

Productive structure and economic growth: the role of the real exchange rate in the symbiosis between the industry and the modern services

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Abstract: The paper discusses the importance of the service sector for innovation, productivity, and improvement of productive efficiency and, consequently, its importance for economic growth. The hypothesis is that the current productive dynamic has stimulated forms of integration between manufacturing and services (symbiosis) that go beyond traditionally known forms. In this case, new challenges are posed to economic policymakers. In empirical terms, the article investigates whether the real exchange rate (RER) has effects on this symbiosis, and subsequently, whether this integration between both sectors affects economic growth. Therefore, econometric models are estimated using the Generalized Method of Moments (GMM) method, for a sample of 41 countries between 2000 and 2014. The results show that the moderately devalued real exchange rate has positive effects on symbiosis because of the returns scale increases and this contributes to growth. The article also contributes to the literature by showing new transmission channels in the relationship between RER and economic growth.

Keywords: Economic growth; real exchange rate; Services; Industry

COD JEL: O0; O4; E6; L8

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1. Introduction

There is robust evidence in the literature showing the advantages of the industrialization process for economic growth. The industrial dynamic, which incorporates dynamic increasing returns to scale (*learning by doing*, positive externalities, and technological *spillovers*), boosts the productivity, the income, and tends to loosen the restriction that comes from the growth condition with a balance in the Balance of Payments (Furtado, 1963; Kaldor, 1966; Pasinetti 1981; Young, 1995; McMillan e Rodrik, 2011).

Taking into consideration the specificities of this sector, a series of efforts was taken towards industrialization in many parts of the globe, which culminated in high growth rates. However, from the mid-1970s onwards, this process of structural change towards the industrial sectors has quenched, partly justified by the very own reconfiguration of the productive structure and manufacturing methods. From then on, especially in the developed countries, is possible to observe a deindustrialization process, which, in turn, was associated with the rise of the service sector¹.

In the following decade, deindustrialization reached the developing countries. Despite being similar (loss of jobs and industry value added as a job share and total value-added), these are distinct processes. For the countries in development, the continuity's interruption of the industrialization process seems to have been more of a consequence of the “globalization” process deepening, which defined new standards regarding the commercial and productive integration of the economies, rather than a naturally expected movement from the point where the economies reach a certain degree of development. Furthermore, there are significant differences with developed countries regarding the form and type of service sector that has risen in these economies.

A short time after the beginning of these changes, it is already possible to have a clearer frame of the effects of these modifications on the economic growth of these countries. Currently, some works in the literature have been highlighting that the sector of sophisticated services has started to significantly contribute to productivity, innovation, and, consequently, economic growth. In other words, aspects thought to belong only in the manufacturing sector are also being associated with the modern services sector.

It is in this context that this work fits in. That is, we start from the premise that is necessary to go beyond the conventional theoretical interpretation that places the industry as the only center of dynamic growth. It does not mean to deny the industry's role, as a growth engine, but implies that other sectors have new roles in the contemporary world.

Some studies suggest that this stage of the productive organization goes toward a kind of integration that articulates symbiotically industry and services (Di Berardino; Onesti, 2018; Giovanini; Arend, 2019; Giovanini et. al, 2020). This is our starting point. That is, we admit that the key to economic growth under a long-term perspective lies in the symbiosis between the industry and the modern services, since the integrated operation of both sectors allows the constitution of what we call amplified dynamic increasing returns to scale. In other words, the increasing returns to scale of the industry and the services are boosted when both sectors work in a coordinated way.

If the previous hypothesis is true, then the elaboration of macroeconomic and industrial policies must consider this. In a particular way, we're interested in the role of the exchange rate policy. Therefore, the goal of this work is to analyze empirically the role of the real exchange rate in the efficiency of the industry and the modern services symbiosis. In other terms, it is analyzed how much does the competitive exchange contributes to the efficiency in the interaction of both sectors and, consequently, to the economic growth. The productive or operational efficiency is understood as the capacity to obtain a product at a lesser cost, given the available technology.

It is important to highlight that there is a gap in the economic growth literature that talks about the effect of the macroeconomic politic on the interaction between the industrial and the modern services

¹ This would be a natural process, since, starting from a certain *per capita* income, it is expected that the elasticity income demand for services tends to grow, becoming bigger than the elasticity income demand for manufactured products. This way, the continuity of the economic development will lead to an increase of the services sector in the GDP, and, from a certain level of *per capita* income, to a decrease in the industry sector in the GDP.

sector. The usual studies are those that investigate the direct impact on a specific sector, such as the impact of the real exchange rate on the industry.

The study's originality lies in the usage of data coming from the input-output matrix to build the productive efficiency index, and, subsequently, to test it through econometric techniques. In this study, we used the *Generalised Method of Moments (GMM)*, for a sample of 41 countries between 2001 and 2014. The choice of the countries is conditioned to the data availability.

The article is divided into three sections, in addition to this introduction and final considerations. Section 2 reviews the literature about growth, and real exchange rate, as well as proposes the transmission channels of the exchange rate on the symbiosis. Section 3 deals with data and methodology. In Section 4, the results are discussed.

2. The role of the industry and the services on the economic growth

The literature review indicates the existence of two approaches (not necessarily dissociated) when analyzing the role of the industry and the services on economic growth.

On the one side, those who advocate for the importance of the industry argue that: i) manufacturing has a positive impact on the added product of a lagging economy and it's the only sector capable of generating high productive earnings in comparison with the other sectors, enforcing Kaldor-Verdoon's law; ii) the industry can advance on the higher added value activities, and; iii) in more advanced stages, the industrial sector becomes a capital goods net exporter and present elasticity income of the foreign trade demand that loses the restriction that comes with the condition of intertemporal balance on the balance of payments (Thirlwall, 1983; McCombie; Thirlwall 1994).

Therefore, the industry is capable of ensuring high indexes of per capita product growth in a sustainable way in the long term. It happens because the industry is subject to dynamic increasing returns to scale (*learning by doing*, positive externalities, and technological *spillovers*) whereas the other economic sectors would be limited to constant returns to scale (services), or decreasing returns (agricultural activities and mining). That way, the dynamics of the industrial activities induces the growth of the economy's general productivity, and, consequently, stimulates the relative differential in terms of per capita income growth among the countries.

The industry role was widely discussed during the 1960s. One of the results is the most known version of the discussion named Balassa Samuelson effect when proposing that the productivity earnings not only happen most in the *tradables* sectors (industry), and has a positive impact on the wages, but their effects overflow to the *nontradables* sectors. As in these sectors, the productivity is lower, the prices rise higher than in the *tradables* sector (Balassa, 1964; Samuelson, 1964).

As a result, considering that the *tradables* prices tend to level in the international market, the currency of the country with a higher production level will tend to be appreciated in terms of purchasing power parity. Besides, this effect has another implication in terms of the expansion of the *nontradables* sector in the economy. That is the second approach in the literature about economic growth, which considers the expansion of the services as problematic.

Baumol (1967) developed a similar theoretical analysis, which was called the "*costs disease*". This approach, on the offer side, pleads that despite the services being less productive, they follow the wage increases on the industry, which would provoke an increase in the costs of production and changes in the economy's relative prices. As a result, the competitiveness of the countries whose productive structure modifies on behalf of the services would be limited.

On the other hand, from the demand side, the literature found a close link between the elasticity income demand for products and services, resulting from the increase of the per capita income. It is assumed that the income growth, because of the industry technical progress, inducts modifications in the society's consumption basket. In other terms, as long as the societies adopt more sophisticated consumption habits, the services sector becomes to get more preponderancy in the economic growth dynamics (Clark, 1940; Fuchs, 1965; 1968).

The most important point to emphasize in this section is that during more than half of the 20th century, the literature on economic growth has shown evidence that the industry has the primacy over the

conduction of the progress, whereas the services sector has not shown particular traits that gave it fundamental importance for the economic growth.

