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Do imports of intermediate inputs generate higher productivity? Evidence from Ecuadorian Manufacturing firms*

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Abstract

International trade has been stated as one of the most important mean of improving firms' productivity, being the channel behind, the technology transfer from foreign companies to local firms. Focusing on imports, they can positively contribute to local firm's productivity performance by incorporating better inputs in their production processes. This paper analyzes, by using an augmented Cobb Douglas production function, the effect of imported intermediates on the production level of manufacturing formal firms in Ecuador, and, the causal relationship between the import decision and firm productivity. For this, we make use of a unique administrative data ranging from years 2007 to 2018 and estimate the total factor productivity (TFP) at firm level using a flexible Levinsohn-Petrin semiparametric method, which allows us to address the endogeneity and simultaneity problem existing in the inputs selection (inherent to this type of estimations). The results show that (i) a 100% decrease in the share of domestic intermediates in total intermediates increases productivity by 7% in the manufacturing sector, (ii) when we use a measure of import intensity, we find that a 100% increase in the share of imported inputs increases firm productivity by 7%, (iii) foreign and domestic intermediates are substitute inputs, with an elasticity of substitution positive and greater than one (4.43), and (iv) we provide robust evidence in favor of the "*learning-by-importing*" hypothesis. Finally, we find that there is self-selection of more productive firms into the import market. The main conclusion is that the decision to import foreign intermediates improves productivity in manufacturing firms. This matters from a policy perspective as increasing productivity levels is crucial for a country's economic growth.

Keywords: Productivity; Imported intermediates; self-selection; learning-by-importing; Ecuador
JEL Codes: D22, D24, F10, F14, L60, L11

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1 Introduction

The relationship between international trade and economic growth has been much discussed in the literature, mostly since the seminal paper by Bernard et al. (1995). International trade, according to many authors such as Van den Berg (1997), Eaton and Kortum (1999, 2002), Caleb et al. (2014), Jouini (2015), Majeed (2016) and Linarello (2018), affects positively the economic growth of a country either in the long or in the short run because, through it, domestic firms may gain access to foreign technologies and potential markets, and establish cooperation agreements with foreign firms (European Commission, 2012).[1] For developing countries, furthermore, it constitutes an important way through which they can absorb more efficient technologies—compared to those produced locally—and especially those created in the developed world (Acharya and Keller, 2009; Amiti and Konings, 2007).

In spite of this, more attention has been devoted to the analysis of exports (Lööf and Andersson, 2010) than of imports in the literature. Regarding research on imports, it has been found that imports positively affect the economic performance of countries (Lööf and Andersson, 2010; Halpern et al., 2015). According to several authors, additionally, such positive effect originates essentially from the productivity gains generated by imports (see, for example, Goldberg et al., 2010; Kasahara and Lapham, 2013; Wagner, 2017; Broda and Weinstein, 2006; Amiti and Konings, 2007). Within this framework, Acharya and Keller (2009) and Amiti and Konings (2007) argue that imports allow economies and firms to stock up cheaper, higher-quality, and more efficient raw materials, technology (Acharya and Keller, 2009; Miller and Upadhyay, 2000; Hasan, 2002), and capital goods for production (Caselli, 2018), and also to implement the know-how of foreign economies to increase local production efficiency and, thereby, productivity levels; thus, by importing, an individual firm can exploit global specialization and employ inputs from the forefront of knowledge and technology (Lööf and Andersson, 2010). In this way, imports can significantly enhance productivity increases by generating firms' advantages in terms of cost and quality of raw materials and technology, so that they are able to reduce monetary and time costs (Bas and Strauss-Kahn, 2014; Fariñas et al., 2014). Also, Máñez Castillejo et al. (2019), Kasahara and Rodrigue (2008), Girma Abreha (2019) and Caselli (2018) supporting the hypothesis of a positive linkage between imports and productivity, mention the existence of a so-called "learning-by-importing" effect, according to which firms that import to produce, have gains in terms of productivity (based on the learning experience of importing). However, a broadly studied issue regarding such effect is the existence of "self-selection" into importing, which argues, conversely, that more productive firms are able to enter in the import market because they can cover the sunk and fixed costs (Vogel and Wagner, 2010; Zhang, 2017).

For developing countries particularly, as stated by Balassa (1987), imports are significantly important since they contribute to the process of accumulation of physical capital that is required for the industrialization process, thus boosting the evolution of the exportable products sector and the domestic industry as well, and—consequently—the production diversification in the long run (towards large-scale production of value-added products). In addition, international trade agreements related to specific imported good or services can enable potential agreements of political and/or financial nature, which can be highly beneficial for participant countries (for instance, in terms of productivity—see, for example, Topalova and Khandelwal (2011); Amiti and Konings (2007); Fernandes (2007); De Loecker (2011)). Imports, therefore, have an even more pronounced role, for developing countries, as sources of technology transfer, which makes them highly demanded; on the other hand, such trend on developing countries demand has encouraged substantially the production of capital and intermediate goods worldwide, which have strongly benefited from R&D investments mostly in developed countries (Coe et al., 1997). It is particularly important for these countries, moreover, that firms' productivity gains generated by imports can translate themselves, in the long run, into improvements in growth and development levels.

Given the importance, thereby, of this topic for several countries worldwide, various related investigations have

[1] See Keller (2004) for a literature review of how international technology diffusion relates to other factors affecting economic growth in open economies.

been carried out, both from a macroeconomic and microeconomic perspective (see, for example, Coe et al., 1997; Melitz, 2003; Kasahara and Lapham, 2013; Girma Abreha, 2019; Zhang, 2017). However, analyzing aggregated data could not correctly capture the existent heterogeneity across different industries, plants and, even more concretely, firms, within the economies; due to this reason, in order to understand changes in aggregate productivity levels it is vital to examine more desegregated data (Pavcnik, 2002). In particular, regarding firm-level data, given that firms are characterized by marked heterogeneity in terms of global orientation, productivity, size, factor intensity, payment, among other factors, the trend in the empirical international trade literature has been characterized, during the last years, by a surge in using microeconomic data (Girma Abreha, 2019).

In this sense, we analyze manufacturing firms from Ecuador. This country is a developing Latin American country, which is mostly a raw materials exporter and an elaborated-products importer country (Díaz-Cassou and Ruiz-Arranz, 2018); such positioning in the international trade sphere causes the country to constantly evidence commercial balance deficits. With such a productive and monetary configuration, import policy tools, and thus, analysis that uncovers the importance (in different dimensions) of imports for this country, are critical. Regarding the imports-productivity relationship in the country, for instance, no research has yet been performed. With respect to total productivity solely,[2] only two studies have been performed. Wong (2009) studied the relationship between trade openness and productivity using plant level data (for the manufacturing sector) during the period 1997–2003 and, in general terms, showed a positive effect of trade openness on productivity for export-oriented manufacturing industries before the dollarization, but a negative effect afterwards. Additionally, Camino-Mogro et al. (2018) using manufacturing firm level data conclude, among other things, that (1) what contributes the most to total factor productivity (TFP) of Ecuadorian firms in the manufacturing sector is the raw materials input, followed by labor force and net fixed assets, and that (2) the TFP for the sample analyzed presents a growth pattern that coincides with gross domestic product (GDP) oscillations.

In this context, we aim to contribute to the analysis of—for first time—the imports-productivity causal relationship in this Latin American and developing country, Ecuador. Although this relationship has been broadly studied for developed countries, still scarce evidence has been obtained for developing ones at firm level (most of the evidence focus on plant level data) and, particularly, no evidence has been pursued for Ecuador. We fill the gap in the literature not only (1) using Ecuador (manufacturing sector) as a case study for estimating the effect of imports on productivity—and also, indirectly, on production—by using different estimators, but also (2) analyzing this effect for two different industry classifications (Pavitt Taxonomy and industries according to their technological intensity following the OECD classification), since restricting the analysis to the manufacturing sector could mask varying roles of different technology transfer channels among firms; (3) we also analyze the elasticity of substitution between imported intermediates inputs and domestic intermediates in the whole sector and for the two different proposed industry classifications; finally (4) analyzing separately the relationship between different firms' import decisions and productivity levels and their growth rates (thus, testing for the "*learning-by-importing*" and "*self–selection*" hypothesis by using a novelty strategy to get more robust results). We use a novel, detailed and underexplored unbalanced annual panel data for the period 2007–2018, that allows to capture the existent heterogeneity across firms and time; the data was collected from the balance sheets and financial statements reported by firms to Superintendencia de Compañías, Valores y Seguros (SCVS) in Ecuador.

We, thus, investigate the causal link between imported intermediate inputs and firm productivity, and aim at answering the following question: Do imports of intermediate inputs generate higher productivity?. Additionally, we capture the elasticity of substitution to analyze the substitutability between imported intermediates inputs and domestic inputs. Finally, we examine the robustness of our results including the effect of an "export decision" on the underlying effect of imports intermediate inputs on productivity, not only distinguishing by industry but also by firm-size.

The structure of this paper is as follows. Section 2 provides a literature review regarding similar studies performed for other countries, Section 3 shows some important characteristics of productivity and imports in Ecuador.

[2] Few analysis regarding labor productivity; however, have been performed. See, for example, Fernández and Gavilanes (2017).

Section 4 explains the methodology applied. Section 5 explain the data and variables used. Section 6 details the results obtained and their interpretation. Finally, Section 7 states the conclusions and policy implications of the research.

2 Literature Review

Since the seminal paper by Bernard et al. (1995) that analyzes the relationship between productivity and international trade through the lens of individual firms, a proliferation of research analyzing the relationship between exports and productivity has been done and such linkage has received more attention than the productivity-imports one (Wagner, 2007, 2012; Altomonte et al., 2013; Máñez Castillejo et al., 2019). However, in recent years, several studies have also been carried out worldwide regarding the latter relationship, for developed and developing countries (although for the latter such studies have been relatively scarce).

In the case of developed countries, for instance, Muûls and Pisu (2009), using a firm panel spanning the period 1996–2004, determined that in Belgium, imports have a positive effect on aggregate productivity levels. Causality running from imports to productivity was also a conclusion drawn in the research of Lööf and Andersson (2010), who additionally stated that in such a relationship the origin of the imports matters; in this study, they analyzed a panel dataset of Swedish manufacturing firms for the period 1997–2004. More recent related studies have drawn similar conclusions. For example, Halpern et al. (2015) found, in a 1993–2002 study of Hungarian firms, that imports have a significant and large effect on firm productivity, about one-half of which is due to imperfect substitution between foreign and domestic goods. They also found that foreign firms use imports more effectively and pay lower fixed import costs. Ahn and Choi (2016), by analyzing a firm-level panel data for Korea during the period 2006–2012, concluded that firms' productivity level is positively influenced by imports levels. Similarly, research regarding the Netherlands, through the use of panel data firm-level information (for the period 2002–2008), concluded that imports have a positive effect on productivity levels of firms (Van den Berg and Van Marrewijk, 2017).

