Measuring Technological Backwardness of middle-and low-income countries: The Employment Quality Gap and its relationship with Per-Capita Income Gap♣

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Abstract: Many Developing economies are increasingly concentrated in activities that combine low added value per capita and low and / or medium-low technological intensity due to premature deindustrialization. This is the main reason for the so-called "middle-income trap" of many developing countries, mainly in Latin America, according to the New-Developmentalist Theory. This regressive structural change had profound impacts over the structure of employment in these countries, that moves towards activities with lower technological intensity, widening the technological gap with developed economies. The aim of the present article is to construct a measure of the quality or technological intensity of the employment structure and relate it with the income gap between developing and developed economies. Our main hypothesis is that the growing per-capita income gap between developing and developed countries can be explained at large by differences in the Employment Quality Index (EQI), defined as the ratio between the share of working force in the sectors of high, medium-high and medium technological intensity with respect to the share of working force in the sectors of medium-low and low technological intensity. This Index allows us to build the so-called Employment Quality Gap (EQG), which is defined as the ratio between EQI for the country in the technological frontier (that will be assumed to be USA), which will be used as an independent variable to explain the behavior of the Per-Capita Income Gap ($PCIG$) of a sample of 47 developing countries in Latin America, Caribbean, Middle-East, Africa and Asia from 2001 to 2014. A series of econometric tests will be run in order to (i) to assess the impact of the Employment Quality Gap over the Per-Capita Income Gap controlling for other determinants of $PCIG$ as, for example, the *Capital* Stock Per-worker Gap, amongst others and; (ii) present a linear equation for the EQG determinants, considering the effects of price (real exchange rate) and non-price variables (human capital). The results will be estimated by the short panel method, in a static and dynamic way, with fixed effects (EF) and by the generalized moments method (GMM). The classification of sectors with respect to low, medium and high technological intensity, were based on the taxonomy presented by Tregenna and Andreoni (2020), in which they were applied for the calculation of EQI and EQG. The results obtained shows that controlling the conditional convergence of income, there is a significant and consistent relationship between the EQG and the Capital Stock per Worker Gap over the $PCIG$. And yet, by controlling endogeneity, the models had expected signals according to the new developmental theory. In the second exercise, which seeks to assess the determinants of EQG, the expected results were significant given the explanatory variables used, both the non-price and the price variable.

Keywords: Structural change, Labor market**,** New-Developmentalist Theory**,** Economic Development, Employment Quality, Model Construction and Estimation.

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1. Introduction

Before the *Industrial Revolution*, the growth rate of the countries' output rose slowly. During this period, differences in the living standards of inhabitants between different regions were comparatively small. After the Industrial Revolution began, in the 18th century, it was noticed that some countries or regions of the world grew relatively faster, while other countries or regions remained stagnant, grew slowly or even declined. In turn, it became evident that the living standards of the inhabitants turned out to be different, due to the accumulated growth rates of the output per head over time. With respect to rich countries, which increased the share of manufacturing industry in total output, the literature[1] explains that the inhabitants enjoy a relatively better standard of living compared to low- and middle-income countries, which in general had some industrialization process and later entered a path of *premature deindustrialization* or that were stuck in the production of primary goods, based on natural resources. Therefore, the relative difference in per-capita income between developed countries and those in the process of development was made explicit.

These international differences[2] in per capita income between countries can be explained by some variables: the share of employment in the industrial sector with respect to the total employment of the economy, the output per worker, the capital per worker, the education of the workforce in worker age, participation of countries in international trade, political factors, institutional factors, among others.

Given the difference in per-capita income between nations, the main objective of this article is to present a measure of the quality of employment by technological intensity of the employment structure and to relate it with the differences in income between developing and developed economies.

Our hypothesis is that the growing per capita income gap between developing and developed countries can be largely explained by differences in quality of employment. A series of econometric tests were performed in order to: (i) assess the impact of the employment quality gap on the per-capita income gap, also controlling the effect of the amount of capital per worker; and (ii) assess the impact of the determinants of the employment quality gap, considering price and non-price effects.

Thus, the present study is structured as follows. In addition to this introductory section, there are 4 more sections. Section 2 highlights the theoretical framework on economic growth, dual economies and the share of manufacturing industry in economies; section 3 describes the

[1] See Schumpeter (1942), Rosenstein-Rodan (1943), Verdoorn (1949), Lewis (1954), Prebisch (1949), Furtado (1964) and Kaldor (1967).
[2] Ross (2013, Chapter 1)

methodology, the construction of indicators and the data source; section 4 is intended for econometric diagnosis and empirical analysis and; finally, in section 5 the conclusions and final considerations are made.

2. Theoretical Framework

2.1. About Industry, productivity and employment

Observing the process of development of nations and the manufacturing industry, Verdoorn (1949, 1956 and 1980) and Kaldor (1957, 1967, 1975, 1977 and 1978) established the theoretical basis for an important empirical relationship that is verified between the growth rate industrial output and the average labor productivity. Verdoorn (1949) [3] comments that one of the difficulties of long-term planning is to estimate the future level of labor productivity. However, he comments that there is a constant relationship, given by the statistical correlation, between the growth in output per worker and the growth in the volume of total production, which in turn is a reflection of the increasing returns to scale of the economies that adopted the strategy of expand industrial output. As a result of industrialization, the faster the manufacturing industry grows in a country, the faster will be the rate of growth in labor productivity and real income.