Only around the 1970s, with the deindustrialization and, more specifically, with the rise of the Information and Communications Technology paradigm – ICTs, there was a deep transformation in the way the services sector started to productively organize and place itself in the economic system's productivity chains.

When becoming itself an autonomous sector, capable to improve productivity and to generate value addition to production, its relation with economic growth became more significant and got the attention of researchers and policymakers (Baumol, 1985; Roach 1988; Dunning, 1989). This question is discussed in the next section.

2.1 Deindustrialization and rise of the modern services

Deindustrialization had its beginning in the 1970s when the manufacture started to lose relative importance on the more developed economies and the services increased their share on the national income generation. Tregenna (2009) argues that deindustrialization is ascertained when the industrial employment and the industry added value are reduced in comparison with the total employment and the GDP.

For the developed countries, this process is considered as a natural result, coming from the well succeeded economic development, whose industry played its role in increasing the society's living standard (Baumol, 1967; Fuchs, 1968; Rowthorn; Wells, 1987; Rowthorn; Ramaswamy, 1997; 1999; Tregenna, 2016). For the countries in development, deindustrialization is considered early or premature, since it happens before the per capita income reaches a level similar to the one in developed countries. In these circumstances, the development opportunities of the countries with lower per capita income tend to be limited in the long term (Rowthorn; Wells, 1987; Palma, 2005; Rodrik, 2016). The limitation on the economic development happens because the countries in development come across: i) a reduction in the capacity of adding value to production; ii) a fall on the investment pace; iii) a limitation of the technical progress; and, iv) imbalances on the trade balance.

The central point of the deindustrialization process is that the economic growth in the long term becomes dependent on the productivity of the services sector, especially the subsectors that arise with the new productive dynamics (Rowthorn e Ramaswamy, 1999). Therefore, the services become relevant in conducting economic development.

A growing literature shows that the *modern* services sector contributes in a positive way to economic growth. The first signs that the services have changed their role on the growth were observed as from the 1980s.

Roach (1988) identified that, in the United States, the capital stock growth rate was higher in the services sector than in the industry, especially in the ICTs activities. The same happened in Europe; despite the productivity in North America, the country has grown more quickly. Overall, it is observed that the improvement of these economies' productivity derived from the biggest share of employment in the sector of ICTs production and from the fast productivity growth of the industries that made ICTs intensive use (Ark, 2003).

Basically, the services repositioned themselves in the productive structure as from the moment when it was observed: a) the rise in the share of the services in the intermediary consumption; b) the outsourcing tendency; c) the amplification of the added value on physical production through the incorporation of marketing, distribution, maintenance, after-sales and assistance services, d) the growth of financial and transportations services, as to generate more efficiency for the economy, and; e) the ability of this sector to create new products and to widen the markets (Dunning, 1989).

The services have assumed a transverse position in the productive structure when granted the diffusion of the information technologies with the use of computing and software used on the financial and operational management of the manufacturing production. (Pavitt; Bell, 1993). The sector places itself as an input in the productive structure, in activities called Knowledge-Intensive Business Services - *KIBS*. The *KIBS* literature shows that they supply the industrial sector with knowledge and contribute to

the creation of innovations. (Miles *et al.*, 1995, 2008; Hertog, 2000; Muller; Zenker, 2001; Miozzo, Soete, 2001; Gallego; Maroto, 2015).

Besides, the services contribute to the productivity and economic growth, since they're also subject to Kaldor's laws (Dasgupta; Singh, 2005; 2006; Ariu *et al* 2016; Felipe; Mehta, 2016; Dimeglio *et al.*, 2016; 2018; Giovanini; Arend, 2017; Ledesma; Moro, 2017). Especially, for the countries in development, the ICTs perform a relevant role not only to increase productivity but also to ensure a relatively satisfactory position in the global value chain (Dasgupta; Singh, 2006; Felipe; Mehta, 2016; Dimeglio *et. al.*, 2018)

One of the forms of how does it manifests occur through reducing the restrictions of the Balance of Payments. (Cainelli *et al.*, 2005; Castellacci, 2008; Cainelli; Mazzanti, 2013; Arbache, 2014). The authors plead that the service's activities add value and contribute to the product differentiation, by generating innovation and ensuring external competitiveness, so they are important to relieve the external pressure.

Regarding specifically the symbiosis, some studies show the importance of considering the integration between the industry and the services to understand the economic development (Engelbrecht, 1992; Park, 1994; Karaomerioglu; Carlsson, 1999; Ascani; Iammarino, 2018; Di Bernardino; Onesti, 2018; Giovanini; Arend, 2019; Giovanini *et. al.*, 2020). The studies show that the services have been massively used by the industry, and the economic and manufacturing success depends on the interaction between both sectors.

In fact, the relationship is bidirectional, where the biggest interaction between the modern services and the industry ensures the maintenance of the economy's total employment, in conditions of intersectoral transition of employment, which is the basic trait of the structural change. In terms of productive efficiency, particularly, the intersectoral dynamics occur mainly through the ICTs, once the efficiency on services is linked to the value chains that are associated with the productive efficiency (Di Bernardino; Onesti, 2018).

More recent studies reinforce the argument that in the most advanced economies, the productive structure is marked by a significant number of companies involved in the production of integrated goods and services, and this process tends to be a trend in the future for many countries in the world (Barreto *et al.*, 2017; Ennis *et. al.*, 2020; Cadestin; Miroudot, 2020). In other words, the result of the current production process stops being made only by tangible goods, because it incorporates a wide range of intangible goods (or a mix of both). This hampers the measuring and qualification capacities of the share of services boarded in the many products offered by the market.

The current production process becomes characterized by the symbiotic productive integration and the development strategies shown through industrial policies that must consider symbiosis as a key factor for the growth. It is not enough to get a product coming from industrial production. This product must have a series of differentials that can only be offered by modern services (design, onboard computing, artificial intelligence mechanisms, and human-computer interaction, etc.).

In synthesis, the literature on services brings a series of elements that show the importance of this sector for the productivity increase, improvement on innovation, quality of the productive efficiency, and, consequently, for economic growth. The productive dynamic has been stimulating forms of integration between manufacturing and services (symbiosis) that overcome the traditionally known forms to assess the production performance.

This question imposes challenges for the economic policymakers. Understanding how to stimulate symbiosis and its impact on economic growth is relevant to improve the creation of macro economical and industrial policies. Especially for the countries in development, services are a new opportunity for job creation, value generation, and, consequently, for the structural UNCTAD change (2017). We dedicate special attention to this question of the macroeconomy policy in the next section.

2.2 The real exchange rate and its role in the symbiosis between the industry and the modern services

There's extensive empirical literature showing that currency depreciation has positive effects on economic growth (Rodrik, 2008; Razmi et. al., 2012; Missio et. al., 2015; Rapetti, 2013; 2016; Bresser-Pereira, 2016; Guzman et. al., 2018; Habib et. al., 2017; Nassif et. al., 2017; Gabriel; Missio, 2018; Gabriel, et. al. 2020; Rapetti, 2020).

Among the transmission channels indicated by the literature, is argued that the real exchange rate depreciation can affect the aggregate savings by influencing the consumption and investment paths through alterations in the functional distribution of income (Gala; Libânio, 2011; Lima; Porcile, 2013; Bresser-Pereira, 2016; Rapetti, 2016). Basically, the RER affects the real wages and transfers the workers' income to the companies. That way, the self-funding capacity of the firms' increases, as well as the availability of funds that can be reverted in the process of expansion and improvement of the productive quality (Levy-Yeyati; Sturzenegger, 2009; Dao et al. (2017)².

In line with this thinking, it is argued that the competitive exchange also affects positively investment and capital accumulation by introducing alterations in the sectorial composition in terms of the product and employment. (Gala, 2007; Razmi et. al., 2012; Rapetti, 2020). The authors point that a real depreciation alters the domestic consumption towards the non-tradable goods and releases a bigger proportion of the tradable sector production for the exports, thus providing an increase in the profitability and investment.