Regarding developing countries, however, empirical evidence is still scarce. For instance, according to Girma Abreha (2019), in Ethiopia there is a positive effect of imports on productivity levels and also a self-selection into importing and learning-by-importing effect; for this analysis, panel data regarding firms for the period 1996–2011 was used. Within the same framework, Bonelli (1992), by analyzing information on Brazilian manufacturing firms, between 1975 and 1985, concluded that imports increase productivity. Kasahara and Rodrigue (2008), additionally, in a study of plant-level Chilean manufacturing panel data for the period 1979–1996, determined that imported intermediates improve plant's productivity. On the other hand, in the study of Zhang (2017), the author examines the long-term effect of importing intermediate inputs on plant's performance—by evaluating the relative importance of such effect through immediately increased revenue and dynamically increased productivity—for the case of Colombian manufacturing plants, using data corresponding to period 1977–1991, and applying an estimation algorithm that combines the insights of Olley and Pakes (1996) and Das et al. (2007); it was found that importing increases both the within-plant current period revenue (static effect) and future productivity (dynamic effect) substantially, and that more productive plants with low importing costs tend to import intermediate inputs. Finally, Zaclicever and Pellandra (2018), using firm-level data on Uruguay during the period 1999–2008, concluded that the same positive effect of imports on productivity also exists for the case of Uruguayan firms. However, Máñez Castillejo et al. (2019) found that studies for Brazil (in 2004) and Colombia (in 2003) suggest the nonexistence of significant effects of imports on productivity.

Additionally, Şeker (2012) concluded that importers have significantly higher productivity levels than noninternational traders, using panel data for 43 developing countries for the years 2002, 2005, 2006, and 2008. Overall, several authors have concluded that importers are more productive than nonimporters (Şeker, 2012; Muûls and Pisu, 2009; Castellani et al., 2010; Zhang, 2017; Kasahara and Rodrigue, 2008; Girma Abreha, 2019; Zaclicever and Pellandra, 2018). It is worth mentioning, in addition, that Van den Berg and Van Marrewijk (2017) also

conclude that productivity gains from imports increase if the counterpart country is a developed one, decrease if it is farther from the importer one, and increase if the import refers to technology goods rather than primary ones. Finally, in line with the analysis of the imports-productivity relationship, Damijan et al. (2014) conclude, that a changing behaviour in imported varieties of capital and intermediate inputs has a significant impact on productivity gains of enterprises and, even also on their exporting scope. In addition, in the research developed by Caselli (2018), he analyses how import activities affect productivity, differentiating imports between two types—intermediate inputs and capital goods—by using a panel data of Mexican manufacturing plants between 1994 and 2003; the methodology applied was mainly the Wooldridge–Levinsohn–Petrin-fixed-effects (WLP-FE) estimator (an augmented version of the LP method), and the results suggested that (1) not only more productive plants tend to become importers of machinery and equipment rather than materials, but that (2) plants that start importing machinery and equipment experience an increase in productivity (while the same does not occur when plants start importing materials), and that (3) there are productivity gains following entry into export markets and complementarities between exporting, importing materials and importing machinery and equipment.

Several previous studies, therefore, suggest that import levels could have important implications, either in the long or in the short run, on productivity levels, in developed and in developing countries as well. The results of most empirical studies suggest, however, for the case of developed countries, the existence of a significant positive effect running from imports to productivity levels, while for the case of developing countries, empirical evidence is still scarce and results are mixed (Máñez Castillejo et al., 2019). Cassiman and Golovko (2018), following an exhausting literature review on this topic, arrived at the same conclusion.

This research seeks to contribute with the growing developed literature with the analysis—for first time—of the imports-productivity effect in Ecuador, a Latin American and developing country. Although this relationship, as noticed, has been broadly studied for developed countries, still scarce evidence has been obtained for developing ones at firm level (most of the evidence focus on plant level data) and, particularly, no evidence has been pursued for Ecuador. We aim at filling the gap in the literature not only using the Ecuadorian manufacturing sector as a case study for estimating the effect of imports on productivity—and also, indirectly, on production—by using different estimators, but also analyzing this effect for two different industry classifications (Pavitt Taxonomy and industries according to their technological intensity following the OECD classification), also analyzing the elasticity of substitution between imported intermediates inputs and domestic intermediates in the whole sector and for the two different proposed industry classifications; finally, study separately the relationship between different firms' import decisions and productivity levels and their growth rates (thus, testing for the "*learning-by-importing*" and "*self–selection*" hypothesis by using a novelty strategy to get more robust results)..

3 Overview of imports and productivity in Ecuador

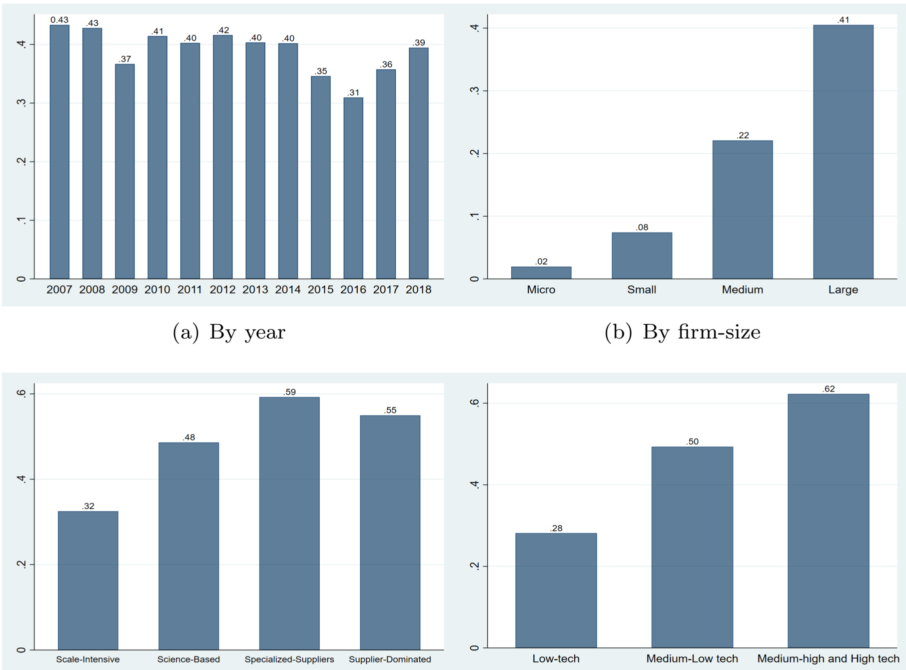
Ecuador is a middle-income Latin American developing country[3]. According to information from Banco Central del Ecuador (BCE), in 2018 its GDP reached $107,562 millions (current terms), and showed an annual growth rate of 1.3%. Additionally, when categorized by industries, in 2018 the total gross added value (GAV[4]) was composed in 69.19% by that of tertiary sector industries, in 17.02% by that of primary sector industries, and in 13.79% by that of secondary sector (manufacturing sector alone). Such composition of added-value creation has remained relatively stable since the early 2000s in the country, while, in absolute terms, total GAV and total GDP as well have been permanently increasing (with an important exception in year 2015, as a consequence of the global oil prices crisis, after which the country returned to its positive growth trend) until nowadays.

Manufacturing sector in the country, therefore, by itself represents around the 14% of creation of the national added value. Given that the country is currently characterized by being essentially a raw materials (mainly crude oil, and agricultural products) exporter and an oil-derivatives importer (Carrillo-Maldonado et al., 2018), this

[3]According to the International Monetary Found (IMF).
[4]Gross Added Value corresponds to the value of production minus the intermediate consumption by industries.

economic sector has a special importance since it constitutes the field where an industrialization process can be enhanced and, consequently, a road towards which development can be built (Camino et al., 2017). In fact, since year 2007, the Ecuadorian government has traced the so-called process of "Productive Matrix Change" as one of the main global economic objectives of the country. In this path, manufacturing sector generated, during the period 2013–2017, around a quarter of the total net profits, gross revenues of the Ecuadorian economy and 18.7% (on average) of the formal employment at national level (Camino et al., 2018).

But Ecuador, in general, is also a country that presents a dynamic mostly leaded by the global economic market (Díaz-Cassou and Ruiz-Arranz, 2018). The principal reason for such a behaviour is that the main export product of the country is the oil, a commodity whose price is determined exogenously (to the country), in the international economic market[5] Such sensibility of the Ecuadorian exports to the international framework, along with the "importer" and "exporter" specific positions of the country in the international trade network, permanently causes Ecuador to show "trade deficits" (specially in the non-oil sectors). Given such a framework, the analysis of "imports" and their effects on important aggregate variables turns to be of great relevance for Ecuador because, according to the BCE, the major share of imports are intermediate and capital goods, so that these variables are an important part of the production of firms.



(a) By year

(b) By firm-size

(c) By Pavitt's taxonomy

(d) By technological intensity

Figure 1: Participation of Imported Intermediates on Total Intermediates (Manufacturing Sector, period 2007-2018)

Particularly in the manufacturing sector, imports of intermediates play an important role as part of the production processes. As can be seen in Panel 1(a) from Figure 1, from 2007 to 2018 the yearly participation of imports on total intermediates in this economic sector fluctuated around 39%, continuously decreasing from 43% in 2007 to 31% in 2016, and presenting an increase during the next years, so that in 2018 it stood at 39%. This suggests that currently the participation of imports on total intermediates in this sector is raising. But such a participation of imports, for the same period 2007–2018, has a different behaviour depending on firm size (Panel

[5] According to Borensztein and Ruiz-Arranz (2018), besides, not just this fact can be causing the strong dependence of the Ecuadorian economy on the global international market evolution, but another fact which can even deepening such dynamics is the current "dollarization" condition of the country. In the early 2000s, Ecuador adopted a dollarization regime with the objective of reducing the then ongoing inflation, and reversing the recession the country was facing. As Borensztein and Ruiz-Arranz (2018) mentions, the monetary conditions in a dollarized economy depend on the liquidity of the dollar in the monetary markets; therefore, the more aligned is the local economic cycle to that of EE.UU., the more appropriated will be the liquidity conditions related to those needed in the local economy.

1(b)), and the region where it is located. On the one hand, while large firms import around 41% of their total intermediates, medium-size firms do it just at an extent of 22% and micro and small firms roughly import not even a 1% of all their intermediates. Undoubtedly, therefore, either important productivity effect of imports or self-selection effect, exist in this sector so that the larger the firm the more it imports.

When taking into account the classification of sectors according to Pavitt (1984) (Panel 1(c)), it can also be noticed that the specialized-suppliers and supplier-dominated sectors are those with the highest participation of imports on total intermediates (around 59% and 55%, respectively), followed by the science-based sector (with a participation of 48%) and by the scale-intensive sector (with 32% as imports participation). Finally, considering sectors categorized by their technological intensity level (Panel 1(d)), it can be noticed that medium-high technology sector has the highest participation share of imports over total intermediates (around 62%), while the medium-low technology sector and the low technology sector present a participation share of imports around 50% and 28% respectively. This observation is consistent given that more advanced technological sectors would tend to require a distinct quality/quantity of intermediates that are likely to not be available in the domestic market of Ecuador.