According to Kaldor (1977), the divide between rich and poor countries is known in the Post-Keynesian literature as the cumulative result of differences in compound growth rates of output over time, something that emerged only with modern industrial capitalism, the so-called Industrial Revolution, which began in England in the eighteenth century. Kaldor (1957, 1967, 1975 and 1977) sometimes, in his writings, takes positions and assertions about economic growth, with narratives that compare countries with agricultural areas, industrial and commercial centers. Kaldor comments that regions with more developed industrial hubs supply the material needs of agricultural and/or commercial countries, causing any industrial hub installed in these countries to lose market to countries a large manufacturing sector. Furthermore, the system described by Prebisch (1949) as center-periphery will be administered by countries that have not adopted the strategy of industrialization, without any compensatory advantage in the form of increased production and agricultural prices.

[3] From the analysis of the historical series for the industry and individual industrial sectors, in several countries, Verdoorn (1949, Table 2.1.) found the average value of the elasticity of labor productivity with respect to the level of production of approximately 0.45 (with limits of 0.41 and 0.57). Thus, over the period, a change in the volume of production, say of around 10%, is associated with an average increase in labor productivity of 4.5%. Under the normal assumptions of long-term analysis, elasticity within reasonable limits, is constant and independent of variations in economic factors. In the long run, the value of the elasticity of labor productivity gives a rough idea of how much industrial production must expand to absorb a certain availability of labor. But this method allows for separate calculations only for the industrial sectors, since there are differences in technical and economic conditions existing between the various industrial sectors (for example, differences in the production function and in the elasticity of labor supply).

The fast economic growth in rich countries was largely, if not exclusively, the result of concentration on the manufacturing activities. And still these countries became large industrial centers endowed with fixed capital, almost exclusive, such as machinery, equipment and factories. Also, they became endowed with human capital, resulting from continuing education. Mass production was a reality in rich countries, where the skills of workers, over time, were improved by the growth rate of industrial production, combined with developments in science, technology and their uses (learning-by-doing). Capital accumulation resulted from industrial development, and this helped the economic development of nations that had such a strategy, improving the population's living standards.

At this point, the specialization in the production of certain products enabled the emergence of industrial clusters [Myrdal (1957) and Hirschman (1958)], making a product manufactured by an industry need inputs from the industrial sector or other sectors. And this core becomes the manufacturing industry, which adds value in the production of a new product, even if using another input already processed, in agriculture and mining. And the industrialized region gains an advantage through economic growth and will tend to sustain it through the process of increasing returns that growth itself induces, the so-called Verdoorn effect (1949).

Kaldor and Verdoorn's arguments inspired Dixon and Thirlwall (1975) to format a model to examine equilibrium growth in a region, making assumptions implicit in the hypothesis that regional per capita incomes and/or growth rates may diverge and that they can then be easily seen empirically. The long-term consequences of the introduction of manufacturing industries led to a tremendous acceleration of technical progress in countries that had such technology. And in the same way, they pulled the level of human capital with more quality, technical and scientific education (Schultz, 1961). Manufacturing Industry is usually associated greater productivity of human capital (Ros, 2013), due to changes that occur over time, in terms of complexity and new technological movements, leaving previously revolutionary techniques in manufacturing obsolete.

Furthermore, the failure to keep up with the growth of modern technology leads countries to remain in a poverty trap. And even a rich country, which does not keep up with the growth of modern technology, can lag behind in technological terms, and converge to a middle-income or poor country in later periods (Oreiro et al., 2020a). Or a country that began to industrialize ends up, for various political and strategic reasons, in a vision of the role of the State in the economy, over decades, which ceases to be sophisticated, and retreats.

Many developing economies are increasingly concentrating on activities that combine low value added per capita and low and/or medium-low technological intensity due to premature deindustrialization (Rodrik, 2016). This is the main reason for the so-called “middle income trap” in many developing countries, especially in Latin America, according to the New Developmentalism Theory (see Oreiro et al., 2020b).

This regressive structural change in underdeveloped economies had profound impacts on the employment structure of these countries, which is shifting towards less technologically intensive activities. Even though developed countries also exhibit some deindustrialization (Rodrik, 2016 and Palma, 2005/2008), there is a widening of the technological gap between developed and undeveloped economies. This reflects in increasing social inequality, great differences in per capita income and a potential decline in the capacity of underdeveloped economies to innovate. These developing and underdeveloped economies have been deindustrializing for decades, a trend that is particularly visible when one observes the participation of the manufacturing industry in total employment.

According to Veugelers (2013), when researching the European industry, he comments that most of the investment in research and development, R&D, and in making patents originate in the manufacturing industry. Manufacturing is a technologically dynamic sector. According to Rodrik (2013), manufacturing sectors show unconditional convergence of labor productivity, it is a sector that produces tradable goods across borders (international market), absorbs significant amounts of unskilled labor in periods of positive economic cycles and can expand and absorb workers even if the rest of the economy remains technologically stagnant. Together, these dynamisms make the manufacturing industrial sector the driver of economic growth (Rodrik, 2014). Therefore, combinations of technology in products and trade shocks, for example, through exports seen in the current account of the balance of payments, help to explain the heterogeneity between poor and rich countries. Economic and labor market conditions are very heterogeneous. In particular, the structural characteristics of the labor market, its levels of technological sophistication and human capital are quite different between developed, developing and underdeveloped countries (see Gala et al., 2018).