The interrelation between these transmission channels can be found in the studies made by Missio and Jayme Jr. (2012); Oreiro, et. al. (2015); Rapetti, (2016), and Porcile et. al. 2020). According to the authors, the competitive exchange promotes changes in the productive structure by inducing the transition of *tradable* sectors of low to high productivity. The result of this process, in the medium and long terms, reflects in the alteration of the elasticity income of the imports and exports, which promotes the relief in the restriction that comes with the growth condition of intertemporal balance on the Balance of Payments. (Missio; Jayme Jr., 2012; Oreiro, et. al. (2015); Rapetti, 2016; Porcile et. al. 2020).

In sum, the literature indicates that the RER management aims to favor the manufacturing sector (Eichengreen, 2007). The depreciated exchange not only affects the investment decisions and alters the share on the intersectoral profits, but also promotes the reallocation of resources in the economy and stimulates the increasing returns to scale (Vaz; Baer, 2014; Dhasmana, 2015; Hunegnaw, 2017; Dao et al., 2017; Alfaro et. al. 2018; Mazorodze; Tewari, 2018; Panda; Nanda, 2019; Gabriel et. al., 2020).

Nonetheless, recent studies also indicate that the exchange depreciation can stimulate the services sector. This evidence was found for Canadian firms and shows that a competitive RER favors the survival and the sales of the services sector, whereas manufacturing is more sensible in terms of profitability (Baggs et. al., 2010).

On the international trade, Pattichis, (2012) indicates that the RER has a statistically significant effect on the services trade balance of the United States and the United Kingdom between 1986 and 2009. The same has been observed for developed and developing countries, being the RER effect stronger for the modern services exports than for the goods exports (Eichengreen; Gupta, 2013a). The authors argue that the depreciated exchange rate alters the relative prices of the exports and promotes the allocation of resources in favor of the tradable sector. In the case of the modern services, the RER effect over the allocation of resources is faster, since this sector uses less imported inputs and has lower fixed input costs, making the offer's answer more elastic, or the demand for these exports is more elastic in terms of price.

Lastly, Sahoo et. al. (2019) investigated the impact of the real exchange rate movements over the total of exports, modern and traditional services in India. The study confirms the inexistence of the J

² It is important to emphasize that the effective economic growth will depend on the regime of accumulation. If the regime is *profit led growth* the expansion of the profit sharing on the income will provide the growth, since the investments' elasticity in relation with the profit sharing is high. Otherwise, the result will be the recession. For more details, please see: Missio et. al. (2012).

curve effect of the real exchange rate over the exports of services but argues that a competitive cambial policy contributes to sustaining the exports of services in the long term.

In this context, considering the studies listed in the theoretical revisions is ascertain the existence of gaps both in the specific literature on the services sector and in the literature on real exchange rate. In the first case, little is studied about the symbiosis between the industry and services, and its impact on economic growth. This intersectoral relation seems to be the key to understand one of the causes of the recent economic growth of the nations.

In the second case, it has emphasized the absence of studies that investigate the role of the macroeconomic policy on fomenting the interaction between the services sector and the industry. This question is relevant, because if the real exchange rate affects the dynamic of added investment, therefore, the industry, may also affect the sophisticated services sector.

These are some of the relevant and unexploited questions we seek to discuss in the next section.

2.3 Real exchange rate Transmission channels and the symbiosis

Illustration 1 shows the investment and symbiosis process deriving from the maintenance of a competitive level for the real exchange rate. The flowchart shows two stages that correspond to the short term (stage 1) and long term (stage 2).

Stage 1 is marked by the presence of productive activities with little to no access to the foreign market. The preexisting demand level and the general economic conditions are unable to stimulate the investment of the existing firms in amplifying/modernizing the productive capacity.

Supposing that there is a productive development policy, organized institutions, macroeconomic stability, and economic and financially healthy companies, in the short term, the moderate exchange rate depreciation (stage 1 in the flowchart) affects the industry and the modern services through two channels: 1) profitability/cost-effectiveness channels, and; 2) investment channel (stage 2).

For the industry case, the channel profitability/cost-effectiveness is very sensible in the initial process of exchange rate depreciation because the economic structure demands some time to reorganize itself. In other words, the short and mid-term effect of the exchange rate depreciation firstly affects the potential of profit, and in the long term, creates the structural change through alterations on the sectorial elasticities.

The expected short-term effect of a competitive exchange rate tends to be distinct among the manufacturing activities. Let's stick to two dynamics whose final result takes to the increase of the investment, namely:

- i) For the industry whose production demands imported inputs, this policy (competitive RER maintenance) implies pressure on costs. These companies are forced to invest in productivity improvement and automation of the production line as an alternative form of cost reduction. In these circumstances, the solution lies in the acquisition of modern machinery and the hiring of modern services staff to implement and/or improve the industrial facility automation.
- ii) The industrial sectors that produce replacement goods for the inputs/imported products face an increase in their demand, and, as a consequence, of their profits. This increase in their demand encourages the investment in amplifying the production.

For the modern services sector, it is important to highlight that the wages are relatively higher than in the traditional services sector. The production stages are reduced and developed in relatively short periods. The investment in physical capital tends to be lower than in manufacturing, in a way that the inflow and outflow costs are relatively lower than in other sectors.

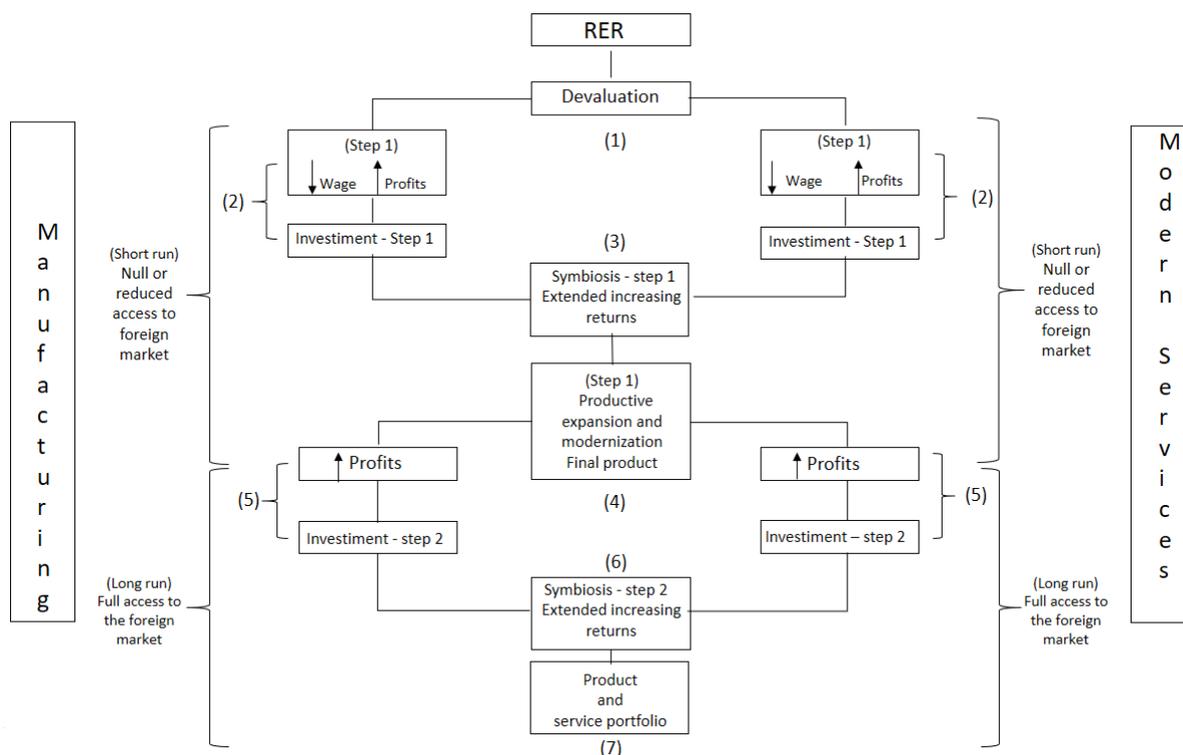
Therefore, because of bigger profits expectation, the expansion of the already established companies' activities and the flow of new entrants is higher. With this, there is higher pressure on the productivity and automation improvement, having the costs reduction, as well as the possibility of a rise on the competition on sight. This process tends to increase the demand for modern services. The

companies in this market are stimulated to invest in hiring new professionals and expanding physical spaces and acquiring new machinery.