Regarding productivity in Ecuador, according to BCE (2000), in 1999 the industries of banana, cacao, coffee, and sugar were those where TFP was the principal contributor to the industrial value added growth. Additionally, Wong (2009) argues that (1) import-competing [6] and nontradable industries experienced productivity growth every year from 1997 to 2003 (in comparison to the base year 1997), and that (2) establishments' productivity in export-oriented industries grew in the years 1998—2000 (at a higher rate than in import-competing and nontradable industries), barely grew in 2001, and fell in years 2002 and 2003 (post-dollarization years). Her results also indicated that aggregate productivity increased in some manufacturing industries during the period 1997–2003. Food processing, apparel and leather, and furniture were the industries that demonstrated growth at the end of the study period (27%, 15%, and 8%, respectively). Other sectors, such as basic metals and metal products, and machinery, equipment and vehicles showed a considerable decrease in productivity at the end of the study period, with a 28% loss and a 10% loss, respectively. Sectors such as textiles, wood and paper, and chemicals, rubber, plastics, and nonmetallic products presented a slightly decreased aggregate productivity in 2003 (Wong, 2009).

Several interesting results about productivity are also derived in the research by Camino-Mogro et al. (2018) regarding the Ecuadorian manufacturing sector. The authors determined that firm productivity levels decreased during the periods around 2008 and 2015. This could be explained by the negative effects of the global financial crisis of 2008 and the oil price crisis of 2015, respectively. In addition, from 2015 to 2016 the aggregated manufacturing productivity level decreased by 3.94%. Manufacturing productivity levels also varied by firm size: large and medium-sized firms are on average more productive than small and micro firms. Likewise, when analyzing productivity levels by region (in consideration of the significant differences between them in terms of weather, ethnic groups, employment types, and production, among others), it was concluded that the firms located in the Coast Region were on average more productive than those of other regions. Finally, by states, Guayas and Cañar stood out as the most productive ones, while Pichincha (where Quito, the capital of Ecuador, is located) presented productivity levels higher than the average just in one year of the study period (Camino-Mogro et al., 2018).

4 Theoretical framework and empirical strategy

4.1 Specification of the production function

We adopt the augmented production function of Kasahara and Rodrigue (2008), like other papers (e.g. Girma Abreha, 2019; Caselli, 2018; Zhang, 2017). This specification allows to analyze the impact of imported intermediate inputs on productivity and also the determination of the elasticity of substitution between domestic and imported intermediates inputs. The proposed technology considers that both domestic and foreign intermediate goods are

[6] The author refers to this term when the import share exceeds 26%.

produced and used symmetrically. Then, the production function of the firm i to obtain the output Y_{it} at time t is given by:

$$Y_{it} = e^{(\omega_{it}+\epsilon_{it})} K_{it}^{\beta} L_{it}^{\alpha} \left[\int_0^{N(d_{it})} m(j)^{\frac{\theta-1}{\theta}} dj \right]^{\gamma \frac{\theta}{\theta-1}} \tag{1}$$

Where ω_{it} is a serially correlated productivity shock (not observed by the econometrician but observable or predictable by firms), K_{it} is capital input, L_{it} is labor input, $m(j)$ represents the intermediate inputs (domestic and foreign intermediate goods) and ϵ_{it} is a standard i.i.d. error term that is neither observable nor predictable by the firm. The β, α, and γ are elasticities of output with respect to each input. The firm's decision to import and use foreign intermediate inputs is denoted by a dummy variable $d_{it} \in \{0, 1\}$, and the variable $N(d_{it}) = (1 - d_{it})N_{it}^h + d_{it}N_{it}^f$ denotes the range of intermediates used by firm i, with N_{it}^h being the range of intermediates produced domestically and N_{it}^f being the range of intermediates available abroad (imported intermediates). If the elasticity between domestic and foreign material inputs is greater than one ($\theta > 1$), both inputs are substitutes (interchangeable) in the production process, when θ is large, the two inputs are more substitutable, meaning that the input variety effect of the imported inputs is small (Zhang, 2017); otherwise, they are complementary. This specification of production function closely follows Kasahara and Rodrigue (2008) and Girma Abreha (2019).[7] However, we simplify our specification in the following manner: *i*) we do not divide the labor force into skilled and unskilled as in these papers because our dataset does not allow this classification, *ii*) we do not use energy separately because we assume that energy is a domestic intermediate input,[8] and *iii*) our specification is adapted to firm level.

As both intermediate inputs are produced and used symmetrically, we assume that $\bar{m}$ units of each intermediate input variety j are used, thus, total material inputs used by firm i in time period t is $M_{it} = N(d_{it})\bar{m}$ in equilibrium. Under such considerations, the production function is given by:

$$Y_{it} = e^{(\omega_{it}+\epsilon_{it})} K_{it}^{\beta} L_{it}^{\alpha} M_{it}^{\gamma} N(d_{it})^{\frac{\gamma}{\theta-1}} \tag{2}$$

Where the total factor productivity (TFP) is defined as $e^{(\omega_{it}+\epsilon_{it})} N(d_{it})^{\frac{\gamma}{\theta-1}} = \frac{Y_{it}}{K_{it}^{\beta} L_{it}^{\alpha} M_{it}^{\gamma}}$. Then, from equation (2),

$$ln(e^{(\omega_{it}+\epsilon_{it})} N(d_{it})^{\frac{\gamma}{\theta-1}}) = lnA(d_{it}, \omega) = \frac{\gamma}{\theta-1} ln(N(d_{it})) + \omega_{it} + \epsilon_{it} \tag{3}$$

This equation indicates that productivity is positively related to the range of employed intermediate inputs on the production process; firms importing intermediate inputs from abroad employ a large variety of intermediate inputs hence exhibit higher productivity than those that only use domestic intermediates (Kasahara and Rodrigue, 2008).

4.2 Empirical model and estimation method

Following Kasahara and Rodrigue (2008), taking logarithms in equation (2) and including a discrete import variable, that suggest the use of imported intermediates into the production process, the relevant expression to be estimated is:

$$y_{it} = \omega_{it} + \beta k_{it} + \alpha l_{it} + \gamma m_{it} + \delta d_{it} + \epsilon_{it} \tag{4}$$

[7] The different varieties of intermediate goods are treated as horizontally differentiated with no quality difference; recently Zhang (2017) include in his model a input quality effect of the imported inputs relative to domestic inputs. However, similarly to Kasahara and Rodrigue (2008) our data set does not contain information on firm-specific product price nor the range of the variety of intermediate inputs a firm uses, it is difficult to empirically differentiate between the quality or variety effect of foreign intermediates on productivity.

[8] We can assume that the energy input is domestic because oil derivatives are imported only by the government (see Díaz-Cassou and Ruiz-Arranz, 2018)

Where the lowercase variables are the log transformation. A firm's discrete choice to import intermediates inputs is denoted by d_{it} to capture the static effect of use foreign inputs $\frac{\gamma}{\theta-1}ln(N(d_{it}))$. Similar to Kasahara and Rodrigue (2008) and Girma Abreha (2019) and under a linear first-order Markov process of productivity, we consider the following stochastic process of ω_{it}:

(5) $$\omega_{it} = \xi + \rho\omega_{it-1} + \eta d_{it-1} + u_{it}$$

Where ξ is an innovation term (or a year-specific productivity shock) uncorrelated by definition with k_{it}, u_{it} is independent of ω_{it-1} and d_{it-1} with a known distribution; Zhang (2017) argues that if a firm was an importer at date $t-1$, its productivity will be enhanced due to the importing experience and this increased productivity further affects future importing decisions, which in turn has an impact on future productivity, the importing decisions are endogenous, this setup implies that productivity is endogenous and similar to De Loecker (2013) we assume that productivity evolves according to an endogenous Markov process. In equation (4) we can examine the static effect of importing on firm output and productivity by testing $\delta > 0$, it implies that using imported intermediate inputs immediately improve output for a fixed quantity of inputs in production (Girma Abreha, 2019) and firm-level evidence of R&D spillovers through trade in intermediate goods (Kasahara and Rodrigue, 2008).

Similar to Kasahara and Rodrigue (2008) and Girma Abreha (2019), our specification for production technology differs from Levinsohn and Petrin (2003) and Olley and Pakes (1996) since we use an additional state variable of import status, d_{it}, and the import status has a dynamic effect on productivity as specified in equation (5).[9] For this, the material's demand function is given as $m_{it} = m_t^*(\omega_{it}, k_{it}, d_{it})$ and assuming that $m_t^*(\cdot)$ is strictly increasing in ω_{it}, the unobserved productivity can be expressed in terms of observable capital, intermediate inputs and imports as $\omega_{it} = \omega_t^*(m_{it}, k_{it}, d_{it})$ and the estimating equation is the following:

(6) $$y_{it} = \alpha l_{it} + \phi_t(m_{it}, k_{it}, d_{it}) + \epsilon_{it},$$

Where $\phi_t(m_{it}, k_{it}, d_{it}) = \beta k_{it} + \gamma m_{it} + \delta d_{it} + \omega_t^*(m_{it}, k_{it}, d_{it})$. In the first stage, the estimation of α from equation (6) is consistent and similar to Levinsohn and Petrin (2003) using a third-order polynomial approximation. In the second stage, we estimate β, γ, δ once we define the innovations in productivity conditional on ω_{it-1}, d_{it-1}:[10]

(7) $$\xi_{it} = \omega_{it} - E[\omega_{it}|\omega_{it-1}, d_{it-1}]$$

This new equation (7) allows the productivity innovations ξ_{it} to be orthogonal to all information at time $t-1$ and with ϵ_{it} in equation (6), We can construct the orthogonality conditions, following Kasahara and Rodrigue (2008), for each candidate parameter vector $\Gamma^* = (\beta^*, \gamma^*, \delta^*)$ we may construct an estimate the residual as:

(8) $$(\hat{\xi_{it}} + \hat{\epsilon_{it}})(\Gamma^*) = y_{it} - \hat{\alpha} l_{it} - \beta^* k_{it} - \gamma^* m_{it} - \delta^* d_{it} - \hat{E}[\omega_{it}|\omega_{it-1}, d_{it-1}]$$

In this sense, we estimate equation (4) with two differences to the traditional Levinsohn and Petrin (2003) estimator.[11] First, d_{it} is treated as additional state variable given that the import decision is not reversible once the productivity shock realizes. Second, d_{it-1} affects ω_{it}. We extend this model to consider explicitly the extent at which imported intermediates are used relative to domestic intermediates, as suggested in equation (2). Kasahara and Lapham (2013) show that when firms have heterogeneous transportation costs of imported intermediates,

[9] See Van Biesebroeck (2007), Van Beveren (2012) and more recently Bournakis and Mallick (2018) for a review of the parametric, semiparametric and nonparametric methods for estimating production functions, and explanations of their benefits and disadvantages

[10] We do not control for selection bias by considering the expectation conditional on the survival probability, since we use an unbalanced panel data set and following Levinsohn and Petrin (2003) they argue that this issue is unimportant in this kind of data.

[11] It is well known that the direct ordinary least squares (OLS) estimator is subject to an endogeneity and simultaneity problem because the labor and intermediate inputs choices are dependent on ω_{it} (Kasahara and Rodrigue, 2008; Zhang, 2017). In this sense, if firm's decision on using more inputs is based on the productivity shocks, is coherent to think that higher productivity firms will use more inputs and this issue will upwardly bias the coefficients estimated by OLS because firm does not make inputs decision independent of its productivity. In addition, the importing status d_{it} is also correlated with ω_{it} because productivity is a Markow process and this correlation aggravates the endogeneity problem (Zhang, 2017).

the benefit from importing may be different across firms and also the higher the ratio of total intermediates to domestic intermediates, the larger the productivity effect from importing. For this, we introduce the term n_{it} that captures the intensity of the foreign and domestic intermediate inputs, as in Kasahara and Rodrigue (2008) and replacing d_{it} by n_{it} in equation (4), we get:

$$y_{it} = \omega_{it} + \beta k_{it} + \alpha l_{it} + \gamma m_{it} + \psi n_{it} + \epsilon_{it}, \tag{9}$$

$$\omega_{it} = \xi + \rho\omega_{it-1} + \eta n_{it-1} + u_{it} \tag{10}$$

As we mention before, This new specification proposed by Kasahara and Rodrigue (2008) allows to capture the impact of imported intermediates on productivity and the elasticity of substitution between domestic and imported intermediates.