2.2. Productive duality, labor productivity and technical progress

In classical economic development theory, there is a distinction between dual economics and mature economies (Lewis, 1954). In a dual economy, there are two sectors where people can work: a modern capitalist sector and a subsistence or traditional sector. The traditional sector employs labor with low labor productivity and wages are determined by the average labor product. Due to the lack of capital, wages are kept at the subsistence level. In the modern sector, modern capital and techniques are used, notably developed in high-income countries, where many technological innovations come from the role of the State with massive public investments, for example, in scientific research and development. And labor productivity in the modern sector is high compared to the traditional sector.

The modern sector pays an additional premium above the wage of the traditional sector, but it will remain constant over time as soon there is excess labor in the subsistence sector.

The dual economic structure, described by Lewis (1954), Prebisch (1949, 1959, 1963), Prebisch and Cabañas (1949) and Furtado (1964) help to explain the high heterogeneity in many developing countries, which nowadays manifests itself differently from that observed by the classical school of economic development[4]. Dualism today express itself by the increase in the service sector, generally unsophisticated, which expands its share in GDP.

The increase in labor productivity makes possible the persistent rise in real wages, once the so-called "Lewis point" is overcome; that is, once the labor employed in traditional sectors (usually agriculture) has been fully transferred to modern or capitalist sectors (Lewis, 1954). At this point, the unlimited supply of labor, characteristic of Phase I of capitalism (Kaldor, 1977), runs out, making the continuous increase in labor demand, resulting from the expansion of the level of economic activity, allowing for a gradual rise real wages at a rate roughly equal to labor productivity growth. The growth of real wages, in turn, is what makes it possible to increase the population's standard of living.

According to Oreiro et al. (2019), technical progress allows, on the one hand, an increase in production efficiency, that is, that the same goods and services are produced using a smaller amount of inputs, especially labor; on the other hand, technical progress leads to the development of increasingly sophisticated or complex products and services, that is, products that incorporate not only a greater amount, but also a more diversified amount of technical and scientific knowledge.

According to Hidalgo (2015, chap. 10), technical and scientific knowledge is embedded in people (human capital), in machines and equipment (physical capital), in people's ability to connect and thus exchange information (social capital). In this way, what an economy produces and exports reveals the sophistication or complexity of its productive capabilities. Gala et al (2018) comment that more sophisticated or complex products are produced by highly skilled workers in companies that operate at or near the technological frontier; which is why such products have greater added value per unit of work employed. Thus, technical progress stems from the advancement of the "state of the arts" and also through a process of structural change, in which productive resources and workers are transferred from activities with lower added value per employed worker (less sophisticated or

[4] In some Latin American countries such as Brazil, Argentina, Uruguay, Chile and Mexico, for example, there is a small modern industrial sector, with a trend decreasing share of the manufacturing industry in GDP (Oreiro and D'Agostini, 2017) and (Oreiro, D´Agostini and Gala, 2020a), an agricultural sector with some technological sophistication and a service sector, generally unsophisticated, with low labor productivity (Gala et al, 2018). These observations on the composition of sectors in GDP today end up being similar to the rural subsistence economies described by Lewis (1954), with the difference that there is now an unsophisticated and uncomplex service sector that replaces the traditional Lewis sector.

complex sectors) for activities with higher added value per employed worker (more sophisticated or complex sectors).

Although the high value added per unit of work employed can also be seen in high technology services and agriculture, recent empirical evidence presented by Gabriel et al. (2020, p. 63), show that a greater participation of the primary sector in the added value is associated with lower growth rates of GDP per capita, even after controlling the level of the technological gap. Thus, for developing countries, a greater share of the service sector is also associated with a lower GDP growth rate. Therefore, the composition of output is important for long-term growth.

Complementarily, for Oreiro et al. (2019), the sectoral composition or productive structure of a country matters, influences labor productivity and affects the level of per capita income. It is not possible to measure the so-called total productivity of production factors without looking at the employment structure, the structure of technological domain, the participation of sectors in GDP (industry, agriculture and services). These ideas are even one of the fundamental propositions of the New-Developmentalist School, as described in Bresser-Pereira et al (2015) and Gala (2017). The low growth of undeveloped and some developing economies is a result of the production structure, since there is an increase in the composition of the product in the composition of the less dynamic sectors and with less technological intensity in the added value generated in the economy.

2.3.Productive structure, structural change and premature deindustrialization

One of the main objectives of development economics is to assess the components that lead to structural change. This analysis focuses on the movement of industrial employment and the mobility of resources across sectors of the economy. Manufacturing Industry plays a prominent role in economic growth and its expansion generates increasing returns to scale and an improvement in productivity in the economy (Furtado, 1964; Kaldor, 1966).

Developing economies suffer from the concentration of output in sectors with low and medium low technological intensities, which is often the result of premature deindustrialization. De-industrialization can be caused by internal or external effects (Rowthorn, 1994), (Rowthorn and Ramaswany, 1997 and 1999). Regarding to internal effects two must be emphasized the income elasticity of products and the industrial productivity gap with respect to the service sector.

In industrialized countries, the service sector concentrates efforts to meet the demands of the manufacturing industry. In this configuration, the services sector is diversified, has a greater share of labor force and generates high added value in the economy. The deindustrialization process of mature economies is inevitable, since the income elasticity of services becomes greater than the ones observed industrial products after some critical level of per-capita income is reached. This deindustrialization is, so to speak, “natural” (Oreiro and Feijó, 2010). In many developing economies, however, this process occurred prematurely, that is, they did not reach the maximum per capita income that economic development can provide. This fact triggers the process of premature deindustrialization and the “middle income trap” (Oreiro et al., 2020b).