Another kind of investment induced by the depreciated exchange is concentrated on the process of product creation. The industry demands from the services sector market, design, and marketing researches as well as the creation of applications that will be boarded on the product. This process, which is focused on creating the product and hiring services companies aimed at improving productivity and automation, implies a new stage named amplified dynamic increasing returns to scale (stage 3).

In stage (3), the interaction between both sectors reaches the highest level. Here we redeem the concept of dynamic increasing returns to scale and propose its amplified version. In other others, it is the space where happens research, innovation, and learning generate positive externalities and technological *spillovers* that are absorbed and shared by both sectors.

Illustration 1 – Transmission channels of the real exchange rate and the investment dynamics.



Source: elaborated by the authors

The amplified dynamic increasing returns to scale happen only when the symbiosis between the industry and modern services happens, and it is the key to understand the economic growth of the 21st century. This process is capable of driving the economic activity cumulatively, increasing productivity and generating experiences that are incorporated into the economy’s stock knowledge.

Stage (4) is the final result of stage 1 and corresponds to the consolidation of the whole investment process. In this stage, we have the completed product and it is ready to be sold. The hired services achieved their goal of mapping the market, creating the best design, preparing the best way of sell, and elaborating specific and integrated applications to the product.

Besides, the industrial facilities are widened and modernized. The productive process is automated and each stage generates information that is processed and analyzed to identify failures and monitor the production performance through time. Both sectors are more competitive and have conditions to enter the international market favorably. This way, there is the beginning of a new cycle of productive development.

Cycle 2 begins after the profit realization. With a depreciated exchange rate, wages continue to suffer a real loss of purchasing power, and access to the external market is the key to increase profitability/cost-effectiveness. The companies start to have more financial resources and begin a new investment cycle aiming to get some shares in the international market (stage 5).

In stage (6), the industry and the services sector return to interact in a symbiotic way. However, in this cycle, both sectors have more experience and knowledge than acquired in the last cycle. Incremental advances are incorporated in the already existing production, as well as new formulations. Taking into consideration the presence of amplified dynamical increasing returns of scale, the interaction process amplifies the options of correlated products to be developed. The complexity of these products becomes bigger.

Lastly, stage (7) is the result of this second cycle. In addition to having a product ready to be sold, the symbiosis between industry and modern services created a range of related products. In other words, the main product makes the way for the offer of auxiliary products and services that ensure differentiation and value addition. Both sectors move forward in the productive chain and begin to have conditions to compete for new markets in international trade.

The depreciated exchange rate played its role in making the economy more dynamic and creating narrower productive links between the industry and the services, as well as it made the way for national businesses to have access to the international market. The economy is on a stage of superior development in the long term. This way, to test our proposition, we will dedicate the next sections to show the data and discuss the results.

3. Data and Methods

The database consists of a sample of 41 countries, covering the 2000 - 2014 period (Annex A). The data is from WIOD Socio-Economic Accounts and World Input-Output Charts, made by 56 sectors. We decide to use these databases due to their disaggregation level. It allows a more precise clustering regarding the service's activities within the classification usually labeled as modern services.

It is possible to find in the literature terms such as modern, sophisticated services, professional or business services, services of cost, and value addition. It is possible to identify, still, the term intermediary services, which correspond to the sum of the modern services plus the transportation, storage, and mail activities. In general, the classification and terminology depend on the disaggregation level of the available data.

The classifications of greater prominence are: i) according to the technological standard developed by Eichengreen and Gupta, (2013b), in which the services are divided into traditional and modern; ii) according to the functionality, in which the services are divided into services of cost and services of value addition (Arbache (2014); iii) according to the destiny, being this divided into final consumption and for business (Singelmann, 1978; Machado et. al., 2015)³; and, iv) according to the OCDE classification, whose services are divided into professional business services and traditional business.

The indexes of interest in this study are: 1) Growth of per capita income, which aims to measure a country's level of economic development, and; 2) Efficiency on the symbiosis between the industry and the modern services, which measures the efficiency with which the interaction between industry and modern services transforms inputs in products

To build the index of the industry and services symbiosis efficiency we aggregated all the industrial activities in an only group labeled manufacturing. From the service's activities, we took a group denominated modern services (see Annex B). After this classification, we extracted the monetary value of the industry consumes by the modern services to form its product and the monetary value the modern services sector consumes from the industry to form its product.

The symbiosis efficiency index (*efsy*) was built accordingly to the traditional approach to assessing the productive efficiency of industrial machinery and unities as a whole, and for this study, can be expressed as:

³ For Singelmann (1978) the services activities are divided into four groups: i) distribution services: commerce and transportation; ii) productive services: financial, real estate and business activities; iii) social services: mail, education, health, public administration and defense; iv) personal services: hotel, restaurants, community services, maintenance and repair of goods.

$$efsy = \frac{Out_{sym}}{In_{sym}}$$

In which: *efsy* is the efficiency of the symbiosis between the industry and the modern services. The Out_{sym} variable is the sum of the industry and services sector product ($Out_{manu} + Out_{serv}$). The In_{sym} variable is the sum of two variables, namely: 1) industrial products consumed as inputs for the modern services sector, and; 2) modern services consumed as inputs for the industry. This way, the aforementioned variable is ($In_{manu} + In_{serv}$).

We chose this strategy because we did not find in the literature a better way to measure the efficiency of the symbiosis between the industry and the modern services that could be put under econometric tests. Besides, from the economic growth point of view, what matters is not the existence of the symbiosis itself, since every country has, in a certain way, some level of interaction between manufacturing and services. What really matters for the growth is the productive efficiency of the symbiosis, since it guarantees increasing returns to scale.

We decided to sum the inputs and the outputs, from the manufacturing and the services, because we assumed as right the arguments of Karaomerioglu and Carlsson (1999), and Hauge and Chang (2019). When defending the thesis of the deindustrialization illusion, the authors plead that part of the activities labeled as services is, in fact, activities that were part of the internal structure of the firms in the past. Therefore, starting from the authors' hypothesis, it is licit to suppose in this study that the industry and the services are one only body. In other words, this configures, in practice, the symbiosis between both sectors itself. For that reason, the analysis of the symbiosis must consider industry and services as a whole (Karaomerioglu; Carlsson, 1999).

This efficiency index is highly sensible. The denominator's variations are fundamental for interpreting since a fall means an efficiency increase in steady or low growth product conditions. If this is happening, the depreciated exchange rate would be inducing a reduction between industry and services, and the symbiosis efficiency would be apparent.

However, this is not the case, because when we graphically analyze the relationship between the real exchange rate and the (In_{sym}) denominator between the years 2000 and 2014 (Graphic A - Annex), it is possible to note that the countries with a depreciated exchange rate level show higher rates of interaction growth through inputs between both sectors. The same is observed when we assess the correlation between the (Out_{sym}) numerator and the exchange rate (Graphic B – Annex).