This augmented production function, with the variable (n_{it}) as the ratio of total intermediate materials to domestic inputs $\left(\frac{M_{it}}{M_{it}^h}\right)$, allows the determination of the elasticity of substitution between domestic and imported intermediates inputs, in such a way that by estimating equation (9) the value of θ is captured, $\bar{\theta} = \frac{\bar{\gamma}}{\bar{\psi}} + 1$. where if it is greater than 1 there is a substitution elasticity, and if it is less than 1 or negative then there is complementarity between these two inputs. Kasahara and Rodrigue's approach allows us to estimate the elasticity of substitution between the domestic and foreign intermediate inputs, with the parameters corresponding to total intermediates (γ) and the usage of total intermediate materials related to domestic inputs (or import participation) (ψ).

As an alternative specification, we use the approach proposed by Girma Abreha (2019) to estimate the impact and intensity of foreign intermediates on TFP. The author proposes to use the ratio between the foreign intermediate inputs and the total intermediate $\left(\frac{M_{it}^f}{M_{it}}\right)$ to examine whether or not intensive use of foreign varieties improves productivity. Also in this approach the import is treated as a continuous variable depending on how intensive is the use of foreign varieties among importing firms. By introducing this ration into the augmented Cobb-Douglas production function and productivity equation, we obtain:

$$y_{it} = \omega_{it} + \beta k_{it} + \alpha l_{it} + \gamma m_{it} + \mu FI_{it} + \epsilon_{it}, \tag{11}$$

$$\omega_{it} = \xi + \rho\omega_{it-1} + \eta FI_{it-1} + u_{it} \tag{12}$$

Where $FI_{it-1} = log\left(\frac{M_{it-1}^f}{M_{it-1}}\right)$. This new ratio is estimated similarly to the discrete import variable d_{it} and also to the continuous import variable n_{it}.

4.3 Testing *self-selection* into importing and *learning-by-importing*

The aim of this subsection is two-fold. The first objective is to analyze the self-selection into the import market. In this sense, the methodology used so far dose not allows us to test this hypothesis. The second objective is to present additional evidence regarding the *learning-by-importing* hypothesis. Moreover, the methodology used in this second analysis allows us to get additional evidence regarding the self-selection hypothesis in the entry and in the exit side of the market.

There is large evidence that mentions that breaking into foreign markets involves significant sunk starting-up costs and fixed costs (e.g. Melitz (2003), Campa (2004), Zhang (2017)). In this sense, it is expected that firms self-select into the import market according to their productivity level. To test the self-selection hypothesis, we first estimate the production function given by equation (4) using the LP estimator but without including the

import dummy (d_{it}) as a regressor and obtain the TFP estimates. In a second step, we regress the estimated TFP on the import dummy and other control variables.

Following Girma Abreha (2019), we consider a subsample of firms with no importing history and estimate the pre-entry import productivity premia between future importers and non-importers. Controlling by firms' capital holding, employment, year, industry and region fixed effects, we estimate the following equation of lagged values of productivity ω_{it-s} on current import status d_{it}.

$$(13) \quad \omega_{it-s} = \beta_0 + \beta_1 d_{it} + \beta_2 capitalholding_{it-s} + \beta_3 employment_{it-s} + \beta_4 ControlVariables + \varepsilon_{it-s}; s = 1, 2, 3$$

Where the estimated coefficient of β_1 represents whether there is or not a self-selection into importing. A positive and significant estimates of β_1 shows a pre-entry productivity premia and confirms the selection of more productive firms into importing. However, this specification does not allow us to test if there is a self-selection in the exit side of the market, only in the entry side of the market.

Following the methodology proposed by Fariñas and Martín-Marcos (2007) for the exporting decision, we perform a second analysis to get robust evidence regarding the self-selection into importing (exit and entry side of the market) and the *learning-by-importing* hypothesis. This analysis allows us not only to study the "import/non-import" behavior, but also to consider different possible import decisions of firms during the period analyzed and mitigate the possible endogenous problem associated to the static import decision.

To perform this analysis, firms are classified into five different categories according to their importing decisions: 1) Continuing importers (firms importing over the entire period), 2) Entering importers (firms becoming importers during the period with no further changes for the rest of the period), 3) Switching importers (firms that change their import decision more than once during the period, 4) Exiting importers (firms that exit from the international market and do not reenter, and 5) Non-importers (firms that do not import during the period).

The main idea of dividing the firm import decision into strategies within a period of time is that generally firms have sunk costs associated with imports, so that the firms which are already productive are self-selected into import status (Halpern et al., 2015; Kasahara and Lapham, 2013); in this vein, the firm import status could be endogenous to productivity. However, when importing is taken as a business strategy over time, we seek to identify the effect of those firms that decided endogenously to import over time, making this decision exogenous since it becomes invariant in time (we apply the same idea with all the considered import decisions). Additionally, by dividing import status, the possible internal effect on forms of managerial decisions due to internal or external shocks is captured. We take advantage of this core idea to give robust evidence of the self-selection and learning-by-importing hypotheses. Now, the relevant equation to be estimated is:

$$(14) \quad \omega_{it} = \alpha_0 + \alpha_1 Continuing_i + \alpha_2 Entering_i + \alpha_3 Switching_i + \alpha_4 Exiting_i + \sum_{t=1}^{t} \beta_{it} Controls_{it} + \varepsilon_{it}$$

Where ω_{it} is the estimated TFP (using equation (4) without d_{it} variable), the omitted group for import category is nonimporters, and control variables include size dummies[12] year, industry, and geographic location.

The estimated coefficients of equation (14) measure productivity differences between nonimporters and the rest of the categories. As said before, this new specification allows to test the self-selection into importing and also the *learning-by-importing* hypothesis. According to the selection hypothesis in the entry side of the importing market, the average productivity of entering importers should be greater than the productivity of nonimporters; and considering the existence of selection on the exit side of the importing market, the average productivity of continuing importers should be greater than the productivity of exiting importers. For the *learning-by-importing* hypothesis, is expected that form productivity growth rate should increase after entry in the import market and

[12]Firm size is defined in the Organic Code of Production, Trade and Investment of Ecuador: microenterprises, between 1 and 9 workers or revenue less than \$100,000; small firms, between 10 and 49 workers or revenue between \$100,001 and \$1,000,000; medium firms, between 50 and 199 workers or revenue between \$1,000,001 and \$5,000.000; large firms, more than 200 workers or revenue above \$5,000,001. Revenue ranks higher than the number of workers.

for this, the productivity gap between import starters and nonimporters should increase after entry.

Additionally, to analyze the possibility that import decisions have a more sustained impact over time on productivity, equation (14) is also estimated with the productivity growth rate as dependent variable. This new specification of equation (14) captures, on the one hand, the effect of entering importers in comparison with the other categories (including the omitted category), and, on the other hand, the effect of entering importers on TFP growth, which suggests an effect of *learning-by-importing* on time[13]. De Loecker (2013) argues that the productivity process suggests that firms entering exporting markets do expect an impact on their future revenue through either increased demand and/or decreased cost of production, also entering export markets is a very costly undertaking for a firm and possible the (sunk) entry cost associated with starting to export prevents firms from adjusting their export status instantaneously upon receiving shocks to their underlying productivity. In this sense, we analyze the effect of entering importers on TFP growth because this allow us to test (in other form) the *learning-by-importing* hypothesis considering the similar arguments from De Loecker (2013) for export markets.

5 Data, variables, and description

The data set used in this research is a novel, under-explored and unbalanced panel data from 2007 to 2018 built with the population of registered manufacturing Ecuadorian formal firms, constructed from the balance sheets and financial statements registered on the official website of the Superintendencia de Compañías, Valores y Seguros (SCVS).[14] This information is reported annually directly by firms to the SCVS. It contains detailed information about geographical location, industry (economic activity) based on ISIC Rev. 4 classification, firm date of creation and dead, and economic and financial accounts of all Ecuadorian formal firms. From here, we obtain our variables of interest such as gross revenue, net tangible assets (capital stock), investments, number of formal employees, domestic intermediates purchases, foreign intermediates purchases, electricity, fuels, and many other firm characteristics (e.g. age, Foreign Direct Investment, wages, exports), all measured in real values (using the respective annual price deflater); firm size, measured as amount of gross revenue or as number of employees; region, state and city location.

Similar to Camino-Mogro et al. (2018), first, we proceeded to debug the financial statements by eliminating all firms that had reported values less than or equal to 0 in gross revenue, number of formal workers, total fixed assets or consumption of intermediate inputs. Second, firms that had reported number of formal workers but zero values in wages were eliminated as well. Finally, firms that were inactive in all years of analysis were eliminated as well. Table 1 shows how the main variables used for the estimation of the production function and the TFP were constructed.

After cleaning the data, the unbalanced panel data set contains 36,061 observations and 5,745 formal firms. This paper focus on the manufacturing sector; for this, we also divided the data set into two different industry classification: Pavitt (1984) taxonomy and Technological Intensity industries by OCDE. The Pavitt taxonomy can be explained by sources of technology, requirements of users and possibilities for appropriation, this definition has implications for our understanding of the sources and directions of technical change, firms' diversification behaviour, the dynamic relationship between technology and industrial structure, and the formation of technological skills and advantages at the level of the firm, the region and the country (Pavitt, 1984), in Annexes in Table 13 the disaggregation of each industry is shown. For the Technological Intensity industries classification we use the traditional disaggregation of technology industry proposed by the OCDE, in Annexes, in Table 14 the grouping of

[13] Recently Camino-Mogro (2019) use this specification in the Ecuadorian manufacturing sector to test the effect of investments on advertising on TFP.

[14] We use administrative data from firms' financial statements contrary to most studies using surveys. The advantage of using administrative data in our case are several. First, we do not use a representative sample but instead use the entire universe of manufacturing firms. Second, firms self-report the information, nevertheless, this information is doubly analyzed since it serves the tax administration and the supervisory institution of companies, so accounting errors are usually minimal. Third, we can track firms over time and be able to detect market exits and entries, something that is limited in surveys.

each industry is shown[15].

We divided the manufactures in these two classifications to analyze the effect of importing intermediate inputs not only in the whole industry but also in the different intrasectorials. All of this intrascetorial classifications are important industries in the Ecuadorian economy since the number of observations in each of these industries are large enough to do empirical research industry by industry. The number of observations varies from 3,343 to 14,226 depending on the industry classification.

