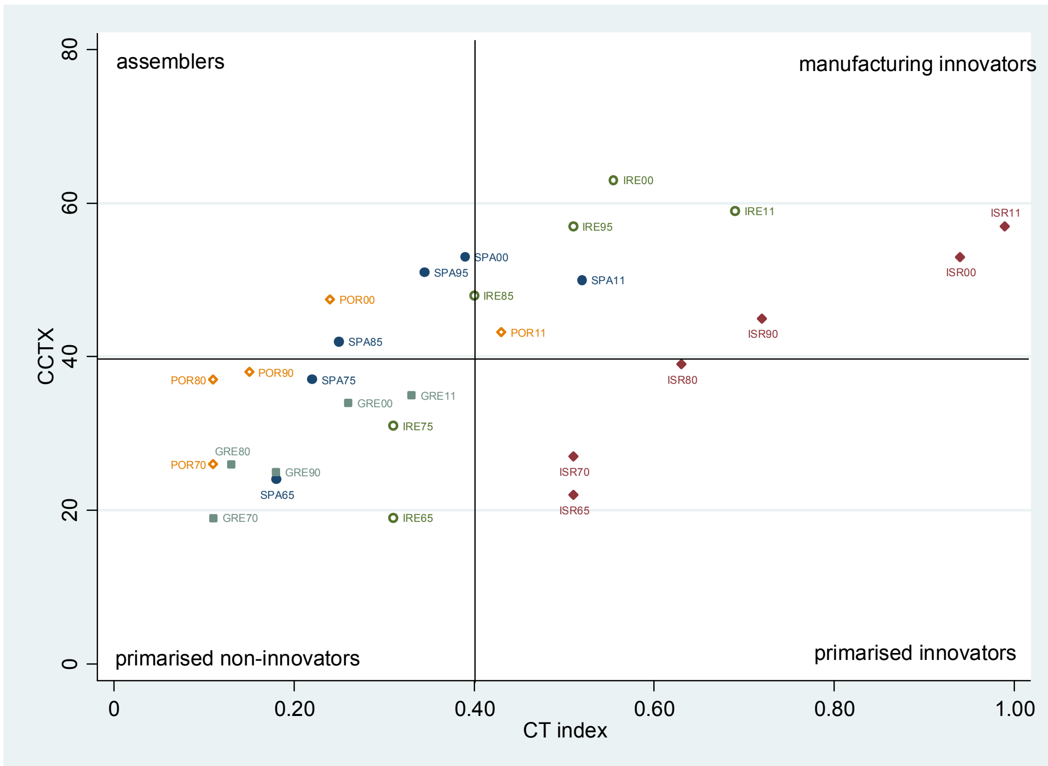
[36] *Kibbutzim* is the plural of *kibbutz*, which in Hebrew means "meeting" or "collective". The *kibbutzim* are Israeli agricultural comunes in which membership is voluntary, and their main ideologies are socialism and Zionism.. The first *kibbutz* was founded in 1909 by a group of Russian Jews who migrated to the region of Palestine. While today only 2% of the population live on *kibbutzim*, they still represent a significant 12% of Israeli exports. The greatest splendor of the *kibbutzim* was in the '50s and the '60s.

that currently it has the largest number of start-ups per capita in the world. At the same time, Israel's CCTX has increased a lot since the mid-60s. If in 1965 only 8% of Israeli exports were MTM or HTM, in 2012 they represent a 50% of them (mainly due to machinery and equipment and pharmaceuticals). Thus, Israel is nowadays a "manufacturing innovator".

Figure 7: The paths of Israel, Ireland, Spain, Portugal and Greece (1965-2011)



Source: author's own elaboration on the base of COMTRADE, USPTO, OECD and World Bank data.

For its part, Ireland has also moved sharply to the "northeast" of our scheme since the mid-60s, although its CT index is currently much lower than that of Israel (see Figure 7). Like the latter, Ireland has steadily increased its CCTX between the mid-60s and the late-90s, going from 19% in 1965 to 63% in 2000. Logically, this is due to a strong decline in the share of PP in Irish exports at the expense of MTM and HTM[37]. It should be highlighted that exports of services nowadays occupy a central place in Ireland's trade balance, as they represent half of total exports of goods and services. Many of them are linked to ICTs: no country exports more software than Ireland[38]. Also, insurance and finance have an important place in Ireland's export basket: they represented another 9% of total exports in 2011. As was said, Irish CT index increased 0.38 points since 1965. However, large part of this increase occurred since the late 80s, as it is shown in Figure 7. In short, since the second post-war period and in particular since the late 80s, Ireland has gone through the path of economic development. Although structural change achieved was very important, Ireland has not yet reached

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[37] In 1965, PP accounted for 60% of Irish exports (mainly, cattle), while MTM and HTM represented a 7% of them. By contrast, in 2011 the share of PP was just 3% of total exports of goods, while MTM and HTM accounted for 51% of them (mostly, pharmaceutical products).

[38] Software activities accounted for 20% of total Irish exports in 2011.

the level of technological density of small countries like Israel, Denmark, Sweden and Switzerland, among others. Also, unlike countries such as the recently mentioned, the Irish development model has been based mainly on FDI, which could generate greater vulnerabilities in the future (Kirby, 2009).

Spain has also experienced a "northeast trend" since the mid-60s (see Figure 7). However, its CT index has grown less than the Irish and has been well behind the Israeli. Although the gap with traditional “manufacturing innovators” like the US or Germany has shrunk over the last half century, is still very wide. Spanish CCTX also showed a sustained increase between 1965 and the early 2000s (from24% to 53%), but since then it declined slightly. The rise of Spanish CCTX was caused by the deepening of its industrialization process. To put it in numbers, in 1965 only 19% of exports were MTM and HTM, while in 2011 this figure reached 48% (the automotive sector accounted for 18% of the export basket).

Portugal has also moved to the “northeast” of our scheme between 1970 and 2011. As in the cases described above, its CCTX increased significantly between 1970 and 2000, from 26% to 48%. While from the 80s Portugal rose 0.22 points its CT index, this was not enough to close the strong gap that still exists with the countries that are in the world technological frontier.

For its part, Greece was the country with the lowest structural change within this group. While it has also had a “northeast” path, the dynamism of its CT index was substantially lower than those of Portugal, Spain, Ireland and Israel. This has resulted in a small reduction of the technological gap with respect to traditional industrial powers, which remains huge. In turn, Greece’s CCTX is currently the lowest of this group (35%).

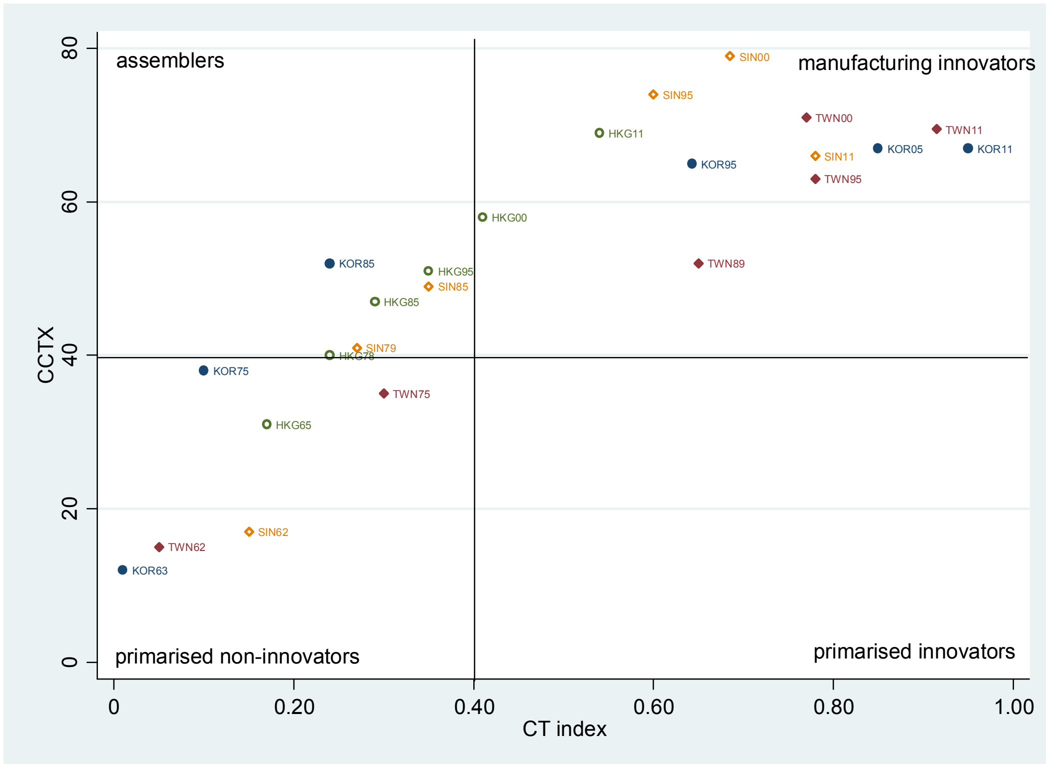
Finally, we would like to close this subsection with two questions: how much has influenced Israel’s huge technological dynamism in the fact that this country has suffered much less the international crisis than the other four? To what extent the particular depth of the current Greek economic crisis is due to its technological weakness?