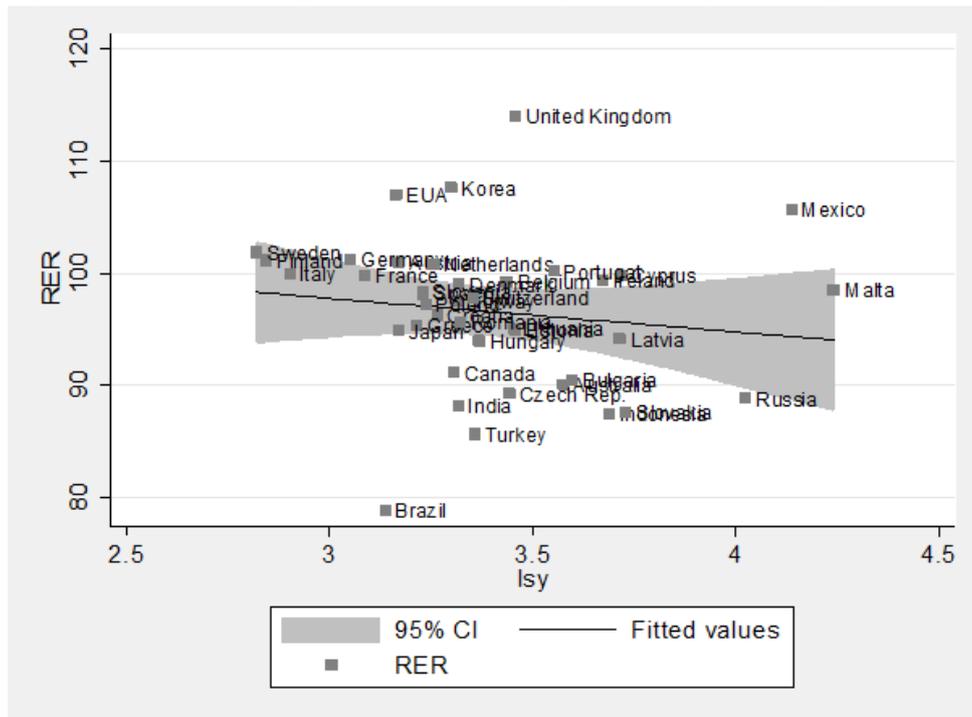
Besides, for the analyzed period, the increase in the symbiosis efficiency was derived from the growth of inputs and output consumption between the sectors (Graphic C – Annex). This ensures that the index is a relatively safe way to measure the behavior of the symbiosis efficiency in conditions of exchange rate devaluation.

Lastly, it is important to emphasize the challenge of choosing the real exchange rates available. To give solidity to the results, we decided to use different measurements. The data for this variable was obtained from the Bruegel dataset, and on the Research and Expertise on the World Economy – CEPII (Chart 01). In the case of the CEPII, we included the real exchange rate weighted by 30 fixed trading partners (30 bar), by 186 fixed trading partners, (186 bar), as well as real exchange rates weighted by 30 and 186 trading partners, alternated every five years (30TV) and (186TV), respectively.

Simple descriptive statistics suggest that countries with more devaluated real exchange rate levels tend to show more efficiency on the industry and modern services symbiosis (Graphic 1). The graphic relation is inverse because of the way BRUEGEL and the CEPII calculate the real exchange rate. The index as it was build means that “a real appreciation (nominal) of the national currency is registered as an increase of the effective real exchange rate index (nominal)” (Couharde et al. 2018, p. 9)

Therefore, this is indicative that the exchange can be stimulating the interaction between both sectors in countries whose development level is lower, compared to the more advanced economies. In other words, given the existing productive structure, small improvements on the productive capacity coming from the interaction between both sectors, generate big effects in terms of productive efficiency.

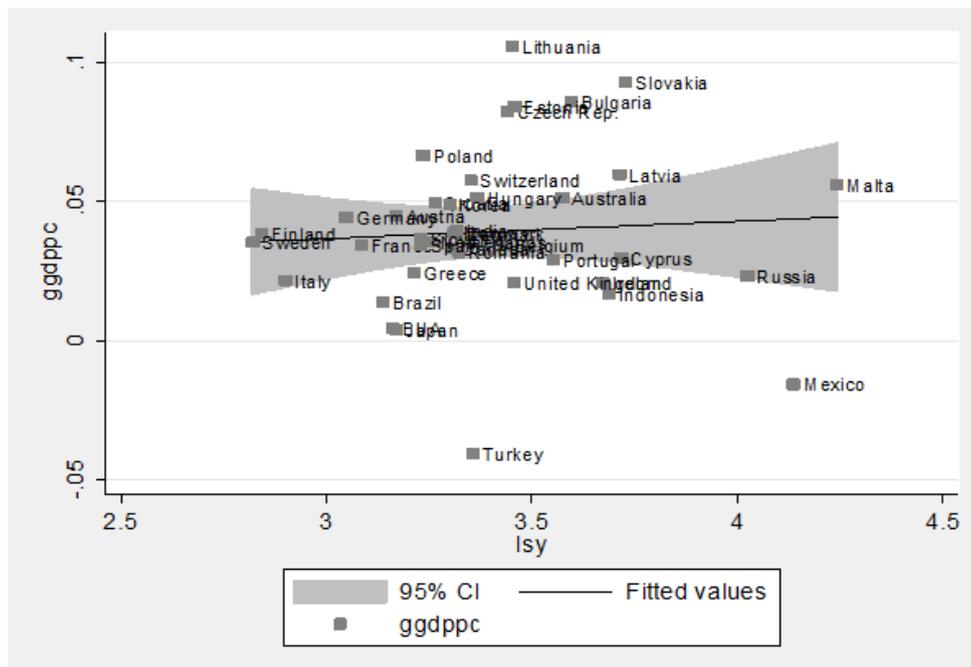
Graphic 1 – Real Exchange Rate (RER) and Symbiosis (Isy) - average, 2000 - 2014



Source: World Input-Output Charts e Bruegel dataset. Elaborated by the authors. Note: Isy = log(sy)

Furthermore, when stimulated by the real exchange rate, the interaction between industry and services can affect the growth rate. Graphic 2 suggests the existence of a lightly positive correlation between the efficiency level of the symbiosis and the economic growth rate. The integration between both sectors helps to explain the development of the countries between the 2000 e 2014 years and contributes to understanding the role of the services in the recent economic dynamics.

Graphic 2 – Growth rate (gdp) and Symbiosis (Isy) - average, 2000 – 2014



Source: World Input-Output Charts e WIOD Socio-Economic Accounts. Elaborated by the authors. Note: Isy = log(sy)

Lastly, in our econometrical test, we selected a group of control variables (Chart 1). Following the literature, we considered variables that represent the gap, the income level and distribution, the industry and services productivity, the manufacturing stock capital, and the level of relationship with the external sector. These are the main factors that influence the economic dynamics and the structural change in the economies.

Chart 1 – Used variables and indicators

Indicators Description	Variable	Source
Gross Domestic Product	gdppc	WIOD
Symbiosis between industry and services efficiency (Output/input)	efsy	WIOD
Real Exchange Rate weighted by 171 trading partners	RER (171)	Bruegel
Real Exchange Rate weighted by 66 trading partners	RER (66)	Bruegel
Real Exchange Rate weighted by 30 trading partners	RER (30bar)	CEPII
Real Exchange Rate weighted by 186 trading partners	RER (186bar)	CEPII
Real Exchange Rate weighted by 30 trading partners	RER (30 TV)	CEPII
Real Exchange Rate weighted by 186 trading partners	RER (186 TV)	CEPII
Industry productivity	pmanu (va/po)	WIOD
Modern services productivity	psm (va/po)	WIOD
Share of the wages on the income	lsh	PWT
Manufacturing capital stock	kmanu	WIOD
Opening level	ot	PWT
Penetration coefficient of imports and services	cpm	WITS

Source: Own elaboration

3.1 Empirical evaluation

The empirical strategy estimated two main equations that are related to each other: 1) the rate of efficiency between the industry and services symbiosis (*gefsi*) with the real exchange rate, and; 2) the per capita income growth (*ggdppc*) with the growth of the efficiency between the industry and services symbiosis (*cefsi*). Therefore, the following empirical models will be considered:

$$gefsi_{sem,i,t} = \alpha_i + \beta_1 rer_{i,t} + \beta_3 X_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$ggdppc_{i,t} = \alpha_i + \lambda_1 ggdppc_{i,t-1} + \beta_3 gefsy_{i,t} + \beta_2 cps + \beta_3 X_{i,t} + \varepsilon_{i,t} \quad (2)$$

In which: *gefsi_{sem,i,t}* corresponds to the growth of the efficiency between the industry and modern services symbiosis. The *RER_{i,t}* variable is the linear real exchange rate. As of a certain level, a higher devaluation not only affects the economic growth rate, however, essentially affects the efficiency of the symbiosis through the aforementioned channels. The *ggdppc_{i,t}* variable corresponds to the rate of per capita income growth. Lastly, *X_{i,t}* corresponds to the group of control variables and; at last, $\varepsilon_{i,t}$ are the terms of the respective equations of error.