Rodrik (2016) comments that deindustrialization reflects on the quality and decline of employment. It is low-skilled workers who bear most of the impact of recent changes in commerce and technology in the manufacturing industry. Countries that have had a strong comparative advantage in manufacturing products using new technologies have avoided the steady decline in manufacturing jobs over the past few decades as a proportion of total employment. Using data from the World Input-Output Database (WIOD), which provides a division of industrial employment into three types of workers (low, medium and high-skilled), looking at 40 countries between the years 1995 to 2009, Rodrik (2016, Figure 4) shows that the reduction in employment occurred in the sector with low technological qualifications (four percentage points). The decline in medium-skilled employment was small, while industry's share of high-skilled employment increased slightly.

The observed differences in the income elasticities of demand for exports and imports reflect the non-price characteristics of goods and, therefore, the structure of production (Thirlwall, 1997). Several other authors claim that structural changes can affect the income elasticities of imports or exports in constrained balance-of-payments models (Setterfield, 1997, McCobie and Roberts, 2002; Palley, 2002). An important contribution to demand-oriented theories of output growth is the structural economic dynamics approach developed by Pasinetti (1983; 1993). For Pasinetti, changes in the production structure lead to changes in the output growth rate, due, for example, to different sectoral demand growth rates that could be produced by differences in sectoral income elasticities. And yet structural change impacts human learning.

The international diffusion of technology and the relationship with human learning is slow and uneven across countries (Prebisch, 1949). A few countries take the lead in innovation and technology, while the vast majority lag behind, being just innovation takers, without learning and appropriating the invention. As technical change is closely associated with structural change and the emergence of new sectors, goods and skills, the productive structure of a few countries diversifies, undergoes major transformations, while most other countries remain stagnant or even decline, being the result, for example, of under accumulation of human capital. As a result, the vast majority of countries end up specializing in a few sectors, generally traditional sectors, which generate low-quality employment.

Sectors with low or negligible technological intensity maintain a high share of workers employed and exhibit extreme difficulty in generating good quality jobs, which should be reflected in higher wages. In the literature on economic growth, the problem of asymmetry generated by the concept of technological gap between rich and poor countries emerges. The question here is whether or not is still relevant to discuss the role of the manufacturing sector in the process economic development.

2.4.Composition of the manufacturing sector and its impacts on economic growth

According to List (1841), what a country produces matters. According to Hirschman (1958), Prebisch (1959), Thirwall (2002) and Szirmai (2012), the manufacturing sector is the engine of growth for two specific reasons, first, the productivity growth rate that occurs in the manufacturing sector is comparatively high, and secondly, productivity growth gains are transferred to wages a higher speed. Furthermore, the composition of the manufacturing sector is very important (Szirmai and Foster-McGregor, 2017), that is, it is important to expand the composition of the high-tech manufacturing sector, compared to the low- and medium-technology sectors. In fact, there is growing evidence of the gap between wages and productivity across sectors (Berlingieri et al, 2017). Technical change and the division of labor within factories represented a turning point for the general process of economic development and, since then, manufacturing has represented the locus of capacity accumulation, learning by doing and dynamic returns with technological innovations[5].

Dosi et al (2021), noting the heterogeneity between sectors, comment that the manufacturing sector with higher technological intensity is the engine of output growth because it generates positive side effects in the economy in terms of: (i) indirect multiplier jobs created in other sectors , as knowledge-intensive services; (ii) in terms of wage effects, through Kaldorian virtuous circles (Kaldor, 1967); (iii) employment created through the supply chain, the so-called forward and backward linkage effect.

By the way, Pavitt (1984) identifies heterogeneity, separating manufacturing into four classes: supplier-dominated industries; intensive scale industries; specialized supplier industry and science-based industries. The industrial classification of the OECD (1984, 1995) by technological intensity, evaluated by spending on research and development as a percentage of production value, are usual criteria for ordering industrial sectors according to technological groups. And in 2016, the OECD updated the classification to five technological intensity categories (high, medium-high, medium, low-medium and low-tech) and included other sectors of economic activity, due to the more active

[5] See Arrow (1962), Kaldor (1967), Abramovitz (1986) ans Cimoli and Dosi (1995).

role of non-manufacturing sectors in the technological development in recent decades (see Galindo and Rueda; Verger, 2016).

Lall (2001) built a taxonomy distinguishing groups of products that are generated in different sectors of the economy, produced by resource-based manufacturers and low, medium and high technology manufactures. Shumpeterians, neo-Schumpeterians and evolutionaries such as Schumpeter (1942), Nelson and Winter (1982); Rosenberg (1982), Dosi et al (1990); Dosi, Malerba and Orsenigo (1994) and Lee (2013) describe different perspectives within manufacturing, particularly in relation to heterogeneity between companies.

Of course, given the heterogeneity among the subsectors, a country that has a manufacturing industry that produces something equivalent like packaged baked bananas is quite different from an industry that produces high-precision processors, cell phone microchips, and sophisticated devices. There is a brutal difference in learning, in innovations, in the process of accumulating capacities, in sophistication and, therefore, in the complexity of a specific industrial subsector. Returns are dramatically different across subsectors.