IV.6. The Asian Tigers (South Korea, Taiwan, Hong Kong and Singapore)

Development experiences of Asian Tigers have been highly studied in the literature on development. The particular interest in the historical determinants of convergence processes experienced by these countries lies largely in the fact that their starting points were very low, in a region where only one country (Japan) had achieved a sustainable development path. In other words, in none of the cases analyzed until now GDP per capita was about 10% of that of the US at the initial moment of convergence, as it did happen in Korea and Taiwan. In "normal" contexts (that is, excluding the turbulent ‘30s and '40s), countries such as Japan, Italy, Spain, Portugal, Greece, Ireland, Finland or Israel had begun their convergence processes with the USA with levels of relative GDP per capita between 20% and 40%. Another particular feature of the experience of the Asian Tigers has been the sustainability of convergence, which still continues. Consequently, if by 1950 the GDP per capita of Hong Kong was just under 25% of that of the US, today is even slightly higher; if by 1965 the per capita income of Singapore was a fifth of that of the US, today they are very similar; if in the early

60s, per capita income in Korea and Taiwan were barely a tenth of that of the US, nowadays there are 70 and 79% respectively[39].

Figure 8: The paths of Korea, Taiwan, Singapore and Hong Kong (1962-2011)



Source: author's own elaboration on the base of COMTRADE, USPTO, OECD, Lee (2011) and World Bank data.

As shown in Figure 8, the recently mentioned process of convergence of the Asian Tigers has gone hand in hand with deep changes in their productive structures. First, Korea and Taiwan are the countries where these structural changes have occurred more intensely. In fact, there has been no country in the world that, since the '60s, have exceeded the rate of creation of technological capabilities. If until now we have mentioned that countries like Japan, Israel and Finland have managed to strongly increase their CT indexes in the last half century, in the case of Korea and Taiwan the rate of growth of this variable has been even more spectacular. In these two countries, the CT index rose 0.94 and 0.87 points respectively, while in Finland 0.57, in Israel 0.48 and in Japan "only" 0.38.

At the same time, it is also striking the change in Korean and Taiwanese CCTXs, which went from barely levels above 10% in the early 60s to about 70% nowadays. In 1962, 80% of Korean exports were primary products, such as rice (16%), fish (14%), non-ferrous metals (14%), silk (8%), iron ores (7%) and coal (5%). By contrast, MTM and HTM represented less than 5% of its exports. Taiwan's export basket was not very different: in 1960, two thirds of it was explained by PP and RBM. One commodity, sugar, accounted for 44% of Taiwanese exports in that year. Since then, both countries experienced a deep industrialization process, by which they could spectacularly diversify their

[39] Data series are from Maddison (2009) and World Bank (naturally, they were joint).

productive structures. By the mid-70s, the composition of the export basket was radically different, making evident the changes that had been taking place in the economy. In 1975, Korea's CCTX was 38%: while PP and RBM had withdrawn their share in exports to only 22%, LTM had increased to 53%. The same occured in Taiwan: its CCTX was 35% in 1975, and LTM represented 60% of exports. In both countries, textiles, garments and footwear were the goods that most explained the high share of LTM in exports. But structural change did not stop there. Since the '80s, LTM have been losing their share in exports, at the expenses of MTM and HTM (electronics, machinery, ships and automotive goods in Korea and electronics and electrical equipment in Taiwan). That is why both CCTXs could jump to about 70%.

Singapore and Hong Kong, which have similar characteristics to each other and very different to those of Korea and Taiwan, deserve a special mention. First, both countries are city-states; second, they were former British colonies. Third, since mid-nineteenth century they have developed strong skills in the commercial and financial sector. Fourth, in both countries the industrial bourgeoisie emigrated from China played an important role in the development process, especially in Hong Kong (Fajnzylber, 1982). Fifth, by 1950 both city-states had a similar GDP per capita, around 20% of that of the US, and more than twice of those of Korea and Taiwan. Sixth, the fact that they were city-states meant that the population employed in the primary sector was marginal (unlike the other two "tigers") and that the "agrarian issue" had therefore less significance. Seventh, the fact of having been comercial hubs in Southeast Asia implies that much of their exports were (and still are) re-exports.

However, between Hong Kong and Singapore there have been two major differences. First, since the early 80s Hong Kong has lost much of the manufacturing sector created in the previous decades, due to the relocation of production in China after Deng Xiao Ping's reforms. In contrast, Singapore has maintained it (Peebles and Wilson, 2003; Wong and Singh, 2008). Second, in Singapore, the main actors of the development process were the transnational corporations and the state. The latter was involved in various spheres, such as the labor market (ensuring low wages in the 60s and 70s), education policy, infrastructure, science and technology, real estate market or public services (Chung Ming Wong, 1987; Fajnzylber, 1983; Wong and Singh, 2008). On the other hand, in Hong Kong, the main agent of development was the Chinese emigrated industrial bourgeoisie. Also, the state was less interventionist than in Singapore, which was reflected in a lower interest in the development of public R&D, for example. Nevertheless, it maintained a strong intervention in certain areas such as land markets, which allowed decreasing the cost of reproduction of the labor force in order to put downward pressure on wages (Sharif and Baark, 2008).

Figure 8 shows that structural change has also been phenomenal in Singapore. However, its intensity was somewhat lower than those of Korea and Taiwan: its CT index rose 0.63 points between 1962 and 2011. Compared to the other "Tigers", Hong Kong has been much less dynamic in terms of it CT index (which grew 0.37 points in the same period). In fact, note that in the mid-60s, Hong Kong was the "Tiger" with the highest CT index, while in 2011 it had fallen far behind Korea, Taiwan and Singapore. However, if we compare its path against other countries, we would see that its performance has been quite remarkable.

Lastly, it should be noted that the CCTXs of Hong Kong and Singapur increased significantly since the 60s, as in Korea and Taiwan. As in these latter cases, those city-states first shifted from PP and RBM to LTM, an then to MTM and HTM.

IV.7. The emerging Asian economies

In this subsection we will focus on the paths of eight Asian countries (China, India, Turkey, Vietnam, the Philippines, Indonesia, Thailand and Malaysia). First, it should be noted that these countries have in common not being developed (although the degree of development is quite heterogeneous between them). Second, these countries share a sustained increase in their CCTXs since the last quarter of the twentieth century, although they differ in their potential to create technological capabilities and in their economic performances during the last four decades. For example, while China's growth was spectacular since 1978 (multiplying by seven its GDP per capita between 1978 and 2008), the Philippines increased it by only a 30%.