Equation (1) investigates the relationship between the RER and the symbiosis between manufacturing and services efficiency. In other words, to which extent the competitive exchange rate contributes to the efficiency of the interaction between both sectors, considered as the key ones for the economic growth. Equation (2) investigates the relationship between symbiosis efficiency and economic growth. In other words, seeks to investigate if the symbiosis is capable to contribute to economic growth. For the variable of interest (*rer*), is expected that the relation with the dependable variables is an inverse one.

The control variables used to estimate the models follow the literature on the theme, being them: (i) modern services productivity (*psm*); (ii) manufacturing productivity (*pmanu*); (iii) share of the wage on the income (*lbshare*); (iv) per capita product of the economy's gap (*gapgdppc*); (v) stock of

manufacturing capital (*kamnu*); (vi) level of economic opening (*ot*), and; (vii) penetration of the imports coefficient (*cpm*).

This way, when we consider equation (1) it is expected that the manufacturing (*pmanu*) and modern services (*psm*) productivity contribute in a positive way to the symbiosis. The interaction between both sectors becomes more efficient the higher the productivity. The amplified dynamic increasing returns to scale play its role of making the economy more dynamic and improving the development of the entire productive chain, of the direct and indirectly involved activities.

In what concerns the per capita product gap (*gapgdppc*), it is expected that this variable contributes in a negative way to the symbiosis between manufacturing and services. Underdeveloped economies are on a stage in which their manufacture is low intensive in terms of technology. In other words, the manufacturers are the *maquila* kind or have products with basic processing. In this case, the interaction with the services sector is restricted. The services literature shows that manufacturing with higher added value demand more sophisticated services, which is typical of more developed countries.

The capital stock (*kmanu*) represents the base on which happens the interaction between the manufacturing and the services. The structural change literature proposes that industrial development is a *sine qua non*-condition for the emergency of competitive modern services. The manufacturing capital stock represents the investment in the physical and technological capital of a country, and, this way, is expected that this relationship with the symbiosis is positive.

Regarding the economy opening level (*ot*) and the penetration of the imports coefficient (*cpm*) is expected an undetermined relationship. The economy opening level and the penetration of the imports coefficient can have a negative impact on the symbiosis because the international competition can expel local businesses from the market. On the other hand, it can affect positively, since the local market starts to have better quality technics and inputs on hand to improve the interaction. However, it is important to emphasize that it depends on the productive development level of each country.

In what concerns equation (2), it is expected that the manufacturing (*pmanu*) and modern services (*psm*) productivity contribute in a positive way for the per capita income growth (*ggdppc*). The literature points out that one of the factors which favor the current development of the economies is sophisticated services productivity. Insofar as the manufacturing segments low in technology shrink, due to the deindustrialization, and the modern services sector expands, and the competitive differential among the countries depends on the performance of the services, it is emphasized that, when lagged, the variable captures the effect of the past productive performance on inducting the current growth.

For the variable of share of the wage on the income (*lbshare*), the result is undetermined. We assume that the relationship depends on the economic structure and technical progress of each country. Overall, the share of the wages on the income captures, in an indirect way, the pressure on the necessity of investing in work-saving capital. This variable, when lagged, shows that this share of the wages on the income is a factor that affects the growth expectations.

Regarding the economy opening level (*ot*), a positive relationship is expected. This variable seeks to capture the engagement level of the countries in the international market in a way that, a country that is more open to international trade can access and offer products and services that improve economic development more easily. It is important to highlight that this argument is controversial since there is evidence of a negative effect in the case of the countries in development. The lagged variable seeks to capture in which way the expectation of higher access to international trade, over time, affects the economic performance.

3.2 Methodology

The equations (1) and (2) present non-observed effects, which are specific to time and country. One of the ways to bypass this problem is through specific *dummy* variables of period and country. However, the steady effect methods, or deviation, are biased when a self-regressive term is included in the equation (Pesaran, 2015).

Besides, the exchange rates and the control variables of the models can show some level of endogeneity regarding the indicators $gef_{si_{sem,i,t}}$ and $ggdppc_{i,t}$. Therefore, the simultaneity or the reverse causality must be properly controlled.

To bypass these problems, we used the *Generalised Method of Moments (GMM)* to estimate the parameters of the models as proposed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). These estimators are based on regressions and deviation instruments to control the non-observed effects of periods and country-specific. In addition, it also uses them as instruments prior observations of dependable and explanatory variables. In this case, two kinds of technics can be applied to the GMM: 1) the GMM *difference* and the GMM *System*.

The GMM *difference* method is an advancement in comparison with the steady fix effects estimators and the standard deviation. The GMM *difference* estimator, by Arellano and Bond (1991) aims to eliminate the country-specific elements and also uses lagged observations from the explanatory variables as instruments. The problem with this method is that it deals with variables that tend to have a high level of persistence through time in a country. This means that we eliminate the biggest part of the deviation in the variable(s) taking the first deviation, but the lagged observations of the explanatory variables tend to be weak instruments for the variables in deviation. Therefore, it ends up creating estimators that are weak as well.

To deal with this problem, we decided to use the Arellano and Bover (1995), and Blundell and Bond (1998) GMM *System* in this study. This method creates a system of regressions stacked in deviation and level form. The regression instruments in the first deviation are the same as those in the GMM *difference*. However, the instruments used in the in-level regressions are the lagged deviations of the endogenous variables. This way, even if the in-level regressors are still correlated to the country-specific effects, the lagged deviation of these variables used as instruments has a higher probability of not being correlated to the country-specific effects.

It is important to emphasize that the GMM estimators' viability depends on the exogeneity of the instruments that are used on the models. The instrument's exogeneity can be tested by the J statistic of Hanen's test. The null hypothesis implies the joint validity of the instruments. It is, the rejection of the null hypothesis indicates the instruments are not exogenous; therefore, the GMM estimator is not consistent. Roodman (2009) orients that a satisfactory p-value of the Hansen's test must be greater than 0.1. Another important test is the Arellano-Bond test for AR (2) in the first deviation. The null hypothesis of this test assesses if the regression residue on the deviation is serially second order.

The first-order serial correlation of the deviation error is usually observed even when a term of level error is not correlated. The second-order serial correlation of the residual term implies that the error term is serially correlated. Therefore, the rejection of the null hypothesis indicates the residual term is serially correlated and follows a process of moving average of, at least, order one. A rejection of the null hypothesis suggests that the used instruments are unsuitable; therefore, superior order laggings as instruments may be necessary.

In what concerns the instruments, the literature is not much specific on determining the maximum number of instruments to be used in each case. Roodman (2009) suggests, as a practical rule, the instruments must not exceed the maximum number of individual unities on the board. We tried to keep the instrumental variables number the least possible. On equations (1) and (4), we used 1 lag of the endogenous variables. In the servitization Index, on the employment side, we also used 1 lag of the endogenous variables used as instruments. For equations (2) and (3), we used 1 lag of the endogenous variables. For better consistency, the equations were estimated in *two steps* and with correction for heteroscedasticity and self-correlation.

It is important to emphasize that it is common for the construction of averages in time frames to smooth short-term fluctuations (Pieper, 2003; Leon-Ledesma, 2000). The time frames also reduce the unwanted effects caused by the possible existence of unitary roots and also adjusts the board structure so to satisfy the consistency properties of the GMM estimators. Since the availability of time points is reduced ($T = 15$), we build time averages of two years.