Dosi et al (1990); Fagerberg (1987); Lee and Malerba (2017) comment on the historical patterns of industrialization in each country, on the patterns of specialization and sectorial diversification, and for this reason there are great differences in the process of economic growth and in the levels of per capita income observed. Researchers using balance of payments constrained growth models (BOPC) point out that the ratio of foreign trade income elasticities reflects the non-price competitiveness of the economy. According to Gouvêa and Lima (2010, 2013) and Romero and McCombie (2016), competitiveness not related to prices is, to a large extent, determined by the diversification and complexity of the productive structure.

Economic diversification is conditioned by the composition of the existing productive structure (Hidalgo et al., 2007; Alshamsi et al., 2018). It is important to note the role played by technological specialization in countries (Fagerberg, 1988; Cimoli and Porcile, 2014) and the changes in the sectoral composition of the economy (Araújo and Lima, 2007; Nishi, 2016).

Treggena and Andreoni (2020) analyzed the dynamics of premature deindustrialization, and the heterogeneity of deindustrialization experiences. They show the high degree of heterogeneity within manufacturing, both between low, medium and high-tech manufacturing, and also within each of these categories. As a stylized fact of deindustrialization, the relationship between gross domestic product (GDP), the share of manufacturing industry in GDP and employment generally follows a U pattern relation, as written by Rowthorn (1994) and Rowthorn and Ramaswamy (1997), between countries and the over time. Significantly, not all manufacturing subsectors exhibit an inverted U pattern. The greater the technological intensity of a manufacturing activity, the less concave is its pattern of development, becoming a monotonically rising line and even a convex curve for high-tech subsectors.

According to Treggena and Andreoni (2020), less than twenty countries control nearly 90 percent of the world's manufacturing value-added. Many low-and middle-income countries are not part of this group of industrialized countries. And many of the countries that managed to achieve middle-income status showed signs of premature deindustrialization. Countries that are traditionally classified in the group of middle-income countries are highly heterogeneous in terms of their sectoral composition and, therefore, also with regard to deindustrialization experiences.

According to Tregenna and Andreoni (2020), Structuralist, Shumpterian and Evolutionary literature have recognized the importance of heterogeneity within manufacturing (and in other sectors) to varying degrees, including differences in technological intensity. The fact that, even within the manufacturing sector, subsectors are characterized by different degrees of technological intensity, different speeds of technological change, different levels of scale efficiency, different degrees of commercialization, etc., has led several scholars to develop multi-sector models of economic growth and various types of sectoral classifications and taxonomies. Given the high degree of heterogeneity in technological intensity within manufacturing, it emphasizes the importance of sub-sector analysis by levels of technological intensity.

In fact, this entire theoretical framework comments that such developments in the manufacturing sector are fundamental and mandatory for developing countries to reach advanced economies and reduce the per capita income gap (see, for example, Bell and Pavitt, 1993); Lall ,1996; Fagerberg ,2000; Hobday, 2003 and Tassey, 2010. According to Tregenna and Andreoni (2020) and Oreito et al (2020), innovation and technological progress is important to avoid the middle-income trap.

In line with structuralism (See Prebisch and Cabanãs, 1949; Furtado, 1964), developing economies still persist in presenting some chronic problems, such as a low proportion of capital per worker, low labor productivity, poorly diversified production, with a low level of endogenization of technical progress and a heterogeneous productive structure. For the most part, a dual structure still prevails, in which there are traditional and modern sectors, keeping a considerable share of the workforce in low-productivity activities. Thus, an underdeveloped (developing) structure does not efficiently use its capital to absorb the labor force at the level of productivity that is found in the more dynamic sector (Furtado, 1964).

As these developing economies can be considered small and open, as well as do not have convertible currencies, as in the case of developed countries, the only component of autonomous demand that provides sustained long-term growth is exports. This component can be affected by the income elasticity of exports, which is linked to the composition of the exports (productive structure), and the growth of external income (Dixon; Thirlwall, 1975; Gouvêa and Lima, 2010). However, for this export-led growth to be sustainable over time, imports must not generate persistent trade deficits, that is, the long-term growth rate must be compatible with a balanced balance of payments.

In this way, asymmetric productive structures can generate uneven growth, affecting external growth restriction (Thirlwall, 1979; Mccombie and Thirlwall, 1994). In other words, the productive structure matters in determining elasticities. Therefore, a structural shift towards more technology-intensive (industrial) sectors tends to relax the external constraint on growth.

An additional step is to connect the relationship between the exchange rate, production structure, income elasticities of demand and growth. The argument is that the level of exchange rate has effects on growth rate of output as it affects productive heterogeneity, technological progress and industry's share of output. In this case, it is assumed that a moderate devaluation of the real exchange rate can lead to a structural change in the economy in the sense of expanding (decreasing) the participation of technology-intensive/industrial sectors in exports (imports).

Complementarily, in structuralist development macroeconomics, the actual level exchange rate must be compared to the industrial equilibrium exchange rate, which is defined as the level of exchange rate that is compatible with a constant share of manufacturing industry in GDP for a given level of technological gap (Oreiro, 2020; Oreiro et al., 2020a). When the first is below the value found by the industrial equilibrium exchange rate, there is a process of premature deindustrialization (Rodrik, 2016) and re-primarization of exports (Palma 2005 and 2008). On the other hand, when the current exchange rate is slightly above the industrial equilibrium exchange rate, it will ensure a trend increase in the manufacturing share.