Similar to Zhang (2017), we are interested in the consumption of intermediate inputs and how much of them are imported from foreign countries. In the data, intermediate input refers to the summation from a list of inputs which the firm is allowed to write for “raw materials, materials, and packaging”; this includes expenditure on raw materials such as water, electricity, maintenance, repair of goods and gasoline, but does not include “general expenses” such as professional services and advertising, all of which are reported separately. Also, firms are allowed to import some of their intermediate inputs from abroad and use both the domestic and imported intermediate inputs in their production.

Table 1: Definition of variables

Variable	**Code**	**Definition**
Gross revenue	Y	Total income from sales = revenues from sales of ordinary activities of the company (income from extraordinary activities is excluded from the business of each company, for example: sale of land, machinery, etc.). This variable is deflated using the industry-specific price index obtained from the Ecuadorian National Institute of Statistics.
Workers	L	Number of legally registered employees.
Capital stock	K	Net tangible assets = the sum of the real dollar value of buildings, machinery, and vehicles, assuming a depreciation of 5, 10, and 20 percent, respectively, similar to Bravo-Ortega et al. (2014). We measure the capital stock with the gross investment in equipment in year t (I_{it}), net fixed assets in real value (physical capital in year $t-1$) (k_{it-1}), a depreciation rate (d_{it}) and the price index for equipment at the industry level (P_t) obtained from the Ecuadorian National Institute of Statistics.
Total Intermediates	M	Initial intermediates inventory + Imports of intermediates inputs + local net purchases of intermediates + transport expenses + fuel expenses + spending on office supplies + expenditure on maintenance and repair + basic services expenditure - final intermediates inventory - final inventory of products in process - final inventory of finished products. This variable is deflated using the industry-specific price index obtained from the Ecuadorian National Institute of Statistics.
Domestic Intermediates	D	Initial intermediates inventory + local net purchases of intermediates + transport expenses + fuel expenses + spending on office supplies + expenditure on maintenance and repair + basic services expenditure - final intermediates inventory - final inventory of products in process - final inventory of finished products. This variable is deflated using the industry-specific price index obtained from the Ecuadorian National Institute of Statistics.
Foreign Intermediates	F	Imports of intermediates to produce a final good.
Investments	I	New investments done by the firm.

Source: Authors, base on data provided by Superintendencia de Compañías, Valores y Seguros.

Table 2 shows mean values for many firm characteristics. The difference between importers and nonimporters with regards to gross revenue, number of formal employees, capital stock, intermediate inputs, domestic and foreign intermediates, exports, wages and age is very large and this trend is maintained when firms are broken down by size. This suggests that size differentials between importers and nonimporters are substantial, importer firms generate more gross revenue, employment, wages and exports and consume more intermediate inputs than nonimporters. On average, importers are 14.65 times larger than nonimporters in terms of gross revenue, 8 times larger in terms of employment and 14 times for capital stock, the difference is slightly higher on total intermediates where importers are 22 times larger than nonimporters. Also, importers have better access to international markets

[15] For the purpose of this paper, we group the Medium-High tech industry and High tech industry in one, because there are few observations in this last industry group, also the High tech industry in the OCDE is different from Ecuador.

because they are 12 times larger than nonimports in value of exports; additionally, pay better wages since they are 13 times larger than nonimports and have more experience in the market.

In Table 3 we present the main descriptive statistics for the output and inputs involved in the analysis, considering also differences by year, firm size, industries, and cities. The table shows that them mean output (gross revenue) was approximately equal in 2007, 2012, and 2018; however, the input variables showed a different trend: the capital stock and labor are larger in 2018 than the other years, but the domestic and foreign intermediates in 2018 are less than in the other years. In terms of size, it is shown that the larger the firm is, the more output and inputs it has. This is in line with larger firms needing more inputs for production, and given that the size of the firm is measured according to sales, this behavior is logical and expected. With regards to the different industries classification, scale-intensive industries (in Pavitt taxonomy) had the most inputs and output on average during 2007–2018 except for foreign intermediates where the science-based industry is the largest one, this also is in line with the development of Ecuadorian industry, where the economy is dependent primarily on commodities and also with little added value; regarding, the technological innovation industries, the low-tech industry has larger output and inputs than the other industries, except for foreign intermediates. Finally, we show the descriptive statistics for the three most important cities in Ecuador, where there is no clear pattern according to the use of inputs.

Table 2: Mean Characteristics for Importers and Non-importers

	All firms		Large firms		MSME firms	
Variable	**Importers**	**Non-importers**	**Importers**	**Non-importers**	**Importers**	**Non-importers**
Y	29.30	2.00	46.80	20.90	2.28	0.66
L	231	29	352	204	43	16
K	8.54	0.60	13.50	6.21	0.83	0.20
M	16.70	0.76	26.70	8.85	1.20	0.19
D	7.61	0.76	12.20	8.85	0.56	0.19
F	9.07	0.00	14.50	0.00	0.65	0.00
$Exports$	4.14	0.34	6.85	4.75	0.11	0.03
$Wages$	1.83	0.14	2.86	1.34	0.25	0.05
Age	29	12	33	20	24	12

Note: Importers are defined as continuing over the entire period. Values are in millions of U.S. dollars, except for workers (L), which are in number of people.
Source: Superintendencia de Compañías, Valores y Seguros.

Table 3: Descriptive statistics

	N	Means	SD	1%	Median	99%	N	Means	SD	1%	Median	99%	N	Means	SD	1%	Median	99%
	Output						Capital stock						Labor					
Total	36,061	13.45	2.11	8.04	13.38	18.61	36,061	11.47	2.81	5.28	11.50	17.44	36,061	2.70	1.54	0	2.56	6.75
Year																		
2007	2,694	13.09	2.12	7.50	13.03	18.27	2,694	10.95	2.60	4.78	10.99	16.48	2,694	2.62	1.50	0	2.56	6.64
2012	3,043	13.55	2.06	8.49	13.44	18.76	3,043	11.58	2.88	5.22	11.65	17.45	3,043	2.75	1.55	0	2.56	6.86
2018	2,951	13.61	2.17	7.72	13.56	18.87	2,951	11.81	2.86	5.32	11.82	17.86	2,951	2.87	1.41	0.69	2.56	6.93
Firm size																		
Micro	5,520	10.26	1.34	5.04	10.66	11.50	5,520	8.98	2.68	3.60	9.14	13.792	5,520	1.21	.71	0	1.10	3.04
Small	15,773	12.75	.63	11.55	12.78	13.79	15,773	10.52	2.18	5.36	10.72	14.27	15,773	2.13	.92	0	2.20	4.02
Medium	8,896	14.53	.45	13.83	14.49	15.40	8,896	12.41	1.72	7.43	12.61	15.51	8,896	3.21	1.11	0	3.40	5.24
Large	5,872	16.71	1.04	15.44	16.44	19.87	5,872	14.94	1.72	9.85	15.01	18.84	5,872	4.82	1.45	0	4.95	7.70
Pavitt Taxonomy																		
Scale-Intensive	15,619	13.67	2.27	7.67	13.58	19.13	15,619	11.88	2.83	5.62	11.91	17.85	15,619	2.84	1.62	0	2.71	7.17
Science-Based	5,741	13.38	2.02	8.04	13.34	18.26	5,741	11.11	2.69	5.29	11.19	16.86	5,741	2.49	1.42	0	2.40	6.16
Specialized-Suppliers	4,343	12.68	1.81	8.21	12.61	17.41	4,343	10.27	2.74	4.46	10.38	15.89	4,343	2.09	1.29	0	1.94	5.77
Supplier-Dominated	10,358	13.49	1.94	8.48	13.50	18.33	10,358	11.57	2.71	5.16	11.66	17.33	10,358	2.85	1.50	0	2.83	6.41
Technological intensity																		
Low-tech	17,908	13.53	2.21	7.67	13.47	18.71	17,908	11.68	2.78	5.32	11.71	17.45	17,908	2.84	1.60	0	2.71	7.07
Medium-low tech	10,570	13.33	1.98	8.48	13.23	18.39	10,570	11.32	2.97	4.99	11.36	17.66	10,570	2.54	1.48	0	2.40	6.43
Medium-high and High-tech	7,583	13.45	2.03	8.35	13.37	18.65	7,583	11.19	2.62	5.47	11.22	16.91	7,583	2.56	1.45	0	2.40	6.26
Cities																		
Quito	14,189	13.43	2.01	8.45	13.32	18.71	14,189	11.31	2.78	5.31	11.30	17.26	14,189	2.72	1.46	0	2.56	6.75
Guayaquil	11,846	13.31	2.12	7.97	13.21	18.55	11,846	11.22	2.99	4.78	11.29	17.45	11,846	2.49	1.59	0	2.30	6.47
Cuenca	2,277	13.41	2.12	7.71	13.41	18.72	2,277	11.74	2.53	5.71	11.75	17.57	2,277	2.88	1.55	0	2.77	6.91
Other cities	7,749	13.74	2.24	7.58	13.77	18.59	7,749	12.08	2.58	5.87	12.22	17.53	7,749	2.91	1.57	0	2.83	7.14

Table 3 Continued: Descriptive statistics

	N	Means	SD	1%	Median	99%	N	Means	SD	1%	Median	99%
	Domestic intermediates						Foreign intermediates					
Total	36,061	11.41	2.82	4.13	11.62	17.46	36,061	3.12	5.74	0	0	17.22
Year												
2007	2,694	11.55	2.53	4.94	11.73	16.97	2,694	3.41	5.81	0	0	17.16
2012	3,043	11.39	2.77	4.83	11.55	17.48	3,043	3.10	5.75	0	0	17.35
2018	2,951	11.10	3.12	3.44	11.36	17.57	2,951	3.06	5.77	0	0	17.52
Firm size												
Micro	5,520	8.06	1.96	2.44	8.33	11.14	5,520	.10	.97	0	0	7.11
Small	15,773	10.55	1.92	4.88	10.97	13.33	15,773	1.05	3.23	0	0	12.40
Medium	8,896	12.61	1.74	7.21	13.14	14.98	8,896	4.35	6.02	0	0	14.56
Large	5,872	15.01	1.73	9.90	15.13	18.76	5,872	9.65	7.34	0	13.86	18.37
Pavitt taxonomy												
Scale-Intensive	15,619	11.84	2.98	4.28	11.99	18.04	15,619	2.70	5.53	0	0	17.60
Science-Based	5,741	11.13	2.54	4.31	11.37	16.06	5,741	3.76	5.94	0	0	16.78
Specialized-Suppliers	4,343	9.83	2.40	3.91	9.73	15.74	4,343	1.06	3.70	0	0	16.26
Supplier-Dominated	10,358	11.57	2.63	4.03	12.02	16.75	10,358	4.27	6.31	0	0	17.21
Technological intensity												
Low-tech	17,908	11.71	2.94	4.01	11.97	17.75	17,908	2.91	5.61	0	0	17.23
Medium-low tech	10,570	11.08	2.68	4.30	11.22	16.68	10,570	3.01	5.71	0	0	17.26
Medium-high and High-tech	7,583	11.14	2.62	4.27	11.32	16.52	7,583	3.76	6.03	0	0	17.17
Cities												
Quito	14,189	11.38	2.62	4.39	11.59	17.29	14,189	3.29	5.79	0	0	17.01
Guayaquil	11,846	11.04	2.87	3.95	11.13	17.28	11,846	2.92	5.64	0	0	17.17
Cuenca	2,277	11.52	2.80	4.04	11.82	17.02	2,277	3.81	6.07	0	0	17.83
Other cities	7,749	11.98	2.99	4.01	12.22	17.82	7,749	2.91	5.69	0	0	17.51

Note: All values are in logs of dollars, except for Labor which are in logs of number of formal employees

Source: The authors, based on data from Superintendencia de Compañías, Valores y Seguros.