4. Results

Charts (2) and (3) show the tests that were made. The results show that a level of moderately depreciated exchange rate contributes to the growth rate of the symbiosis between manufacturing and modern services efficiency

In other words, the depreciated exchange rate induces a series of chain reaction events that affect the interaction between manufacturing and services through the aforementioned transmission channels. An environment characterized by a higher profit expectation induces the businesspersons to invest in production. This stimulates new input flows on the productive net, which deepens the relationship between both sectors.

Chart 2. Index of the symbiosis efficiency growth and Real Exchange Rate GMM System

	(171)	(66)	(30bar)	(30TV)	(186bar)	(186TV)
<i>rer</i>	-0.0080** (0.004)	-0.0096** (0.004)	-0.0077** (0.003)	-0.0077** (0.003)	-0.0075** (0.003)	-0.0072** (0.004)
<i>gpmanu</i>	0.6876*** (0.143)	0.6600*** (0.138)	0.8910*** (0.197)	0.8903*** (0.196)	0.8957*** (0.201)	0.8946*** (0.215)
<i>gpsm</i> [t-1]	0.3176*** (0.116)	0.2896** (0.118)	0.3126** (0.130)	0.3128** (0.130)	0.3362*** (0.130)	0.3357** (0.139)
<i>gapgdppc</i> [t-1]	-1.6001*** (0.345)	-1.5599*** (0.346)	-1.7342*** (0.349)	-1.7343*** (0.349)	-1.7523*** (0.347)	-1.7915*** (0.376)
<i>lnkmanu</i>	0.0715** (0.031)	0.0622** (0.031)	0.0856* (0.048)	0.0856* (0.048)	0.0867* (0.049)	0.0881* (0.053)
<i>ot</i> [t-1]	0.0254 (0.018)	0.0275 (0.018)	- -	- -	- -	- -
<i>gpmsm</i> [t-1]	- -	- -	0.0311 (0.037)	0.0311 (0.037)	0.0323 (0.038)	0.0304 (0.033)
<i>const.</i>	0.6912* (0.412)	0.8701** (0.443)	0.6552* (0.385)	0.6533* (0.384)	0.6337* (0.391)	0.6019 (0.397)
Observations	164	164	164	164	164	164
Instruments	47	47	43	43	43	43
Arellano-Bond test for AR(2) in first difference (p-value)						
Hansen test of joint validity of instruments (p-value)	0.8225	0.7589	0.8308	0.8298	0.7745	0.8638
hansenp	0.4517	0.4485	0.3354	0.3351	0.3408	0.3258

Source: Own elaboration. Note *p<0.10 ** p<0.05; *** p<0.01

This proximity between both sectors, to increase production and offer a new product, generates the amplified dynamic increasing returns on scale that improve productivity and create an environment that favors innovation.

This interaction generates a positive effect for both sectors and the economy as a whole because the integrated production process creates experience gains that will be incorporated into the productive knowledge stock.

Manufacturing demands from the services not only the elaboration of softwares that improves the operational capacity of the facilities, but also softwares that can be boarded in their products. Besides, support services are demanded on all the development stages of a product (from creation to market release).

On the other hand, the services sector demands from the industry, mainly ICTs related machinery for use in the offer of services for the productive activity. This symbiotic process creates, in a way similar to the industry's, dynamic increasing returns to scale (*learning by doing*, positive externalities, and technological *spillovers*). However, in this case, this dynamic happens on an amplified scale due to the sector's integration.

Lastly, on Chart 3, we assessed if the symbiosis contribute to the growth of the per capita income (*ggdppc*). The results suggest that the symbiosis between manufacturing and services is relevant for the growth in the four models that were used, with a significance of 5%, excepting the steady effects model. The literature points out that both industry and the services are responsible for the technological *spillovers*, productive externalities, and the *learning by doing* (Dasgupta; Singh, 2005; 2006; Ariu et al 2016; Felipe; Mehta, 2016; Dimeglio et al., 2016; 2018; Giovanini; Arend, 2017; Ledesma; Moro, 2017).

Therefore, the symbiosis between manufacture and modern services is the key for the growth of the economies in this new stage of the structural change that moves on in the 21st century. The integration

of these sectors grants a new kind of “circular cumulative causation” a la Myrdal that amplifies the innovation capacity, increases productivity, and boosts the external competitiveness.

The manufacturing (*gpmanu*) and services (*gpsm*) productivity coefficients indicate that manufacturing still stands as a relevant sector for inducing growth. However, we consider that part of the manufacturing performance comes from the productivity of the very own services. Besides, the most suitable understanding of the growth *drivers* must entail a broader dimension. It is not about considering just the industry or the services, but both sectors in an integrated way.

Chart 3. PIBpc growth rate and symbiosis efficiency

	Pooled (OLS)	Steady effects	Random effects	GMM System
<i>gsi</i>	0.0249** (0.012)	0.0174* (0.009)	0.0242** (0.010)	0.0218** (0.009)
<i>gpsm</i> [t-1]	0.0793*** (0.023)	0.0754*** (0.019)	0.0806*** (0.021)	- -
<i>gpsm</i>	- -	- -	- -	0.3321*** (0.056)
<i>gpmanu</i>	0.7646*** (0.026)	0.7699*** (0.036)	0.7664*** (0.036)	0.5499*** (0.049)
<i>lbshare</i> [t-1]	- -	- -	- -	-0.0024* (0.001)
<i>lbshare</i>	-0.0005** (0.000)	-0.0056*** (0.002)	-0.0006* (0.000)	- -
<i>ot</i> [t-1]	0.0049 (0.003)	-0.0058 (0.010)	0.0049 (0.004)	0.0076 (0.007)
<i>const.</i>	0.0265* (0.014)	0.3128*** (0.086)	0.0287* (0.017)	0.1233* (0.069)
Observations	533	533	533	533
Instruments				57
<i>R</i> ² <i>adjusted</i>	0.7238	0.7491	0.7264	
Arellano-Bond test for AR(2) in first difference (p-value)				
Hansen test of joint validity of instruments (p-value)				0.9660
Hansen				0.8741

Source: Own elaboration. Note: *p<0.10 ** p<0.05; * p<0.01. Hausman Test Prob>chi2 = 0.0000**

The remaining control variables, such as the share of the wages on the income (*lbshare*) were significant and in all of the methods. The economy opening (*ot*) was not significant and presented a positive relationship in all of the methods, except in the steady effects test.

5. Final considerations

This study aimed to achieve two main goals. The first, to test if the real exchange rate affects the symbiosis between manufacturing and services. The second was to examine if this symbiosis contributes to economic growth. The results show that the real exchange moderately depreciated contributes to the efficiency of the symbiosis between both sectors.

The depreciated exchange activates the productive dynamics by signaling opportunities for incremental profits. Lingering on this tendency, the decision of amplifying the productive capacity to meet the external market induces the dynamization between both sectors with the goal of not only ensuring profitability but also ensuring the biggest shares of the international market.

The results also show that symbiosis contributes to economic growth. This way, we argue that the current ongoing structural change must be analyzed from the integration between manufacturing and services point of view. The integration and productive efficiency level of both sectors contribute to the growth because it makes possible the existence of amplified dynamic increasing returns on scale.

In other terms, the symbiosis amplifies and potentializes *learning by doing*, the positive externalities, and the technological *spillovers*. This seems to be the key to the success of the Asian countries and the maintenance of the competitive leadership of the developed countries (Dasgupta; Singh, 2005; Felipe; Mehta, 2016; Di Meglio et. al., 2018). Therefore, the countries in development must dedicate

special attention to this question and include in their development strategies the stimulus to integrate services and manufacturing suitably.

Lastly, we recognize that this research topic is open. Efforts must be undertaken to try to improve the way of measuring the symbiosis, whether by developing more precise indicators, whether by choosing other variables. The question of classification and terminology, as pointed out by Hauge e Chang (2019), shows the care the topic must be approached, but also stimulates creative investigation ways on the field of economic growth theories.