3. Methodology

This section presents the methodological steps required to: (i) calculate a measure of the quality gap of the employment structure; (ii) relate it to the per capita income gap between the developed and the middle and low-income economies, controlling for other variables that could also explain the per capita income gap in order to isolate the effect of the employment quality gap over per capita income gap and; (iii) evaluate the effects price and non-price competitiveness factors over the employment quality gap in order to determine the importance of real exchange rate over the employment quality gap and hence over per capita income gap. For this, we adopted the following steps:

(i) separating the industry into several subsectors by technological intensity (low, medium and high), according to the classification described in Tregenna and Andreoni (2020, table 1);

(ii) built the *Employment Quality Index*[6], $\text{EQI}_{i,t}$,, by country, i, and by period, t, defined by the ratio between the sum of the share of the workforce in the high technological intensity sectors, $HT_{h,i,t}$, and the sum of the labor force share in the low and medium technological intensity sectors, $LT_{l,i,t}$ *and* $MT_{m,i,t}$, according to equation 1, below:

$$\text{EQI}_{i,t} = \left[\frac{\sum_{h=1}^{n} HT_{h,i,t}}{\left(\sum_{l=1}^{p} LT_{l,i,t} + \sum_{m=1}^{q} MT_{m,i,t}\right)}\right] \qquad (1)$$

Where:

- $t = 1, 2, \ldots, T; l = 0, 1, 2, \ldots, p; h = 0,1,2, \ldots, n; m = 0,1,2, \ldots, q$ e $i = 1, 2, \ldots, I$; where t is the time period; l, m *and* h are, respectively, the number of subsectors of low, medium and high technological intensity; i is the number of countries
- $N = n + q + p$, where N is the total number of sectors; n, q and p represent, respectively, the total number of high, medium and low technological intensity sectors;
- The denominator of $\text{EQI}_{i,t}$ must be greater than zero, $\left(\sum_{l=1}^{p} LT_{l,i,t} + \sum_{m=1}^{q} MT_{m,i,t}\right) > 0$, and indicates that at least a fraction of the workforce of the national productive structure employed in at least one of the sub-sectors, of low or medium technological intensity, is needed;

(iii) build the *Employment Quality Gap* [7], $\text{EQG}_{i,t}$, by country, i, and by period, t, defined as the ratio of the Employment Quality Index of the country considered as the benchmark, $\text{EQI}_{benchmark,t}$, with respect to a country that has low or middle income, $\text{EQI}_{i,t}$:

$$\text{EQG}_{i,t} = \frac{\text{EQI}_{benchmark,t}}{\text{EQI}_{i,t}}, \text{ com } \text{EQG}_{i,t} > 0 \qquad (2)$$

(iv) Estimate the *per capita income gap*, $\text{PCIG}_{i,t}$, as a function of the conditional convergence of per capita income, $CCINC_{i,t}$, employment quality gaps, $\text{EQG}_{i,t}$, and the capital stock per capita, $CSG_{i,t}$, according to the following linear stochastic model:

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[6] In its original format, elaborated by Oreiro et. al (2019), the Employment Quality Index (EQI) measures the ratio between the sum of jobs in the high, medium-high and medium technological intensity sectors over the sum of jobs in the medium-low and low technological intensity sectors of each country.

[7] The $\text{EQG}_{i,t}$equation shows that no country has complete specialization only in the high technological intensity subsector, that is, even if the country is at the technological frontier, at least a fraction of the workforce will be employed in at least one subsectors, which are of low or medium technological intensity.

$$\text{PCIG}_{i,t} = \alpha_i + \beta_1 CCINC_{i,t} + \beta_2 \text{EQG}_{i,t} + \beta_3 CSG_{i,t} + \varepsilon_{i,t} \quad (3)$$

(v) Estimate the employment quality gap, $\text{EQG}_{i,t}$, as a function of the human capital index, $HC_{i,t}$, of the economic complexity index, $\text{ECI}_{i,t}$, and the bilateral real exchange rate, $BEER_{i,t}$, according to the following linear stochastic model:

$$\text{EQG}_{i,t} = \alpha_i + \beta_1 HC_{i,t} + \beta_2 \text{ECI}_{i,t} + \beta_3 BEER_{i,t} + \varepsilon_{i,t} \quad (4)$$

To estimate the per capita income gap, $\text{PCIG}_{i,t}$, and the employment quality gap, $\text{EQG}_{i,t}$, described by equations (3) and (4), we used the method of generalized moments (GMM) applied to panel data, according to Arellano and Bover (1995) and Blundell and Bond (1998). In equation (3), the robust fixed effects (EF) method was also used, in which all independent variables are considered exogenous (Pesaran, 2015). In addition, *the GMM-System dynamic panel model will be used to correct the endogenous variable bias.* Furthermore, according to Arellano and Bover (1995) and Blundell and Bond (1998), the use of the GMM-System estimator captures the difference of the endogenous variable in time and serves as an instrument for the level equation. In the GMM-System method, regressors can be level-correlated with the specific effects of each individual. However, the instrumentalized variables, taking the first difference, may not be correlated.

(vi) Elaborate the decomposition of the variance of the dependent variables, of equations (3) and (4), from the analysis of the principal components of the independent variables;

(vii) Carry out the validation tests of the GMM estimators, suggested by Roodman (2009), to assess the model specification and the robustness of its instruments, namely: (a) joint exogeneity test of the instruments used in the GMM, through Hansen's method and; (b) residual autocorrelation test, by the Arellano-Bond method for AR (2) in first difference.