6 Results

6.1 Effect of imports on productivity

In this section we present the main results. First, we show the results from various estimators using the discrete choice import variable (d_{it}) and two continuous measures of import variables (n_{it}) and (FI_{it}). The variable (n_{it}) corresponds to the theoretical model of Kasahara and Rodrigue (2008) and the variable (FI_{it}) is similar to Girma Abreha (2019) assumption where this variable captures how intensive is the use of foreign intermediates among importing firms. Second, we present the results by two industry classification: Pavitt taxonomy and the technological intensity using only the Levinsohn and Petrin (2003) method with the modification that we explained in section 4. Third, we show how different import strategies affect TFP in all the manufacturing sector and in the two industry classification. Finally, we present several robustness checks, in order to show how exports and being importer and exporter affects TFP.

Table 5 shows the results of OLS, Fixed Effects (FE) and Levinsohn-Petrin (LP) estimator; using three different variables of imports: a discrete variable (d_{it}) and two continuous variables (n_{it}) and (FI_{it}). Columns (1)-(3) present the parameter estimates where importing is treated as a discrete variable; the OLS result in column (1) shows that all inputs coefficients (elasticities) are positive and significant; however, the discrete import variable (d_{it}) is negative but not statistically significant at standard levels. In addition, we show that compared to the FE and LP estimators in columns (2)-(3), the OLS estimator upwardly bias all the estimated inputs (except the capital stock), this is due to the endogeneity problem of the labor and intermediates choices that are dependent on ω_{it}. In column (2) we report the FE estimator, the results are similar to the OLS estimator; nevertheless, the import discrete variable (d_{it}) is positive and statistically significant in this case, implying that there is an effect of approximately 6% on firm output; again this estimator does not address the simultaneity between inputs and productivity shocks. To relax the restrictive assumptions of OLS and FE; the LP estimator is applied to correct the simultaneity and endogeneity problems, we impose a richer structure in the form of the endogenous productivity process to control for both selection and correlation between inputs and the unobserved productivity shock by using intermediate inputs as proxies for unobserved productivity shock (Kasahara and Rodrigue, 2008).

Column (3) of Table 5 reports the LP estimator under the flexible specification for ω_{it} using a third order polynomial in (ω_{it-1}, d_{it-1}) as in equation (5). The estimated coefficients of inputs are positive and statistically significant at standard levels, more important is that $\delta > 0$ and significant, also indicating a productivity effect of 3% that comes from the usage of imported intermediate inputs. This result is the expected and imply that firms experience an immediate improvement on productivity due to importing; nevertheless, this result only suggest a static effect from importing on productivity.

In columns (4)-(6) in Table 5, we show the estimation results using the continuous measure of import usage proposed by Kasahara and Rodrigue (2008) measured by the ratio of total intermediate inputs to domestic intermediate inputs (n_{it}). In line with Kasahara and Rodrigue (2008) theoretical framework, we estimate equation (9) to capture the effect of importing depends on how much imported intermediates are used relative to domestic intermediates (import participation), and also to quantify the elasticity of substitution between foreign and domestic intermediates. The variable n_{it} implies that a higher ratio of total intermediates to domestic intermediates leads to higher production levels, contrary to the traditional production function where this variable is the total intermediates consumption and does not differentiate between domestic and foreign intermediates.

The results of OLS and FE show that the estimated coefficients for labor, capital stock, and intermediate inputs are all positive and significant at 1%, also displays similar patterns as in the discrete import variable (d_{it}). For the continuous measure of import usage n_{it}, this coefficient is positive and significant indicating the importance of foreign intermediates in explaining productivity differences across firms and over time. The LP estimator reported in column (6) again supports an important impact of an increase in the share of imported intermediates on productivity, since after controlling for year, industry, and region (location), we get robust evidence that a 100% decrease in the share of domestic intermediates to total intermediates increases productivity by 7%. Again,

this evidence supports the significant effect of using foreign intermediate inputs on firm production in Ecuadorian manufacturing firms. This results is similar but smaller from those of Kasahara and Rodrigue (2008) who found that a 100% decrease in the share of domestic intermediates increases productivity by 17.7% to 27% in Chilean manufacturing plants.

In addition, once we obtain the estimated coefficients of intermediate inputs $\bar{\gamma}$ and continuous import variable $\bar{\psi}$, we can compute an estimate of the elasticity of substitution as $\bar{\theta} = \frac{\bar{\gamma}}{\bar{\psi}} + 1$. Again, and similar to Kasahara and Rodrigue (2008) and Feenstra et al. (1992) but contrary to Zhang (2017), we obtain that the elasticity of substitution is 4.43 using the LP estimator for all the manufacturing sector. This result implies that foreign and domestic intermediate inputs are substitutes inputs; in addition, our result in comparison with the Chilean manufacturing plants are similar in terms of substitutable than the Chilean context, but also means that the input variety effect of the imported inputs is small, since $\bar{\theta} > 1$.

This evidence is particularly interesting for manufacturing formal firms in Ecuador and for dollarized economies generally, because then a policy of restricting imports (often of goods that serve as input to produce a final good) that aims to replace them by local goods, may be effective in the Ecuadorian manufacturing context since domestic and imported intermediates are substitutes. However, as we do not investigate the input quality effect of the imported inputs relative to domestic inputs as Zhang (2017), because we do not have the physical quantity of domestic and imported intermediates nor their prices to capture a real quality effect parameter, we can not ensure that those inputs have similar characteristics on quality and the final good will be better with one or other intermediate inputs.

In a dollarized emerging economy context, imported goods, particularly intermediate inputs, are subject to the changes of the international exchange rate with respect to the main suppliers of raw material, so that an increase in the price of imported inputs would generate a decrease in the demand for domestic inputs, given that the great majority of products depend on imported inputs. Bacchetta and Van Wincoop (2003) presented a framework where domestic firms import goods priced in foreign currency and sell them in domestic currency, and argue that they prefer pricing in local currency due to competitive pressure in the domestic market. In addition, if the final good also needs domestic inputs in its production, it is even more likely that producers of final goods would price in domestic currency. Furthermore, if the real exchange rate is an important factor in competitiveness, an increase in this variable would make imported intermediates more expensive and therefore boost the demand for domestic intermediates, thus reactivating the production. This is not the case; however, for Ecuador, since the real exchange rate does not depend on the central bank to set conditions for using the dollar; in other words, Ecuador does not have monetary policy to handle the real exchange rate.

According to the second measure of continuous imports variable (FI_{it}) proposed by Girma Abreha (2019); Zaclicever and Pellandra (2018) that captures the effect of the relative weight of foreign intermediates (import intensity), the results are shown in columns (7)-(9) at Table 5. To deal with the fact that firms may anticipate the impact of imports on their productivity, as described by Girma Abreha (2019) and Zaclicever and Pellandra (2018), We estimate equation (11), which implies that a higher ratio of total intermediates to domestic intermediates leads to higher production levels, for $FI_{it} = ln\frac{F_{it}}{M_{it}}$ which is the share of foreign intermediate inputs (or, its 'intensity') in total intermediates. This adaptation in equation (11) does not capture the elasticity of substitution; nevertheless, the results obtained from this specification allow us to confirm the results obtained using the Kasahara and Rodrigue (2008) approach and provides a robustness of our evidence of the effect of imports intermediates inputs on productivity.

Both the OLS and FE estimates display similar patterns as in the discrete import variable d_{it} and continuous variable n_{it}. The elasticities of the three traditional inputs (capital stock, labor, and total intermediates) are similar in magnitude and significance, showing the robustness of the traditional inputs estimation. However, in the FE estimator the variable FI_{it} is negative and significant suggesting that 100% increase in the share of imported intermediates decreases firm productivity by 1% in manufacturing sector; nevertheless, we explained that OLS and FE estimators are biased since they do not correct the simultaneity problem of selection of the

inputs. To correct this, we estimate equation (11) using our flexible LP estimator and found that a 100% increase in the share of imported intermediates increases firm productivity by 7% immediately. Our results are similar to those of Girma Abreha (2019), who found that import intensity ratio increased productivity by 15.5% to 18.5% in Ethiopian manufacturing firms. Zaclicever and Pellandra (2018) also found evidence in favor of a positive association (with similar magnitudes) between imported intermediate inputs intensity and firms' productivity for the case of Uruguayan manufacturing firms.

Table 5: Effect of import decision and import intensity on TFP

Estimators	**OLS**	**FE**	**LP**	**OLS**	**FE**	**LP**	**OLS**	**FE**	**LP**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	(Discrete import variable)			(Continuous import variable)					
k_{it}	0.12***	0.05***	0.13***	0.12***	0.05***	0.14***	0.12***	0.05***	0.12***
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.04)
l_{it}	0.41***	0.15***	0.31***	0.41***	0.15***	0.31***	0.41***	0.15***	0.31***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
m_{it}	0.37***	0.28***	0.23***	0.36***	0.28***	0.24***	0.37***	0.28***	0.24***
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.02)
d_{it}	-0.001	0.06***	0.03*						
	(0.03)	(0.02)	(0.02)						
n_{it}				0.04**	0.02***	0.07***			
				(0.02)	(0.01)	(0.01)			
FI_{it}							0.03***	-0.01**	0.07***
							(0.01)	(0.00)	(0.02)
Implied θ				10	15	4.43			
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	36,061	36,061	28,602	36,061	36,061	28,602	36,061	36,061	28,602

Notes: Standard errors in parentheses. The Levinsohn-Petrin estimator uses the third-order polynomials (ω_{t-1}, d_{t-1}) for discrete import; (ω_{t-1}, n_{t-1}) for continuous import and (ω_{t-1}, FI_{t-1}) for import intensity.
The LP estimator is used with the command prodest in Stata developed by Rovigatti and Mollisi (2018)
$*p < .10$, $**p < .05$, $***p < .01$.

Also, we present the results for two industry classifications (Pavitt Taxonomy and industries according to their technological intensity following the OECD classification) using only our flexible LP estimator. In Table 6 the results of the three measures of import variable are presented for the Pavitt taxonomy. Using the discrete import variable d_{it}, we show that for the Science-based industry there is a negative and significant effect d_{it} of 9% on productivity. Also, for Specialized-Suppliers industry the discrete import variable suggests a negative static effect of importing on productivity of 34%, this result is unexpected; nevertheless, firms in this industry might need to adjust their production structure to benefit from the availability of cheaper and probably better imported intermediates (Girma Abreha, 2019). On the other hand, there is a positive effect of the usage of imported intermediates in the Scale-intensive and Supplier-dominated industries of 14% and 7% respectively. Also, the elasticities of the traditional inputs are different across industries but in all the cases the labor input is the dominated input; the different results of the effect of imports on output suggest heterogeneity in the use of foreign intermediates across Pavitt industries.