Let us start with China. Structural transformations of the Asian giant have taken place at an accelerated pace since the liberalizing reforms of Deng Xiaoping in 1978. These changes have been accompanied by a rapid (but still unfinished) convergence with the developed world and a phenomenal export performance. Regarding the latter, it is worth noting that since 2010, China has been the largest world's exporter of goods. The reforms initiated in 1978 were very different from those implemented by the Eastern Europe countries, though both started from a situation of widespread inefficiencies within the state aparatus. Thus, the transition from socialism to capitalism has been much more gradual. This is reflected, for example, in the fact that China did not privatize public enterprises to the extent that Eastern European countries did. Indeed, Chinese government preferred them to be exposed to greater competition (through increased openness to private initiative) and to be managed by private profitability criteria (Arceo, 2011). This Chinese gradualism was also expressed in the policy towards foreign investment, whose actions have been slowly liberalized. The Chinese gradualism has allowed enhancing state capabilities built since the 1949 revolution, rather than weaken them. Without these powerful capabilities of intervention in the economic sphere, China might have not experienced the economic and technological dynamism of recent decades.

It is in this context that we must understand the development path of China, shown in Figure 9. Since the '80s, China has increased its CT index more than any other country in this group. Furthermore, there has not been any country in the world that has increased more than China its CT index during the last decade. In 1985 China's CT index was only 0.14 points; by contrast, in 2012 scored 0.47. Thus, year on year China has been moving towards the club of innovative countries. The Chinese CCTX has followed a path which is similar to those of the Asian Tigers. First, it grew pulled by LTM, whose share in the export basket grew from 17% in 1985 to 46% in 1995. Since then, MTM and HTM have been the main engines of growth of the CCTX, rising their weight in total exports from 30% to 55% in 2013. It should be noted that China accelerated the pace of growth of the CT index once the CCTX was relatively high. In other words, China first went to the "north" of our diagram, and only then to the "east".

Figure 9: The paths of China, India, Thailand, Philippines, Vietnam, Indonesia, Malaysia and Turkey (1965-2013)

Source: author’s own elaboration on the base of COMTRADE, USPTO, OECD, Fan (2004), Mani (2008) and World Bank data.

The process experienced by India[40] has been less vigorous than China. While India has also been converging with the developed world since the late '80s, it has done so at a more moderate pace, both in terms of GDP per capita and structural change. The latter is reflected in Figure 9: India also has been going "northeast", although at a much slower rate than China.

For its part, Thailand and the Philippines are similar in that their CCTXs have strongly increased since the 60s and that, in turn, they have been unable to move “eastwards” in our scheme. In both countries, the transformation of their export pattern has been commanded by TNCs (mostly Japanese and American) that have taken advantage of the cheapness of their labor forces. Also, both countries share the fact that high-technology manufacturing industries, although statistically high in its relation to GDP, are characterized by very weak "backward" linkages (Kohpaiboon, 2010; Reyes-Macasaquit, 2009; Usui, 2011; Doner, 2012). This is consistent with the low level exhibited by their CT indexes.

[40] The abbreviation in Figure 9 is "IND".

Anyway, they differ greatly in the pace of economic growth achieved since the '60s. According to Maddison (2009), in 1960 Thailand's GDP per capita was just 10% of that of the US, while in 2008 this figure was 28%. By contrast, Philippine GDP per head dropped from 13% of that of the US to 11% in the same period. The Philippine case shows that a higher technological content of exports does not always lead to higher economic growth in the long term. Furthermore, the sustainability of Thai convergence process is unknown. As Doner (2012) and OECD (2013) noted, the Thai growth has been "extensive", that is, it was based on factor accumulation (mainly due to relocation of rural labor in manufacturing activities of higher productivity).These studies indicate that, after reaching certain levels of GDP per capita, this growth model becomes exhausted, thus generating a "middle income trap". Hence the need for developing endogenous technological capabilities.

The Malaysian case is a midpoint between the Thai and Chinese ones. On the one hand, like these two countries, Malaysia has also partially converged with the developed world (its GDP per capita went from 14% of that of the US to 33% between 1960 and 2008[41]). However, the CT index has risen considerably more than that of Thailand, but it does not have the dynamism of that of China. Furthermore, its CCTX has sharply risen in recent decades, as in these other countries (see Figure 9).

Vietnam, in turn, began its process of economic liberalization and mutation towards a strategy of export promotion in 1986, later than other Asian emerging countries. Since then, it has experienced a process of partial convergence with the developed world. Vietnam has being moving "northwards" in our diagram since the 2000s: its CCTX grew from 19% in 2000 to 33% in 2011. In recent years, Vietnam accelerated the growth of its CCTX: in 2013 it scored 45%. Thus, Vietnam nowadays is rather an "assembler" than a "primarised non-innovator". However, as in the Philippines or Thailand, this change in the composition of exports has not been accompanied by an increase in the CT index, which has remained near zero.

For its part, Indonesia is Southeast Asia's largest economy, which is due to its large population (about 255 million, the fourth largest population in the world). Like other countries in the region, Indonesia adopted a strategy based on export promotion since the late 60s. However, two issues should be remarked: first, in the 50s, the GDP per capita of Indonesia was similar to that of Thailand. But in the long term, the latter country has experienced a much faster convergence with the developed world[42]. Second, unlike Thailand, Malaysia, the Philippines or China, in Indonesia the CCTX never became too high (in 2000 it touched a peak of 32% and has since retracted up to 23% in 2011, see Figure 9[43]). In part this was because Indonesia has had higher oil endowments than its neighbors, which was reflected in its export basket. In turn, as in the Philippines, Vietnam or Thailand, Indonesia's increase in the CCTX has not been accompanied by a growth in the CT index.

Lastly, Turkey shares several features with the cases mentioned above, but also some differences. Among the similarities, we note an upward trajectory of the CCTX in the last thirty years and, like Malaysia, India or China, a noticeable increase in the CT index (see Figure 9). The main difference we want to highlight here has to do with the economic geography: while Turkey is much more linked

[41] According to Maddison (2009).

[42] According to Maddison (2009), Thailand's GDP per head grew 85% more than that of Indonesia between 1960 and 2008.

[43] The abbreviation in Figure 9 is "IDO".

to the European Union, Southeast Asia's countries are much more integrated into the Pacific area, with Japan and China as the major links of the trading block.

IV.8. The former European Communist states

This subsection focuses on Eastern European countries that went through communist experiences: Czech Republic, Slovakia, Poland, Hungary, Romania, Russia and Ukraine.

During the second post-war period, these countries had high growth rates (not very different from those of Western Europe), which allowed them to partially close the gap in GDP per capita with the United States[44]. However, 1975 marked a turning point in socialist economies: since then, they began a process of divergence with the developed world, which would become much more intense in the 80s. Finally, as it is widely known, socialist models of development collapsed in the early 90s. Transitions to capitalism were traumatic in all these countries. However, some of them could stay afloat quicker than others in which the economic depression was much deeper. For example, in 1996 Poland restored its 1988 GDP per capita (which coincided with the peak of the communist era). Hungary, Czech Republic and Slovakia spent four more years to recover its previous GDP per head. In Romania, Russia and Ukraine the crisis was significantly stronger: the first two only regained their late-80s income per capita in 2006, while the latter could never return to such levels[45]. It is noteworthy that Poland, Hungary, Czech Republic and Slovakia are, togheter with Slovenia, the former communist countries that more easily were incorporated into the German circuit influence first, and in the European Union later[46].

Figure 10[47] presents the development paths of these countries since 1970. If we go back further in time, we could notice that during the 50s and 60s there were pronounced processes of technological capabilities creation in these countries which, however, occurred with different intensities[48]. The Soviet Union, Czechoslovakia, and Hungary had a scientific and technological system that was much

[44] In 1950, West Europe's GDP per head was 48% of that of the US; in 1975, this figure had risen to 71%. In the Soviet Union, these numbers were 30% and 38% respectively, while in the rest of Eastern Europe's countries (Czechoslovakia, Hungary, Poland, Romania, Yugoslavia, Bulgaria and Albania) they were 22% and 33%.