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Annex A – Countries of the sample

Germany	Denmark	Hungary	Mexico
Australia	Slovakia	India	Norway
Austria	Slovenia	Indonesia	Poland
Belgium	Spain	Ireland	Portugal
Brazil	United States	Italia	United Kingdom
Bulgaria	Estonia	Japan	Czech Republic
Canada	Finland	Latvia	Romania
Cyprus	France	Lithuania	Russia
South Korea	Greece	Luxembourg	Sweden
Croatia	Netherlands	Malta	Switzerland
			Turkey

Source: WIOD Socio Economic Accounts

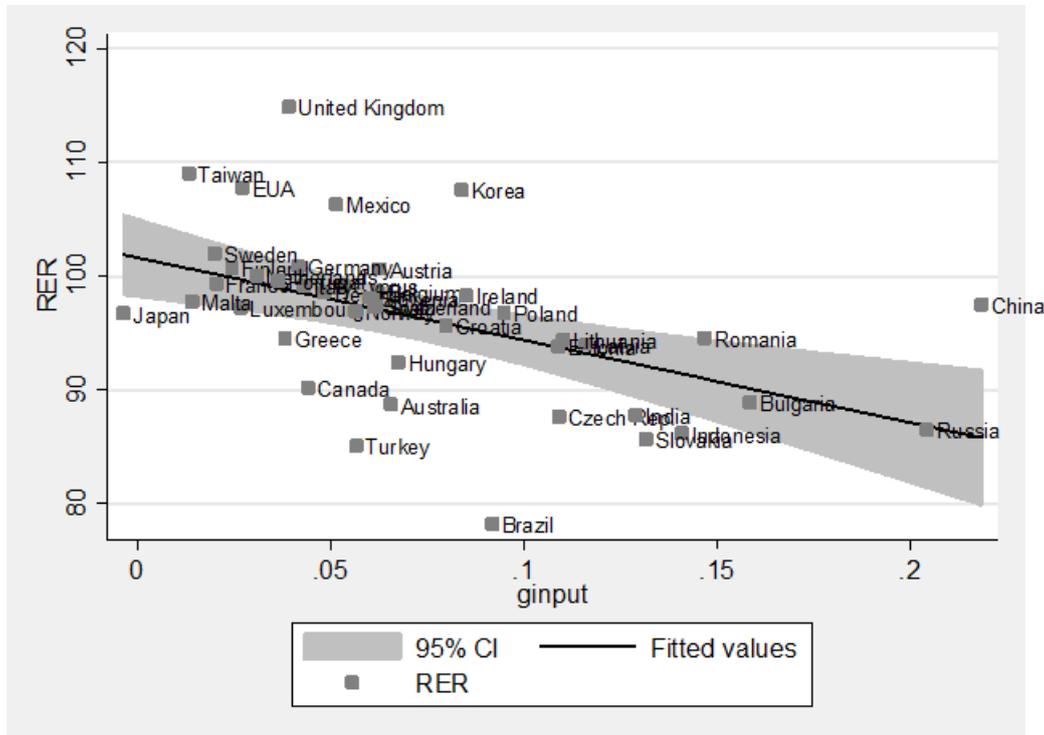
Annex B – Modern services activities

Publishing activities;	Financial services auxiliary activities and insurance activities;
Movie, video and television programs production activities, sound recordings and music edition; programming and broadcasting activities;	Real estate activities;
Telecommunications;	Legal and accountability activities; head office activities; management consulting activities;
Computer programming, Consulting and related activities; Information services activities;	Architecture and engineering activities; technical tests and analysis;
Financial services activities, except insurance and pension funds;	Research and scientific development;
Insurance, reinsurance and pension funds, except compulsory social security;	Publicity and market research;

Other professional, scientific and technic activities; veterinarian activities;

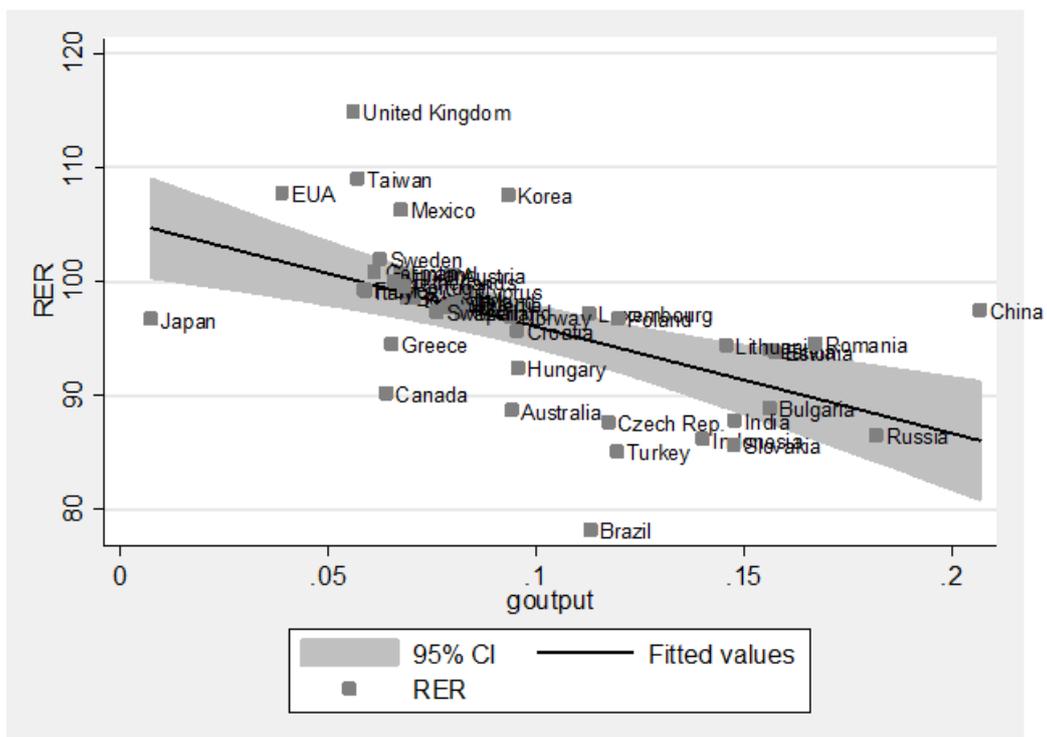
Source: WIOD Socio Economic Accounts.

Graphic A – Real Exchange Rate (rer) and Input growth (ginput) - average, 2000 – 2014



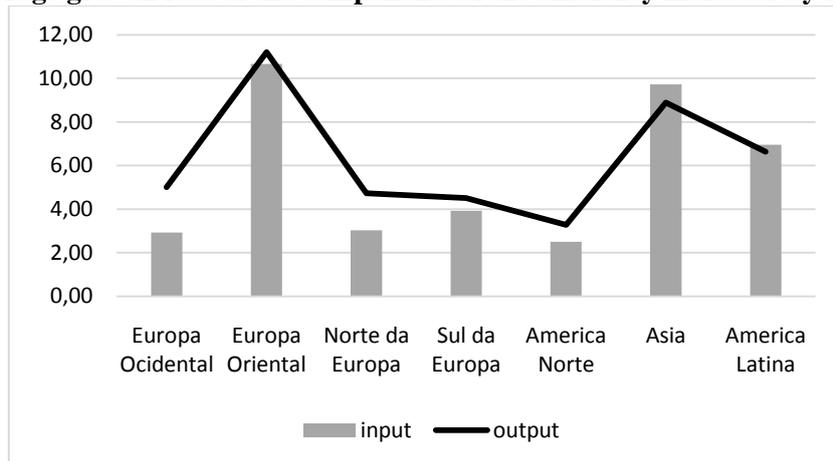
Source: WIO Charts and Bruegel dataset. Elaborated by the authors. Pearson correlation = -0.50

Graphic B – Real Exchange Rate (rer) and Output growth (goutput) - average, 2000 - 2014



Source: WIO Tables and Bruegel dataset. Own elaboration. Pearson Correlation = -0.55

Graphic C – Average growth rate of the components of the efficiency indicator by region, 2000 - 2014



Source: World Input-Output Charts. Elaborated by the authors.