Table 6: Effect of import decision and import intensity on TFP: Industry level results using the Pavitt taxonomy

Variables	Scale-Intensive	Science-Based	Specialized-Suppliers	Supplier-Dominated
		Discrete import variable		
k_{it}	0.14***	0.03	0.15***	0.10***
	(0.01)	(0.05)	(0.01)	(0.04)
l_{it}	0.28***	0.38***	0.40***	0.30***
	(0.01)	(0.03)	(0.03)	(0.01)
m_{it}	0.25***	0.30***	0.23***	0.23***
	(0.01)	(0.04)	(0.01)	(0.03)
d_{it}	0.14***	-0.09***	-0.34***	0.07***
	(0.02)	(0.01)	(0.01)	(0.01)
No. of obs.	12,502	4,561	3,343	8,196
		Continuous import variable		
k_{it}	0.11***	0.03	0.15***	0.11***
	(0.01)	(0.04)	(0.01)	(0.03)
l_{it}	0.28***	0.38***	0.40***	0.30***
	(0.01)	(0.03)	(0.03)	(0.01)
m_{it}	0.25***	0.28***	0.22***	0.23***
	(0.01)	(0.03)	(0.01)	(0.02)
n_{it}	0.12***	0.09***	0.01	0.10***
	(0.01)	(0.03)	(0.01)	(0.02)
Implied θ	3.08	4.11	23	3.30
No. of obs.	12,502	4,561	3,343	8,196
		Continuous import variable		
k_{it}	0.13***	0.02	0.14***	0.11**
	(0.03)	(0.05)	(0.01)	(0.04)
l_{it}	0.28***	0.39***	0.40***	0.30***
	(0.01)	(0.03)	(0.03)	(0.01)
m_{it}	0.25***	0.31***	0.23***	0.24***
	(0.01)	(0.04)	(0.01)	(0.03)
FI_{it}	0.002	0.07***	0.22***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
No. of obs.	12,502	4,561	3,343	8,196

Notes: Standard errors in parentheses. All parameters are estimated according to the Levinsohn-Petrin estimator and uses the third-order polynomials (ω_{t-1}, d_{t-1}) for discrete import; (ω_{t-1}, n_{t-1}) for continuous import and (ω_{t-1}, FI_{t-1}) for import intensity. The LP estimator is used with the command prodest in Stata developed by Rovigatti and Mollisi (2018)
We include Year Fixed Effects, Industry Fixed Effects (two digits of ISIC Rev. 4.0) and Region Fixed Effects
$*p < .10$, $**p < .05$, $***p < .01$.

Additionally, Table 6 reports the results for the use of the continuous measure of imports n_{it} in the production function. We show that the traditional inputs are very similar (in magnitude and significance) with the results reported when we use the discrete variable d_{it}; also, we find evidence that support an important impact of an increase in the share of imported intermediates on productivity, a 100% decrease in the share of domestic intermediates in total intermediates increases productivity to 9% and 12% depending on the industry. However, for Specialized-Suppliers industry the continuous import variable suggests a positive static effect of importing on productivity of 1% but it is not statistically significant at standard levels. According to the elasticity of substitution, in all the industries the domestic and imported intermediates are substitutes inputs since in all the cases $\bar{\theta} > 1$.

Table 7: Effect of import decision and import intensity on TFP: Industry level results by technological intensity

Variables	Low-tech industry	Medium-low tech industry	Medium-high and High tech industry
		Discrete import variable	
k_{it}	0.11**	0.10***	0.03
	(0.05)	(0.01)	(0.05)
l_{it}	0.28***	0.31***	0.39***
	(0.01)	(0.02)	(0.02)
m_{it}	0.24***	0.24***	0.30***
	(0.03)	(0.01)	(0.04)
d_{it}	0.12***	0.04***	-0.11***
	(0.02)	(0.01)	(0.02)
No. of obs.	14,226	8,377	5,999
		Continuous import variable	
k_{it}	0.09*	0.11***	0.04
	(0.05)	(0.01)	(0.04)
l_{it}	0.28***	0.31***	0.40***
	(0.01)	(0.02)	(0.02)
m_{it}	0.25***	0.23***	0.28***
	(0.03)	(0.01)	(0.03)
n_{it}	0.10***	0.10***	0.10***
	(0.02)	(0.02)	(0.01)
Implied θ	3.50	3.30	3.80
No. of obs.	14,226	8,377	5,999
		Continuous import variable	
k_{it}	0.13**	0.12***	0.03
	(0.05)	(0.01)	(0.05)
l_{it}	0.28***	0.31***	0.40***
	(0.01)	(0.01)	(0.02)
m_{it}	0.25***	0.25***	0.30***
	(0.04)	(0.01)	(0.03)
FI_{it}	0.02	0.10***	0.11***
	(0.01)	(0.01)	(0.02)
No. of obs.	14,226	8,377	5,999

Notes: Standard errors in parentheses. All parameters are estimated according to the Levinsohn-Petrin estimator and uses the third-order polynomials (ω_{t-1}, d_{t-1}) for discrete import; (ω_{t-1}, n_{t-1}) for continuous import and (ω_{t-1}, FI_{t-1}) for import intensity.
The LP estimator is used with the command prodest in Stata developed by Rovigatti and Mollisi (2018)
We include Year Fixed Effects, Industry Fixed Effects (two digits of ISIC Rev. 4.0) and Region Fixed Effects
*$p < .10$, **$p < .05$, ***$p < .01$.

To compare our evidence obtained using n_{it}; also, we report the results using FI_{it} in each industry. Again, the results of the coefficients of traditional inputs are quiet similar with the other specifications; our variable of interest FI_{it}, that captures the intensity of imported intermediates on firm production and productivity, is always positive and significant, except for the Scale-intensive industry where is not statistically significant at standard levels. This result is in concordance with the theoretical framework of Kasahara and Rodrigue (2008), not only in the whole manufacturing sector, but also when we desegregate with the Pavitt taxonomy. Okafor et al. (2017) argue that international access to foreign inputs is one of the channels for enhancing productivity in Ghanaian firms and found that firms in industries such as machinery have high levels of absorptive capacity (ABC) and are better positioned than other industries to enjoy productivity gains from the use of imported intermediates.

Results by the technological intensity of the industry are shown in Table 7. We present the estimates with the three measures of imported intermediates, in general our results are very similar with the Pavitt taxonomy and with the evidence obtained from the whole manufacturing sector.

The results of the coefficients of traditional inputs are quiet similar with the three specifications of the production function (d_{it}, n_{it}, FI_{it}) in Table 7. Our results support the idea of a static effect of importing on productivity of 4% for Medium-low tech industries and of 12% for Low tech industries; nevertheless, there is negative and statistically significant evidence in the Medium-high and High industries when we use the discrete import variable d_{it} of 11%. Additionally, when we use the continuous measure of imports n_{it} in the production function, we find evidence that supports an important impact of an increase in the share of imported intermediates on productivity, a 100% decrease in the share of domestic intermediates in total intermediates increases productivity by 10% in each industry. According to the elasticity of substitution, in all the industries the domestic and imported intermediates are substitutes inputs since in all the cases $\bar{\theta} > 1$.

Regarding the effect of import intensity FI_{it} in each industry, the variable FI_{it} is always positive and significant for all technological intensive industries (except for Low-tech industry where it is not significant at standard levels). Again, this result is in concordance with the theoretical framework of Kasahara and Rodrigue (2008), and also implies that there is an improvement in productivity of 10% to 11% depending on the industry.

Overall, the three different specifications are robust since the traditional inputs are quite similar for each industry and also the effect of importing intermediates is always positive independent of using a discrete variable or a continuous measure of imports. However, the effect of imports varies depending on the industry and sectorial classification, this could be because in different industries the ability to acquire imported inputs is easier than in other given different industrial policies or simply because the supply of raw materials is simpler than in other industries.

6.2 Robustness check: the role of exports

One may be concerned about the fact that firms who are importers are also exporters and therefore the result capture by the import dummy may contain the effect of being exporter and in this case Kasahara and Lapham (2013) and Zaclicever and Pellandra (2018) argues that failing to control for the linkages between importing and exporting might lead to an upward bias in the coefficient of imported inputs since "*good*" firms often both export and import.

For this, we check the sensitivity of our results controlling for export status as dummy variable, being one if the firm i export at time t and zero otherwise. We modify equation (4), (9) and (11) by adding the variable *Export* as state variable and also their lag as an endogenous variable, similar with the case of the imports. With this new specification, we assume that productivity evolves according to an endogenous Markov process not only by the import status but also with export status, De Loecker (2013) argues that being exporter affects firm's future productivity and this allow an endogenous productivity process.

In Table 8, we present the results of our robustness check using our flexible LP estimator. We show that the traditional inputs are very similar than our base line model. Also, when we use the discrete import variable d_{it} an the discrete export variable *Export* (column 1) we find that there is no productivity effect coming from the usage of imported intermediate inputs but there is a productivity effect of 34% that comes from being exporter. However, when we use the two measures of continuous import variable and the discrete export variable *Export*, we find in column (2) that there is evidence that a 100% decrease in the share of domestic intermediates to total intermediates increases productivity by 7% after controlling for being exporter and year, industry and region fixed effects. Finally, in column (3) we get evidence that 100% increase in the share of imported intermediates increases firm productivity by 2% immediately controlling by exports.

Table 8: Effect of import decision and import intensity on TFP: with exports decision as endogenous process

	(1)	**(2)**	**(3)**
k_{it}	0.13***	0.12***	0.10***
	(0.04)	(0.03)	(0.03)
l_{it}	0.31***	0.31***	0.31***
	(0.01)	(0.01)	(0.00)
m_{it}	0.24***	0.24***	0.24***
	(0.03)	(0.03)	(0.03)
d_{it}	0.001		
	(0.01)		
n_{it}		0.07***	
		(0.01)	
FI_{it}			0.02***
			(0.00)
Export	0.34***	0.34***	0.37***
	(0.02)	(0.02)	(0.02)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
No. of obs.	28,602	28,602	28,602

Notes: Standard errors in parentheses. The Levinsohn-Petrin estimator uses the third-order polynomials (ω_{t-1}, d_{t-1}) for discrete import; (ω_{t-1}, n_{t-1}) for continuous import and (ω_{t-1}, FI_{t-1}) for import intensity. In all the cases we use $Export_{t-1}$ as third-order polynomial in the productivity process *$p < .10$, **$p < .05$, ***$p < .01$.

Overall, our specification is robust when we include the discrete export variable, the effect is always positive and significant except in column (1) where the discrete import variables is positive but no significant at standard levels. This results suggest, again, that imports affect positively productivity even when controlled by export status.

In addition, we check the sensitivity of the results controlling for export status and being exporter and importer firm (traders). First, we estimate the production function as in equation (4) by LP estimator without including import status (d_{it} variable) and with this, we obtain the estimates of TFP. Second, we regress the estimated TFP (ω_{it}) on import variable, export variable, traders variable and year, industry, region and size fixed effects.[16]

Table 9 shows the results for the effect of imports, exports and traders on TFP using discrete variables as regressors. In column (1), the variable imports is positive and significant, suggesting that there are a 3% positive productivity effect when we control for export status and year, industry, region and size fixed effects. In addition, the export variable is positive and significant indicating a possible productivity effect from becoming an exporter of 1%; our results are similar to Kasahara and Rodrigue (2008) who found that the effect of exports on TFP are around 1.4% to 2.1% for Chilean plants; and also to Zhang (2017) who found that this effect is around 0.3% to 1% depending the Colombian manufacturing industry.