4. Econometric and empirical analysis

To estimate the determinants of the per capita income gap, equation 3, and the determinants of the employment gap, equation 4, the following databases were used: World Bank (WB), United Nations Industrial Development Organization (UNIDO), Penn World Table (PWT version 10.0), Global Change Data Lab (GCDL) and Observatory of Economic Complexity (OEC)[8]. The period of analysis was from 2001 to 2014, which is the period of the “commodities boom”, for a sample of 47 developing countries[9]. We use the United States as a benchmark for developed countries, $\text{EQI}_{benchmark,t}$, to find the employment quality gap, $\text{EQG}_{i,t}$.

Variables were collapsed into their mean, with 2-year time windows. The variables that were considered endogenous in the GMM–System model were as follows: (i) $CCINC_{i,t}$ and $\text{EQG}_{i,t}$ in equation 3; (ii) $HC_{i,t}$ in equation 4.

The convergence of per capita income and the employment quality gap endogenously help to explain the behavior of the per capita income gap (equation 3), while human capital impacts and is impacted by the employment quality gap (equation 4). Tables A3 and A4 in the appendix show, respectively, the correlation matrix between the determinants of the per capita income gap and the employment quality gap. The per capita income gap, equation 3, presents: (i) strong correlation with the convergence of per capita income and capital stock and; (ii) moderate positive correlation with the employment quality gap. Likewise, the employment quality gap, equation 4, presents: (i) moderate negative correlation with the economic complexity index and human capital and; (ii) weak negative correlation with the bilateral real exchange rate.The estimates for the per capita income gap and the employment quality gap are presented, respectively, in Tables 1 and 2. All variables were significant and with the expected sign.

[8] See the set of variables used and data sources in the Appendix, Table A1.
[9] See table of countries reviewed in Appendix, Table A2.

Table 1. Per capita income gap (2001-2014)

	FE (1)	FE (2)	GMM System (3)	GMM System (4)
Conditional convergence of per capita income	0.93766*** (0.007)	0.90515*** (0.012)	1.11129*** (0.012)	0.92205*** (0.019)
Employment quality gap	0.15693*** (0.043)	0.17271*** (0.054)	0.15937*** (0.038)	0.27481*** (0.034)
Capital stock per worker gap	-	0.32784*** (0.087)	-	0.43595*** (0.030)
Constant	4.72654*** (0.262)	2.50899*** (0.595)	1.15754*** (0.297)	0.74357** (0.338)
Observations	328	328	328	328
Instruments	-	-	55	50
R^2 Adjusted	0.9868	0.9883	-	-
Arellano-Bond test for AR(2) in first difference (p-value)	-	-	0.2923	0.2167
Hansen test of joint validity of instruments (p-value)	-	-	0.6949	0.4896
F Test	0.0000	0.0000	-	-

Source: Authors' elaboration. Notes: All the equations are robust standard errors. Below the coefficients we report the standard errors. *** p < 0.01, ** p < 0.05, * p < 0.10. Two-step standard errors are robust to the Windmeijer (2005) heteroscedasticity correction, which greatly reduces the downward bias of the one-step standard error.

Table 2. Employment quality gap (2001-2014)

	GMM System (1)	GMM System (2)
Human capital	-3.87830** (1.595)	-4.09919** (1.735)
ECI	-0.00003** (0.000)	-0.00002** (0.000)
Bilateral real exchange rate		-0.00041** (0.000)
Constant	14.12276*** (4.144)	14.88814*** (4.615)
Observations	299	299
Instruments	29	26
Arellano-Bond test for AR(2) in first difference (p-value)	0.3861	0.4032
Hansen test of joint validity of instruments (p-value)	0.3676	0.2575

Source: Authors' elaboration. Notes: All the equations are robust standard errors. Below the coefficients we report the standard errors. *** p < 0.01, ** p < 0.05, * p < 0.10. Two-step standard errors are robust to the Windmeijer (2005) heteroscedasticity correction, which greatly reduces the downward bias of the one-step standard error.

When performing the endogeneity control procedure in the estimates of the per capita income gap in Table 1, the coefficients of the employment quality gap and of the capital stock per worker had an increased. Using the fixed effect and GMM-System methods, from the moment the conditional convergence variables of per capita income and the employment quality gap were endogenized, it is noted that there was an increase of the estimated coefficients for the capital stock per worker. It is important to note that the gap in the capital stock per capita had two effects effect in the model. The inclusion of this variable increased the coefficient of the employment quality gap; but, at the same time, the coefficient of the per capita capital stock gap was greater effect than the coefficient of the employment quality gap, that is, $\beta_3 > \beta_2$.

Likewise, in the estimation of the employment quality gap, Table 2, all variables became significant from the moment when human capital was considered endogenous. It should be noted that by adding the bilateral real exchange rate, there was an increase in the effect of human capital and a reduction in the effect of the economic complexity index. The considerable effect of human capital in reducing the distance between the quality of employment in developing economies and the pattern of a developed country is highlighted. In addition, the inverse price effect was observed, that is, the depreciation of the bilateral real exchange rate induces a reduction in the employment quality gap between developing countries to the standard of developed countries.

Finally, in tables A5 and A6 of the appendix, we present the decomposition of the variance of the dependent variables, corresponding to equations 3 and 4.

The effects on the variability of the per capita income gap (Table A5), from highest to lowest, are respectively: conditional convergence of per capita income, employment quality gap and gap in the capital stock per worker. Likewise, the variability of the employment quality gap (Table A6), from highest to lowest, are, respectively: human capital, bilateral real exchange rate and economic complexity index.