[45] In fact, in 2013 Ukraine's GDP per head was 20% lower than that of 1989.

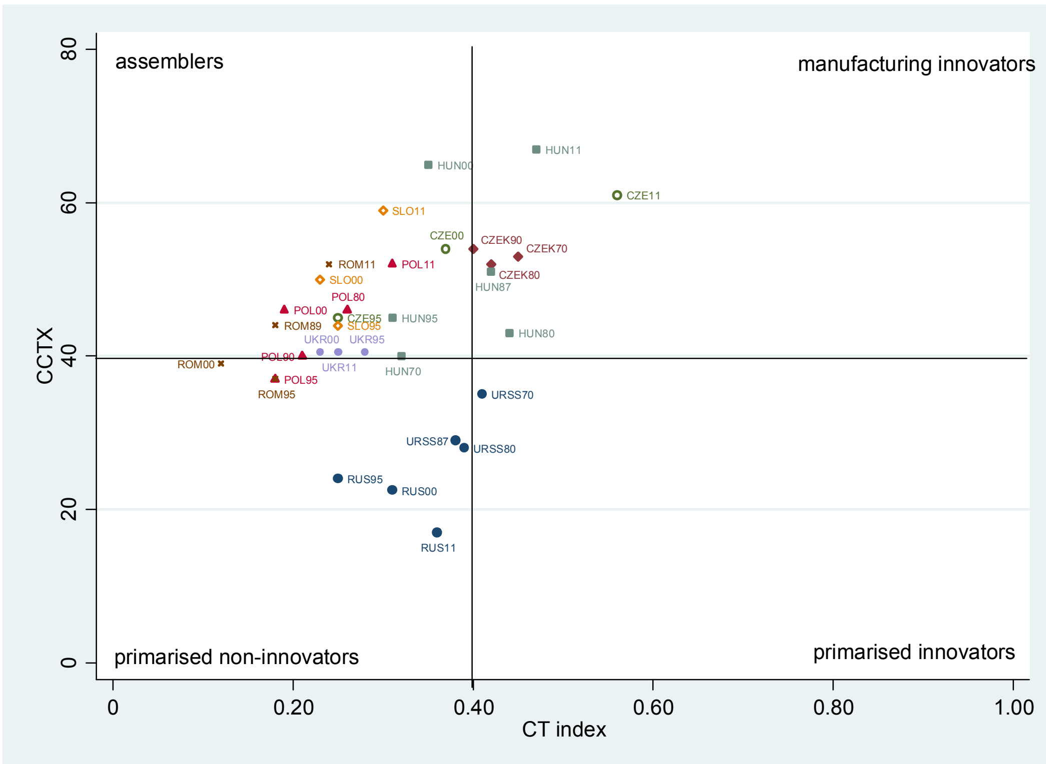
[46] These five countries joined the EU in 2004, together with Latvia, Lithuania, Estonia, Malta and Cyprus. Romania joined it in 2007, together with Bulgaria. On the other hand, Russia and Ukraine are not part of the EU.

[47] The abbreviations "CZEK", "CZE" and "SLO" represent Czechoslovakia, Czech Republic and Slovakia respectively.

[48] Already in the 1920s, Hungary and Czechoslovakia had tended to converge, in terms of patents, with the world technological frontier. The Socialist experiments did not alter this greater technological dynamism of these two countries respect to other neighbors in Eastern Europe like Romania, Bulgaria, Poland and Yugoslavia (Radosevic and Kutlaca, 1998).

more developed than those of Poland and Romania. Thus, it is not surprising that those three countries had considerable technological capabilities around 1970, as shown in Figure 10[49].

Figure 10: The paths of European former communist countries (1970-2011)



Source: author's own elaboration on the base of COMTRADE, USPTO, OECD, UNESCO, World Bank, Radosevic and Kutlaca (1998), Reiner and Kattel (2010) and Kattel and Primi (2010). Soviet Union's CCTX was built with data from Lavigne (1992).

However, what characterized the national systems of innovation in these countries was a disconnection between the basic science (which was strongly developed, particularly in subjects such as physics, mathematics, chemistry or astronomy) and applied science (which has a very close link with the materialization of innovations). It is for this reason that real socialisms saw the combination of a high expenditure in R&D (which exceeded 1.5% of GDP in Czechoslovakia, the USSR and Hungary) and low patenting outside their own patent offices. In general, as in Latin America, the innovation model adopted was "linear supply-side", by which it was considered that investment in extramural R&D would automatically spill over the productive network. In the case of communist countries, R&D was generated in technological institutes (and, particularly in the USSR, was associated with military

[49] CT indexes of the pre-1989 period must be taken with some caution, given the lack of precise information on the amount of expenditure on R&D in these countries. For the cases of Czechoslovakia, Hungary and the USSR, we have inferred, for 1970 and 1980, the same level of R&D that actually happened in 1989, before the final collapse of their communist regimes. Unlike the cases analyzed so far, in which it has been possible to infer spending on R&D from performance in patents (due to the strong correlation between the two variables), in the countries of Eastern Europe as well as in Latin Americans, this is not possible, because of the divorce between inputs (such as R&D) and outputs (such as patents).

goals) that should officiate as a link between the academy and the productive sector. However, the established networks ended up being lax because the technological knowledge produced was not exactly what the industrial sector needed, a problem that persists even today (Kattel and Primi, 2010).

According to Radosevic and Kutlaca (1998), communist countries' low patenting in the United States (which, in turn, was mostly performed by these institutes) is also explained because they were going through a learning phase rather than an innovation stage. The authors note that despite sharing a model of planned economy, former Soviet bloc countries differed from each other in the areas in which they patented. For example, Hungary and Yugoslavia (which tried to move away from the rigid Soviet orthodoxy by introducing some market mechanisms into their economies) tended to innovate in chemicals and drugs, while Romania, Bulgaria, Poland, Czechoslovakia and the USSR focused more on electrical and mechanical equipment (Czechoslovakia, for example, was specialized in textile machinery). However, all Soviet bloc countries were behind in electronics and transport equipment. Reinert and Kattel (2010) assure that it was this inability to develop skills in electronics (a sector that has been central in post-Fordism) one of the cornerstones of the Soviet system's collapse.

The implosion of the Soviet system involved a huge destruction of technological capabilities, due to the sharp decline in R&D and patenting. That is the reason why all of these countries experienced a strong drop in their CT indexes during the 80s and the 90s. As stated above, the mode of transition from socialism to capitalism in these countries has been very abrupt, unlike what has been happening in China.

The Washington Consensus policies implemented in these countries in the 90s rapidly generated deep structural changes. By emphasizing the withdrawal of the state from economic affairs, macroeconomic stability and trade and financial liberalization, the Washington Consensus policies put aside the scientific-technological issue. Rather, it was considered that innovation would sprout by itself if macroeconomic stability, FDI and a conducive environment for market competition were ensured. However, according to Kattel and Primi (2010), until 1998 (when Washington Consensus approach was strictly adopted) the neglect of the technological innovation issue was great. The massive privatization of public enterprises and the disintegration of public R&D institutes (which were policies that implicitly or explicitly were accepted by the defenders of Washington Consensus) led to the deepening of the decline of the scientific-technological system. Also, rapid trade liberalization did not give public companies[50] enough time to successfully adjust to increased competition. While vertical integration of public companies was very high, problems arising in any of the links in the supply chain, affected the rest of the cluster. In particular, the most technologically-sophisticated companies (with higher fixed costs than variable ones) were those who had to face greater challenges in this new scenario (Kattel et al, 2009).

Only after the end of the 90s could these countries be able to rebuild their technological capabilities, in tune with the return to economic growth. However, there were different situations: first, as presented in Figure 10, Czech Republic is the country that has most increased its CT index since 2000 (0.19 points), even having started from a higher level than the other countries of the group. For its part, Hungary, Poland and Romania have risen their CT indexes at a similar pace (0.12 points) within the same period, although it should be noted that Hungary started from relatively intermediate levels, while Poland and Romania from lower-middle and very low ones, respectively.

[50] Naturally, we are referring to those public companies that survived privatization.

Apparently, Slovakia has shown less dynamism in its CT index (it grew just 0.07 points in the same period). On the other hand, Russia and Ukraine have shown a very slight increase in their CT indexes between 2000 and 2011 (0.05 in Russia and only 0.02 in Ukraine). Despite this, Russian technological capabilities are by no means negligible nowadays. While much of the military-industrial-scientific complex of the Soviet Union has been dismantled, some sectors thereof have survived.

With regard to the CCTX, the trajectories have been heterogenous. Figure 10 shows that in 1970, Czechoslovakia had a high technological content of exports (52%), over Hungary (41%) and the Soviet Union (36%). Between 1970 and the late 80s, the Soviet Union primarised its exports due to the strong rise in fuel prices after the oil shocks of 1973/4 an 1979, while Czechoslovakia remained at those levels, and Hungary approached the latter country. For its part, Poland in 1980 and Romania in 1989 had a relatively high CCTX (46% and 44%, respectively), greater than that of the USSR but lower than that of Czechoslovakia.

The explanation for these CCTXs lies in the trade specialization that had been given under the CMEA (Council for Mutual Economic Assistance)[51]. The Soviet Union was the main trading partner of Czechoslovakia, Hungary, Poland and Romania. Trade was rather interindustrial: USSR bought mostly manufactured goods from these countries, and sold them raw materials (especially oil), arms and certain manufactures articles. That is why the Soviet CCTX was lower.

However, it is interesting to note how the trade of the Soviet bloc countries with the rest of the world was. Take the example of Czechoslovakia, the most industrialized of these countries behind East Germany. By 1985, West Germany was Czechoslovakia's main export market within the non-Communist world: 5% of total Czechoslovak exports went there. The composition of Czechoslovak exports to West Germany showed a very different pattern than those which were directed to the CMEA. 60% of Czechoslovak exports to West Germany were PP and RBM (as for example, fuels, forest products, minerals and some low-sophisticated chemical manufactures), 27% were LTM (as textiles, clothing, footwear and low-tech steel products) and only 13% were MTM or HTM. Thus, the Czechoslovak CCTX with West Germany, country that indoubtedly could be considered in the global technological frontier, was only 29%. By contrast, Czechoslovak imports from this country were very different: 83% of them were MTM and HTM (capital goods and highly sophisticated chemical manufactures). Thus, West Germany's CCTX with Czechoslovakia was 67%. What this indicates is that the high Czechoslovak CCTX should be taken with caution, because, under free trade conditions, much of its exports of higher technological content would not be able to materialize due to both a higher production inefficiency and lower quality standards (the same goes for other CMEA countries). All this is quite consistent with former communist countries poor performances in patenting.

The first years of transition to capitalism (basically, the first half of the 90s) were marked by a decline of the CCTX in CEECs[52], which is due to two factors: first, the disappearance of manufacturing companies product of sudden competition and, second, the disintegration of the CMEA. Nevertheless, by the mid-90s CEECs could again increase their CCTX. Currently, they have reached levels that are higher than those of the communist era (see Figure 10). However, this rise in the CCTXs has not been led by domestic firms. In fact, it is the result of the processes of Western

[51] The CMEA was the main economic organization of the socialist bloc, and it was led by the USSR.

[52] Central and Eastern Europe countries. Here, we are referring to Czech Republic, Slovakia, Hungary, Poland and Romania.

Europe's (mainly, Germany's) production relocation with the aim of taking advantage of CEEC's low labor costs, high skills of the workforce and geographical proximity (Jürgens and Krzywdzinski, 2009; Haar, 2010).

In particular, the automotive sector has experienced strong growth since the mid'90s, explaining 20% of the CEEC's export basket in 2010. This process, led by transnational corporations, has left ambiguous results in terms of structural change in these countries. On the one hand, foreign investment has contributed to upgrade many manufacturing sectors, and it has also allowed the quality of manufactured goods to be similar to that of Western Europe. But on the other hand, as in the "assembler" countries, multinational companies have built few linkages with the rest of the technological-productive matrix. This is reflected in relatively low levels of R&D and in the fact that the most part of the value of output in high technology manufacturing sectors is generated abroad.

Anyway, this has not been the same in all these countries; in fact, Czech Republic saw a more virtous process. For example, the technological intensity of the Czech automotive sector (measured as R&D's share in value added), was 10.4% for the period 1995-2005, a figure that is even higher than what happens in countries like the UK and Italy. By contrast, in Poland, Hungary and Slovakia this technological effort was significantly lower (2.5%, 1% and 0.9% respectively). Furthermore, if we compare Czech Republic with Hungary and Slovakia (which are similar countries in terms of size), we can see that the import content of total inputs is considerably lower in Czech automotive sector than in the Hungarian or Slovakian ones (55.6% versus 73.8% and 73.4% respectively). This may be indicating a higher use of local inputs and, thus, more linkages with the rest of the productive structure. These issues might contribute to explain why Czech CT index is the highest within these countries.

Finally, we will dedicate some lines to describe Russia's path. As shown in Figure 10, the largest country in the world has been decreasing its CCTX since the disintegration of the USSR. What is beyond this is not only the price-effect generated by the changes in the relative prices of commodities since the 2000s, but also the serious destruction of the Russian manufacturing matrix as a result of the catastrophic '90s (Kattel and Reinert, 2010). Before the Soviet collapse, Russia was probably the most technologically-advanced BRIC[53] country. Currently, it has lost that position (indoubtedly, China replaced it), and it also has the most "primarised" and concentrated export basket within this group (the BRICs). To illustrate the latter, it is enough to point out that fuels accounted for 70% of Russia's exports in 2012.

Despite the heavy disintegration of its national innovation system during the 80s and 90s, Russia has preserved certain technological capabilities, and that is reflected in a relatively intermediate CT-index. Anyway, as Yegorov (2009) argues, these capabilities are still much stronger in Russia's defense system than in the civil one. Proof of this is that, within the few manufactured goods exported by Russia, weapons are one of the most noticeable ones (in 2012 represented 3% of exports). In fact, in 2012 Russia was the second largest exporter of arms, only behind the United States[54].

IV.9. The big Latin Americans: Argentina, Mexico and Brazil

[53] "BRIC" is an acronym that refers to the countries of Brazil, Russia, India and China.

[54] Data from Stockholm International Peace Research Institute.

This subsection (which will be the last of this paper) analyzes development patterns of the most industrialised Latin American countries: Argentina, Mexico and Brazil[55]. It should be noted that, in general, Latin America region shares with the countries of the former group a profound process of divergence with the developed world during the last two decades of the twentieth century and a stagnation (or even reverse) of its technological capabilities.

Two issues should be considered: on the one hand, not all countries have had the same performance[56]. On the other hand, the measurement of technological capabilities in the period before 1995 is very difficult for two reasons: first, because we only have official data on R&D since then. Second, because the great gap between R&D and patenting does not allow us to infer expenditure on R&D from regressions, as we could do for many developed countries.

Thus, CT indexes were estimated based on two criteria: first, by assuming that technological capabilities are strongly correlated with productivity in manufacturing (for which we do have data), we have outlined some possible trends of their performances; secondly, from qualitative literature respect to their endogenous technology absorption and creation between the mid-60s and mid-90s.

For a Latin American overview, we relied on the contributions of Katz (2000a), ECLAC (2007, Chapter IV) and Sagasti (2013); for the Argentinian case, moreover, we have complemented with researches like Katz and Ablin (1977), Lopez (2002) and Azpiazu & Schorr (2010), while for the Brazilian one we have also used IPEA (2010). Therefore, CT indexes' values prior to 1995 should be taken with some caution. By contrast, the figures of CCTX are more accurate, because COMTRADE data goes back to 1962.