In addition, it is important to note that the employment quality gap generates greater variability in the per capita income gap than the variability generated by the capital stock gap per worker, even though the coefficient effect of the first variable is smaller than the second.

Even though the bilateral real exchange rate has a smaller effect compared to human capital in explaining the behavior of the employment quality gap, its impact must be considered because it explains a good part of the variability of the employment quality gap.

5. Final Remarks

The results endorse the arguments presented in the literature, according to which the quality of employment, the capital stock per worker and together industrial police are fundamentals to reduce of the income gap between developing economies compared with the benchmark economy, which we consider to be the United States.

It can be said that the productive structure of countries that concentrate activities with low value added per capita and low and medium-low technological intensity are factors that explain the growing delay of catching-up for low-and medium-income per capita economies relative to developed countries.

Since developing economies are more labor intensive and increasing labor productivity helps to reduce the per capita income gap, policies that encourage the growth of human capital in these economies will allow for a reduction in income inequality between the development and the developed economies.

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Appendix – Statistical Steps and econometric results

Table A1 – List of variable, equations and data source

Variables	Description	Unit	Data Source	Equation
$\text{PCIG}_{i,t}$	Per-Capita Income Gap*	%	World Bank Open Data, avaliable at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD	$\frac{GDPpc_t^{USA}}{GDPpc_{i,t}}$
$CCINC_{i,t}$	Convergence condition of per capita income, with respect to 2001*	%	World Bank Open Data, avaliable at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD	$\frac{GDPpc_{2001}^{USA}}{GDPpc_{i,t}}$
$\text{EQG}_{i,t}$	Employment Quality Gap*	%	United Nations Industrial Development Organization (UNIDO), avaliable at: https://stat.unido.org/database/INDSTAT%202%202020,%20ISIC%20Revision%203	$\frac{EQI_t^{USA}}{EQI_{i,t}}$
$CSG_{i,t}$	Capital Stock Per-Worker Gap*	%	Penn World Table (PWT) 10.0, avaliable at: https://www.rug.nl/ggdc/productivity/pwt/?lang=en	$\frac{(CS)_t^{USA}}{(CS)_{i,t}}$
$HC_{i,t}$	Human Capital	Absolut value	Global Change Data Lab, avaliable at: https://ourworldindata.org/grapher/mean-years-of-schooling-1?time=2017	-
$\text{ECI}_{i,t}$	Economic Complex Index	Index	Observatory of Economic Complexity (OEC), avaliable at: https://legacy.oec.world/en/rankings/country/eci/	-
$BEER_{i,t}$	Bilateral real exchange rate*	Absolut value	Penn World Table (PWT) 10.0, avaliable at: https://www.rug.nl/ggdc/productivity/pwt/?lang=en	$\frac{xr}{pl\_gdpo}$

Source: Authors' elaboration. Notes: 1) *Authors' calculation; 2) Capital Stock per worker were calculated as $CS = (\frac{rnna}{emp})$ where rnna is the capital stock at constant 2017 national prices (in mil. 2017 US$) and emp is the number of persons engaged (in millions); 3) Bilateral real exchange rate* were calculated as ratio of the xr that is exchange rate, national currency/USD (market+estimated), with the pl_gdpo, that is the price level output-side real GDP at current PPPs (in mil. 2017 US$)

Table A2– Country list (47 countries)

Albania	Iran	Philippines
Azerbaijan	Jordan	Qatar
Bolivia	Kazakhstan	Russia
Botswana	Kenya	Saudi Arabia
Brazil	Korea	Senegal
Chile	Kuwait	Singapore
China	Lao People's DR	South Africa
Colombia	Macedonia	Tanzania
Costa Rica	Malaysia	Thailand
Ecuador	Mexico	Turkey
Egypt	Moldova	Ukraine
Ethiopia	Mongolia	United Arab Emirates
Georgia	Morocco	Uruguay
Ghana	Oman	Viet Nam
India	Panama	Yemen
Indonesia	Peru	-

Source: Authors' elaboration.

Table A3– Correlation Matrix of Equation 3

	Per capita income gap	Conditional convergence	Employment quality gap	Capital stock gap per worker
Per capita income gap	1			
Conditional convergence	0.9927	1		
Employment quality gap	0.3305	0.3147	1	
Capital stock gap per worker	0.8761	0.8329	0.1765	1

Source: Authors' elaboration.

Table A4– Correlation Matrix of Equation 4

	Employment quality gap	Human capital	Bilateral real exchange rate	Economic complex index
Employment quality gap	1			
Human capital	-0.3519	1		
Bilateral real exchange rate	-0.0577	-0.1086	1	
Economic complex index	-0.5782	0.4855	-0.0158	1

Source: Authors' elaboration.

Table A5. Decomposition of variance of the per capita income gap

	Proportion	Cumulative	Eigenvalue
Human capital	0.5025	0.5025	1.5074
Bilateral real exchange rate	0.3313	0.8337	0.9938
ECI	0.1663	1	0.4987

Source: Authors' elaboration.

Table A6. Decomposition of variance of the employment quality gap

	Proportion	Cumulative	Eigenvalue
Conditional convergence	0.6531	0.6531	1.9593
Employment quality gap	0.2953	0.9484	0.8858
Capital stock gap per worker	0.0516	1	0.1547

Source: Authors' elaboration.