Figure 11 shows that Argentina's development path was particularly marked by volatility. First, between 1962 and 1974, a process of increased exports of industrial manufactures, which rose from 3% to 25% of the export basket, was given. Thus, the CCTX grew from 5% to 19% during that period. Also, Argentina experienced a continued GDP per capita annual growth of 3.9% between 1964 and 1974, noticeably higher than that of the US (2.7%). This significant economic expansion was led by the manufacturing sector and accompanied by a loosening of the external constraint, which had generated severe crisis in the balance of payments in 1949, 1952, 1959 and 1962. This was mainly due to three factors: first, to an improvement in the terms of trade between 1962-1964 and 1969-1973; second, to a small but significant increase in agricultural exports, which was a result of increased mechanization in the rural area since the late 50s (Belini and Korol, 2012; Rapoport, 2007); third, to the drop of the industrial trade deficit, especially towards early '70s, when Argentine manufacturing exports began to take off[57].

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[55] Since the 60s, Latin American countries such as Colombia, Paraguay, Chile, Peru, Venezuela, Uruguay and Bolivia have experienced a very low mobility within our scheme, thus remaining in its bottom-left quadrant. Costa Rica is an exception: since the late 90s it moved from bottom-left quadrant to the upper-left one, mainly due to Intel's new plants. Note that, as ECLAC has been warning, the important process of economic growth that occurred in these countries over the last decade has not been accompanied by significant structural changes in the productive matrix.

[56] For example, since the mid '80s Chile has noticeably converged with the OECD countries, but with a moderate increase in its CT index. On the other side, as we will see, Argentina's path was terrific between the mid '70s and the early 2000s.

[57] For example, trade deficit in machinery and equipment declined from 1,34% of GDP in 1964 to 0,47% in 1974. If we measure trade deficit in machinery equipment in terms of exports (from 27% to 10% in those years) we would confirm that fall. See Schteingart (2015) for a more detailed analysis.

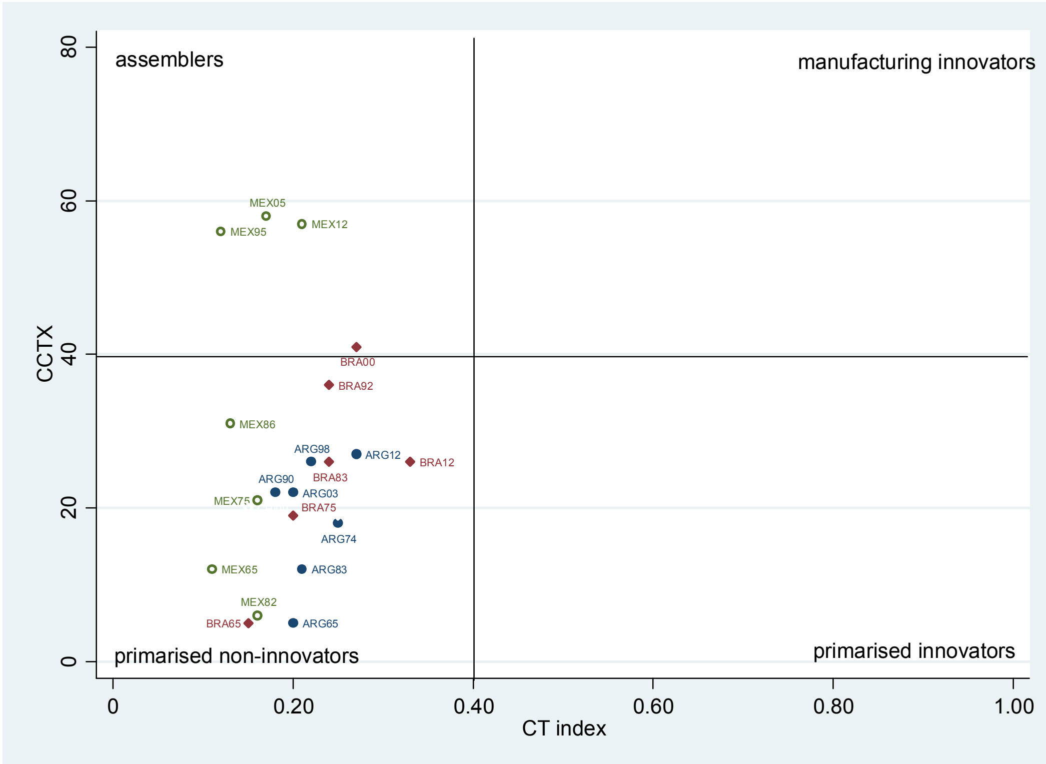
Probably, the latter is related with the fact that technological capabilities of Argentina's productive sector were incrementally increasing, though more by learning and imitation than throught innovation in the global technological frontier (Katz and Ablin, 1977). Despite the gradual growth of intramural R&D in the private sector, during this stage the main driver of the creation of technological capabilities was the state. (It should be remarked that, at the regional level, this was not an Argentinian anomaly, but rather the rule.) The Argentinian state began to promote scientific and technological development in the 40s, but especially in the 50s, when public institutions such as the National Council of Scientific and Technical Research -CONICET-, the National Atomic Energy Commission -CNEA-, the National Agricultural Technology Institute -INTA- and National Institute of Industrial Technology -INTI-) were created. Furthermore, public companies, which then played a central role in Argentina's (and Latin America's) economic dynamics were also an important part of the emerging national system of innovation, through their R&D laboratories and their employee training[58] (Katz, 2000a). In sum, available literature seems to demonstrate that technological capabilities effectively grew, but limitedly. Thus, that was not enough to abandon its peripheral country status. That is why Figure 11 show a moderate rise in Argentina's CT index between 1962 and 1974.

The oil crisis impacted negatively on Argentina, through a brutal fall in the terms of trade which in turn triggered a new crisis in the balance of payments in 1975. Unlike previous crises in the external sector, this one was given in a framework of distributive and political high conflict, without which it can not be fully understood the military dictatorship of 1976-1983. Between 1975 and 2002, Argentina would experience a strong structural adjustment process, which was accompanied by a profound divergence with the developed world. The economic policy implemented by the military government of 1976-1983 (centered in the abrupt trade liberalization, currency appreciation and falling domestic demand due to the fall in real wages) seriously damaged the industrial, scientific and technological matrix of the country, reversing the gains of the previous period. The debt crisis of the 80s, which was also suffered by most of Latin American countries, deepened these trends.

Note that in 1983 the CCTX was 12%, representing a drop if compared to 1974. This was due to the fact that the economic policy implemented severely affected the industrial manufactures, to the favor of those sectors in which Argentina had higher static comparative advantages (PP and RBM). During the rest of the '80s the CCTX again increased, exceeding 20% by 1990. However, this is explained by three factors that have little to do with a ripening of generalized technological capabilities. On one hand, the recessionary environment of that period meant that many industrial companies attempted to locate part of its production abroad. A second factor is the maturation of industrial promotion projects initiated in the 70s, especially in sectors as chemicals, steel and pulp. A third reason of that is the implementation of several subsidies to non-traditional exports, due to the pressing need for foreign Exchange (Azpiazu and Schorr, 2010).

Figure 11: The paths of Argentina, Mexico and Brazil (1962-2012)

[58] Note here a similarity with the former communist countries, which also had a supply-side model of technological development. However, in that region the state dominated the whole economy, while Argentina (and Latin America) had a mixed variety of capitalism.



Source: author's own elaboration on the base of COMTRADE, USPTO, OECD, UNESCO, World Bank, ECLAC (2007) and Katz (2000a)

During the 90s there were major changes in Argentina's productive structure, within a macroeconomic context marked by a deepening of the economic liberalization began in 1976 and a strong growth between 1991-1994 and 1996-1998. However, many industries could not survive the phenomenal increase in international competition, and disappeared. Thus, during those years there were mixed trends in technological capabilities: while some sectors favorably adapted to the new environment, others were severely affected and even destroyed. The CCTX continued to grow over those years, reaching 26% in 1998. However, the main reason behind this is the automotive integration agreement with Brazil, whereby car exports became very dynamic. It should be noted, however, that the Argentine automotive sector was integrated in global value chains more as an "assembler" than as an "innovator". A proof of this is that sectorial expenditures on R&D were practically nonexistent, while the sectorial requirement of imports rose steadily, thus reducing linkages with whe rest of the productive matrix (CEP, 2008; Azpiazu and Schorr, 2010; Schteingart, 2013, 2015).

Argentina's economy suffered a huge economic crisis between 1998 and 2002, where the GDP per capita declined 22%. The deep recession further disintegrated the productive structure, while also caused an even higher destruction of technological capabilities. The CT index declined in those years due to both the reduction in expenditure on R&D and patenting. However, between 2003 and 2011, Argentina experienced a remarkable economic growth of around 8% per year (except in 2009). The reasons for this Argentina's spectacular recovery are debated and we shall not elaborate on them[59].

[59] See Amico (2013) for a brief description of this debate.

Despite this, it is clear that the phenomenal improvement in the terms of trade that began in 2002 has had much to do. Also, there is agreement in the literature that the intense growth was not accompanied by a significant transformation in the productive structure[60]. This is reflected in the fact that in 2012 the composition of Argentina's exports was relatively similar to that of 1998, and also in the fact that innovative processes within the production sector were more the exception than the rule. If the CT index rose moderately between 2003 and 2012, this was mainly due to the sharp increase in public R&D spending.

For its part, Mexico partially converged with the developed world between the end of the Second World War and the early 80s. In fact, Mexico averaged a 3.3% GDP per capita growth between 1950 and 1980, much higher than that of the US (2.2%). As in many other developing countries, manufacturing was the key driver of that growth. However, since the debt crisis of the 80s, Mexico has retraced the convergence experienced during the decades of the 50s, 60s and 70s.

In this context, if we compare the current Mexican CT index to that of the mid-70s, we would see that, as in Argentina, there has not been a significant shift. Similarly to this country, during the state-led industrialization[61] (1930-1982), Mexico tended to generate a scientific-technological infrastructure with strong roots in public institutions (for instance, the National Council for Science and Technology -CONACYT-) and state enterprises (eg, PEMEX, Mexico's largest oil company). Also, similarly to Argentina, this scientific-technological development had reduced linkages with the private sector. However, both countries have differentiated in the depth of this development: in Mexico was somewhat less advanced, which is probably associated with a longer backwardness in human capital (eg, illiteracy rates were considerably higher in Mexico than in Argentina in that time) and which is also reflected in lower per capita patents. Anyway, during that period, GDP per capita and manufacturing productivity grew faster in Mexico than in Argentina. Thus, it is plausible to suppose that these differences were declining.

As in Argentina, during the 60s and the early 70s of Mexico increased the participation of its industrial exports (its CCTX went from 13% in 1962 to 29% in 1973), which helped to reduce the trade deficit in the manufacturing sector[62]. 1975 marked the beginning of the *oiling* of the Mexican economy: if Mexico had hitherto been a net importer of oil, since the mid-70s phenomenally increased its production and export after the commissioning of oil wells discovered in the last 60s and the early 70s (Hirschman, 1987). Furthermore, the international price of this commodity was at record high levels because of the oil shocks of 1973/4. Thus, the drastic fall of its CCTX during the second half of the '70s and the early' 80s (from nearly 30% to 6% between 1973 and 1982) is due to this process (see Figure 11). In 1982, oil had come to represent 75% of Mexico's export basket, 12% of its GDP and more than a quarter of its tax receipts (Hirschman, 1987; Castañeda and Villagomez, 2006).

While the Mexican economy continued to grow faster than the development world in the period 1975-1981, the dynamics of this growth was very different from that of the previous decades. The oil boom went hand in hand with an increase in inflation that, in the eyes of Castañeda and Villagomez

[60] For example, see Porta and Fernandez Bugna (2008), Porta et al (2014) and Azpiazu and Schorr (2010).

[61] This expression is used by Bertola and Ocampo (2013).

[62] In 1962, manufacturing trade deficit accounted for 5,4% of GDP and 98% of total exports. By contrast, in 1973 those figures had dropped to 3,6% and 74% respectively.

(2006), was due to a very excessive expansion of economic policy. According to Hirschman (1987), inflation was not accompanied by a rise in the nominal exchange rate, which led, on the one hand, to an real exchange rate appreciation which made imports explode (even more than exports, despite the oil boom) and, on the other, to massive capital flight performed by investors who saw this as an unsustainable process. Within an international context of high global liquidity, international banks financed these external imbalances, at the cost of a phenomenal increase in Mexican external debt. In this scenario, the rise in international interest rates and the decline in oil prices in the early 80s led to a severe economic crisis during the rest of the decade.

Since 1982, Mexico saw a steady increase of the "maquiladora"[63] sector (which was mainly directed by American transnational corporations), while oil production stagnated (at least until the mid 90s). Thus, after a decade, the Mexican CCTX had grown from virtually zero to over 50% in the mid-90s. Automobile and electronic assembly led this process. As technological capabilities generated by the "maquilas" were very low, Mexico moved from the bottom-left quadrant of our scheme to the upper-left one (see Figure 11). Trade integration with the United States and Canada under the North American Free Trade Agreement (NAFTA) deepened this process. As we can see in Figure 11, since the 90s Mexico has virtually had no movement in our scheme. Even more, Mexico's GDP per capita increased less than that of the US between 1991 and 2013[64] (30% against 37%). Thus, as a country such as the Philippines, the Mexican case casts doubts on Rodrik & Haussmann's hypothesis, which states that the rate of economic growth in underdeveloped countries would be higher than that of the developed ones, if the former imitated the latter's export baskets.

Finally, compared to Mexico and Argentina (and other Latin American countries), Brazil has been the country that has most deepened its industrialization process and the development of certain endogenous technological capabilities. Also, Brazil's rates of growth were one of the world's highest between 1950 and 1980, when averaged 6.8% annually (3.8% per capita). Particularly, Brazilian economic performance was spectacular between 1967 and 1980: its GDP per capita growth averaged 5.6% annually, when that of the US was 2.0%. But since the debt crisis of the 80s, Brazil's economy has lagged. Two figures account for it: first, no year exceeded 1980 in terms of Brazil's manufacturing GDP per capita; second, 1980 was the year in which the GDP per capita gap with the USA was the smallest of Brazilian contemporary history[65].

As in Mexico and Argentina, the core of the current Brazilian national system of innovation was founded during the state-led industrialization process (1930-1980). According to the Institute of Applied Economic Research of Brazil (IPEA is the acronym in Portuguese), 1951 is the year that marks the beginning of government actions explicitly focused on the support of science and technology in

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[63] The "maquila" is an enclave within a given economic structure, in which multinational companies take advantage of reduced labor costs in order to produce manufactured goods for export. The difference with other forms of export-oriented FDI is that in the maquila, the share of imported inputs is even higher. Thus, "backward" or "forward" linkages to the rest of the productive structure are extremely low. The only value added is limited to the workforce which is very cheap, as mentioned. The "maquilas" have a special legal regime, involving a differential customs treatment by which import and export taxes are minimized. Some scholars argue that "maquila" has some advantages, such as employment creation and foreing exchange generation (Gomez Vega, 2004; Fujii et al, 2005). Naturally, "assembler" countries like the Philippines or Thailand could also be classified as "maquiladores".

[64] We took 1991 because in this year the CCTX reached 50%.

[65] According to Maddison (2009), Brazil's GDP per head was a 28% of that of the US in that year.

Brazil, due to the creation of the National Research Council (CNPq in Portuguese, now called National Council for Scientific and Technological Development) and the National Campaign for the Improvement of the Senior Staff (Capes) (IPEA, 2010). As in Mexico and Argentina, Brazil's scientific and technological development was also characterized by a supply-side focus, by which the training of human resources and the promotion of scientific production would result naturally in innovative processes in the productive sector. However, in Brazil both private and public R&D have historically been higher than in those countries.

While Mexico's and Argentina's speding in R&D barely reaches a 0.2% of the GDP, Brazil's scales up to 0.5%. The development of big-sized Brazilian companies, focused both on natural resources -such as mining company Vale; Petrobras, in oil; and Embrapa, in the field of biotechnology-, as well as those whose main focus is industrial -for instance Embraer, in aerospace-, has been primarily encouraged by the military and state sectors during the state-led industrialization. They have developed strong and endogenous technological skills and they have had internal R&D laboratories that partially account for Brazil's better performance. World leader in oil technology, Petrobras in particular has developed an internal network with local companies through its own promotion policies, which has generated clusters of increasing productivity and technological enhancement (Ocampo, 2011). Notwithstanding the aforementioned, Brazil's productive structure continues to be deeply heterogeneous in terms of productivity and territoriality. Such heterogeneity has been, in turn, deepened with the structural adjustments started in the 80s and continued in the 90s.

Brazil experienced a sharp increase in its CCTX between the early 60s (when it was just 5%) and the late '80s, when it exceeded 35%[66]. If virtually all exports were primary products in 1962 (coffee accounted for 53% of foreign sales) in 1990 those “only” represented 28% of these. In turn, LTM, MTM and HTM, virtually nonexistent in the export basket of the early 60s, came to represent 15%, 26% and 4% respectively of it. Thereafter, Brazil's CCTX remained stable until the mid-2000s (except for a peak in 2000, driven mostly by higher exports of aircraft). The sharp increase in prices of raw materials, within a context of strong currency appreciation not sufficiently compensated by other policies, explain why in 2012 the CCTX was much lower (26%). In particular, iron ore, whose share in the export basket rose from 5% to 16% between 2006 and 2011, explained 40% of that CCTX's fall (Ludmer and Schteingart, 2012).

Nevertheless, Brazil's development pattern had a particular weakness: its chronical deficit in the current account brought about by comercial imbalances and further worsened by the oil crisis (Brazil was a net-importer country). Being a peripheral economy with a high presence of foreign capitals, the country's balance in its external sector was only possible through its capital account. Therefore, Brazil resorted, during the 70s, to external credit in order to further its rapid growth. However, the debt crisis of the 80s took a serious toll on the country. From then on, Brazil's developing model lost its dynamism completely and was drastically restructured in the 90s to fit a profile with a diminished governmental involvement.

The orthodox spin of the Brazilian economic policy in the 90s (which still lasts until today) has not allowed a significant convergence with the developed world, which is reflected in the fact that the CT index has expanded at a moderate pace in the last two decades, being unable to close the gap

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[66] As in Mexico and Argentina, during the second half of the 70s Brazil reduced its industrial trade deficit (in 1973, it represented 4,1% of GDP and 73% of exports, while in 1980 those figures had dropped to 2,0% and 14% respectively).

with countries of the right half of our scheme. In terms of GDP per capita it happened the same: between 1995 and 2013 Brazil's income per head increased at the same rate than that of the US (1.6% annually). It is worth noting, however, that Brazil could preserve several key parts of its scientific and technological assets, which were mainly built during the period of state-led industrialization. This was possibly due to a more gradual economic liberalization, and also to the use of certain industrial policy instruments such as BNDES' segmented loans to strategic sectors[67]. By contrast, the stagnation of the CT indexes in Mexico and Argentina, has meant a deepening of their technological dependence on advanced countries.

V. Concluding remarks

Throughout this paper we proposed three goals. The first one was to analyze the relationship between the composition of exports of a country (*what* is exported), their endogenous technological capabilities (*how* it is produced) and economic development, using a large sample of cases while also a synchronous approach (a picture of the period 2000-2012). The second one was to establish a typology of cases derived from the crossing of our two independent variables (ie, composition of exports and endogenous technological capabilities). Finally, the third goal (the most ambitious one) was to enrich the synchronous approach mentioned in the first objective with a long-term analysis (1965-2012), in order to understand what the national trajectories have been in terms of technological content of exports and endogenous technological capabilities.

By adopting a neoschumpeterian-neostructuralist framework, we attempted to provide evidence to support the idea that *how* countries produce seems to be more important than *what* they produce (and export). In fact, when we controlled the relationship between the CCTX (our independent variable) and the HDI (our dependent one) by technological capabilities (proxied with our CT index), we could see that the latters seemed to be more relevant to explain the HDI's differences between developed and undeveloped countries. Despite the value of the CCTX, every country in the right side of our scheme is undoubtedly developed in terms of HDI, while those in the left half of it have lower levels of development. In other terms, it is true that most of developed countries export manufacturing goods of medium and high technological content while most of undeveloped ones export primary products or resource-based manufactures. But they are also some exceptions that we remarked through the tipology built in Section 3: the "assemblers" and the "primarised innovators".

Thus, we have attempted to dialogue with several theories of economic development: first, with a version of industrialism (typically embodied in the classical Latin American structuralism) for which the only way to be developed is by standing in the upper-right quadrant of our diagram (that is, only the "manufacturing innovators" can be developed). As we have seen, the existence of the "primarised innovators" qualifies such assertion, which assumes that technological progress tends to occur in engineering-intensive sectors (MTM and HTM). However, the fact that the vast majority of developed countries are "manufacturing innovators" shows that it is much more likely to develop technological capabilities in engineering-intensive sectors than to do it in those resource-based[68].

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[67] BNDES is the acronym for "Banco Nacional de Desenvolvimento" (Brazilian Develpment Bank).

[68] In fact, the classic Latin American structuralism was skeptical about the probabilties of technological development in primary sectors due to the fact that, at that time (1950-1980), the Green revolution and the nanotechnological paradigm had not yet been materialized in developing countries.

Secondly, we have relativized Rodrik and Haussmann's postulates, who claim that the key to development resides in exporting what is exported by developed countries (ie, technologically sophisticated goods). According to this view, an increase in the CCTX would probably tend to accelerate economic growth. The problem with this theory, if interpreted in its strictest sense, is that it does not take thorougly into account the endogenous technological capabilities utilised when manufacturing a product. In other words, it does not recognize the probability that a country that became an "assembler" would not then turn into a "manufacturing innovator". As we have seen in Section 4, the development paths of Mexico, the Philippines and Thailand have shown, so far, that nothing guarantees a shift from the upper-left quadrant to the upper-right one, and much less a sustainable high economic growth (in fact, since the Philippines and Mexico had become "assemblers" their economic performance has continued volatile and modest in terms of acumulative growth).

Thirdly, we have also discussed with the resource-curse theory. In our opinion, this current can not properly explain why countries like the Scandinavians or the English-speaker settlers could stand out despite having high endowments of natural resources. Finally, the neoclassical theories have some problems to study the determinants of development, because according to them how and what countries produce is not really of importance. Rather, they believe in the idea that development and general welfare would automatically be deduced from the free play of market forces and the adherence to static comparative advantage, thus ensuring the system's efficiency which, in turn, is always static in their visions.

When rethinking the possibilities of development of Latin American countries, it is necessary to overcome the limitations of neoclassical economics, but also some heterodox assumptions should be problematizad, especially those who sometimes fall in an exaggerated distrust of natural resources. Beyond this, we want to point out a last issue: a national development strategy that takes the "primarised innovators" as a desirable model can be problematic if multiple other factors were not taken into account. In other words, it should be analyzed how these two groups of countries differ (or not) in several dimensions, as for example: a) geopolitical contexts; b) social, historical and cultural characteristics of the different social actors who live within the country; c) the balance of power between themselves and between them and the state; d) the existent institutional matrix (and the path-dependency that this matrix provokes); e) the effective amount of natural resources' endowments (are those endowments sufficient to encourage improvements in the quality of life of all people?); f) the demographic issue (evidently, development strategies would be very different between a five million people country than that of a two hundred million people country) and g) the human capital stock, which is also related to the status of the education policy, among others.

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