In column (2) of Table 9, we include the variable traders, which are firms that imports and exports ate least one time t. Our results are robust when we include this variable because the magnitude and significance of imports and exports are the same as in column (1) suggesting a positive productivity effect of importing of 3% and exporting

[16]For this exercise, the variable Imports is made up by firms that exclusively import (but do not export), the variable Exports are firms that only exports (but do not import), and traders are firms that imports and exports at least one time t.

of 1%. Furthermore, we find that being importer and exporter has a positive and significant effect on productivity of 4%, implying that there are greater premia to be trader and not only importer or exporter in the Ecuadorian manufacturing sector, this result is similar to Caselli (2018) that found for Mexican manufacturing plants that there are some complementarities between exporting and importing materials .

Table 9: OLS regression of TFP on import, export and traders: discrete variable

Variables	**(1)**	**(2)**
Imports	0.03***	0.03***
	(0.00)	(0.00)
Exports	0.01***	0.01**
	(0.00)	(0.00)
Traders	–	0.04***
	–	(0.00)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Region FE	Yes	Yes
Size FE	Yes	Yes
No. of obs.	36,061	36,061

Note: Standard errors in parentheses
*$p < .10$, **$p < .05$, ***$p < .01$.

We also test how our results could change across the two industry classifications (Pavitt Taxonomy and industries according to their technological intensity following the OECD classification). Table 17 and 18 in Annexes show the evidence of being exporter and trader, we find similar results than Table 9, suggesting a positive positive productivity effect of importing to 2%-3% depending on the industry classification and exporting of 1% for all the industries. In the case of being exporter and importer (traders) the positive effect on productivity is around 4% to 5%.

Additionally, we believe that could have different effect of importing on productivity by firm size. It is well know that large firms enter the international market easier than small firms because they are more productive, have better production process, and could assume the sunk cost and fixed cost of import and export. In this path, we perform other robustness check in order to capture how different is the effect of imports and exports on TFP. In Table 10, we show that the variable imports is positive and significant in all firm size, suggesting that there are a 4% positive productivity effect in large firms, a 3% positive productivity effect in medium firms, 2% for small firms and 1% for micro firms. There is a clear pattern that the larger the company, the effect of importing on productivity is greater, this result is as expected given the problem of sunk costs that is not addressed in this analysis.

Also, Table 10 present the results of being exporter. We get evidence that there is a positive and significant effect of exports, indicating a possible productivity effect from becoming an exporter of 2% for large firms and 1% for medium and small firms, the effect in micro firms is not significant at standard levels. Again, this result is the expected, the larger the firm, the effect of exporting is greater. Finally, traders firms have the larger effect on TFP; ranking the effect of being exporter and importer firm, large firms has the larger effect (7%) and micro firms have the less effect (2%).

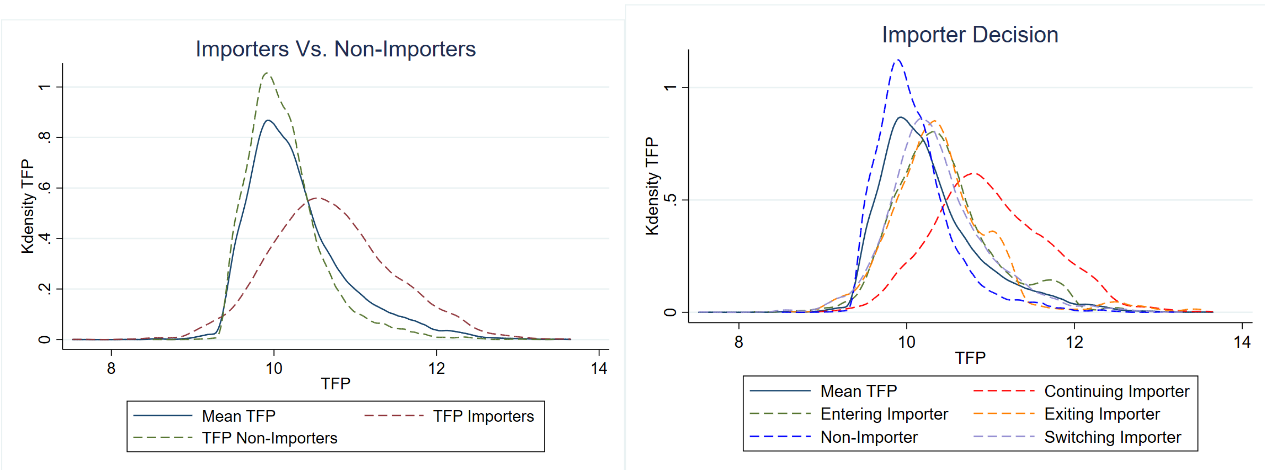
Table 10: OLS regression of TFP on import, export and traders: discrete variable
(Size Classification)

Variables	Large	Medium	Small	Micro
Imports	0.04***	0.03***	0.02***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Exports	0.02***	0.01***	0.01***	0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Traders	0.07***	0.03***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
No. of obs.	5,872	8,896	15,773	5,520

Note: Standard errors in parentheses
$^*p < .10$, $^{**}p < .05$, $^{***}p < .01$.

6.3 *Self-selection* Vs. *Learning-by-importing*

Once we estimate the production function using equation (4) by LP estimator but without d_{it} variable as a regressor, and obtain the estimates of TFP at firm level for all the manufacturing sector and for each industry classification during the period 2007–2018, we compare the TFP of importer firms and nonimporter firms. For this, we show in Panel (a) in Figure 2 that importer firms are more productive than nonimporter firms. The TFP for nonimporter firms is similar to the mean of manufacturing sector, while the TFP for importer firms is higher not only than the TFP for nonimporter firms, but also than the mean for all the manufacturing sector.



(a) Mean TFP of importers and nonimporters

(b) Mean TFP by importer strategies

Figure 2: Mean total factor productivity (TFP) of firms

This first evidence in terms of productivity is similar to that of Zaclicever and Pellandra (2018), who found that the positive association between imported intermediate inputs and firms' productivity does not necessarily imply a productivity-enhancing effect of foreign intermediates (i.e., causality from imported inputs to productivity growth). In this sense, we start to analyze the classical issue of productivity and entering in the international market, that is the self-selection of more productive firms in the international market, particularly in this case of the import market. For this, we estimate equation (13) and Table 11 reports the main results of self-selection hypothesis (without consider the exit side of the market). It is shown that the estimate of current period import dummy

variable is positive and significant in the whole manufacturing sector and also in each industry desegregation (Pavitt taxonomy and Technological intensity).

Table 11: Self-Selection into importing

Lags	ω_{it-3}	ω_{it-2}	ω_{it-1}
Manufacturing sector	0.0197***	0.0236***	0.0267***
	(0.00179)	(0.00181)	(0.00177)
Pavitt Taxonomy			
Scale Intensive	0.0180***	0.0209***	0.0249***
	(0.00345)	(0.00336)	(0.00327)
Science Based	0.0414***	0.0461***	0.0480***
	(0.00470)	(0.00461)	(0.00427)
Specialized Suppliers	0.0321***	0.0348***	0.0420***
	(0.00540)	(0.00514)	(0.00548)
Supplier Dominated	0.0221***	0.0276***	0.0288***
	(0.00310)	(0.00331)	(0.00318)
Technological intensity			
Low-tech industry	0.0162***	0.0192***	0.0221***
	(0.00286)	(0.00290)	(0.00279)
Medium-low tech industry	0.0135***	0.0184***	0.0218***
	(0.00232)	(0.00257)	(0.00271)
Medium-high and High tech industry	0.0342***	0.0380***	0.0410***
	(0.00375)	(0.00364)	(0.00346)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes

Standard errors in parentheses
$^*p < .10$, $^{**}p < .05$, $^{***}p < .01$.

Similar to Girma Abreha (2019) our results provide evidence that current importers were already more productive compared to nonimporters even before the former started importing, in this case we can not reject the self-selection hypothesis in all the manufacturing sector even when we group by different industries. In this sense, Zhang (2017) argues that firms will import, because their gains from importing are larger than the sunk/fixed costs of importing, and also an obvious selection based on productivity and sunk/fixed costs of importing—more productive firms with low importing costs tend to import.

In addition, to obtain solid evidence on the causality of imported inputs on productivity and growth, we propose four different decisions that firms may face with regards to imports, that is, continuing, entering, switching, and exiting strategies. To evaluate the direction of the causality in the import-productivity relationship, and explore the channels through which it might operate, we regress our TFP estimate on firm-level measures of the different import strategies as in equation (14). This evidence could test the self-selection in the entry and in the exit side of the market into importing, and *learning-by-importing* hypotheses.

Also, Figure 2 in panel (b) shows that the decision to import yields higher TFP than not to import. This means, a priori, that firms that import intermediate inputs at least one time during the period analyzed have higher productivity than nonimporter firms. This evidence is consistent with the model of Antras and Helpman (2004), who argue that high-productivity firms outsource intermediate inputs in international markets whereas low-productivity firms acquire them domestically. According to this, we estimate equation (14) to find robust evidence of causality in the import-productivity relationship; this boosts our analysis of the selection into importing and *learning-by-importing* hypotheses.

Table 12 indicates the results of equation (14); our results show that for the manufacturing sector the decision to import leads to higher TFP than their nonimporter counterparts. The productivity of continuing and entering importers is significantly higher than the productivity of the nonimporters and, again, the coefficient of entering importers confirms the existence of self-selection of more productive firms into the import market. A similar

results was found by Fariñas and Martín-Marcos (2007) for Spanish manufacturing exporter firms. In addition, the ranking of TFP shows that continuing importers have higher productivity levels than exiting importers; this confirms the selection on the exit side of the market. We also confirm the selection on the entry side of the market since entering importers have a higher productivity level than nonimporters. Overall, our results provide support for the argument that current importers are more productive than nonimporter firms, even if the former starts importing (Girma Abreha, 2019).

Table 12: Productivity Performance by Import Decision
(Manufacturing sector)

Variable	**TFP level**	**TFP growth**
Continuing Importers	0.05*** (0.001)	–
Entering Importers	0.02*** (0.001)	0.03*** (0.005)
Switching Importers	0.02*** (0.001)	–
Exiting Importers	0.02*** (0.001)	–
No. of observations	36,061	28,602

Note: Numbers in parentheses are robust standard errors using equation (14) in the text. We use 12 year dummies, 24 industry dummies, 4 size dummies, and 4 region dummies. Dependent variables in levels are in logs.
$*p < .10$, $**p < .05$, $***p < .01$.

In Annexes, Tables 15 and 16 the results of equation (14) for the two industries classification are analyzed in this paper. Similar to the evidence for all the manufacturing sector, our results confirm the selection on the entry and exit side of the market since entering importers have higher TFP levels than nonimporters and continuing importers have higher productivity levels than exiting importers in all the Pavitt industries and in all the technological intensity industries.

Across all industries and similar to Kasahara and Rodrigue (2008), the coefficients for the continuing importer firms are often positive and significant at standard levels; again, these results confirm the importance of foreign intermediate inputs in explaining productivity differences across industries and over time. These results provide support for the selection of more productive firms into the importing market, in accordance with substantial market entry costs of importing (Girma Abreha, 2019; Zhang, 2017).

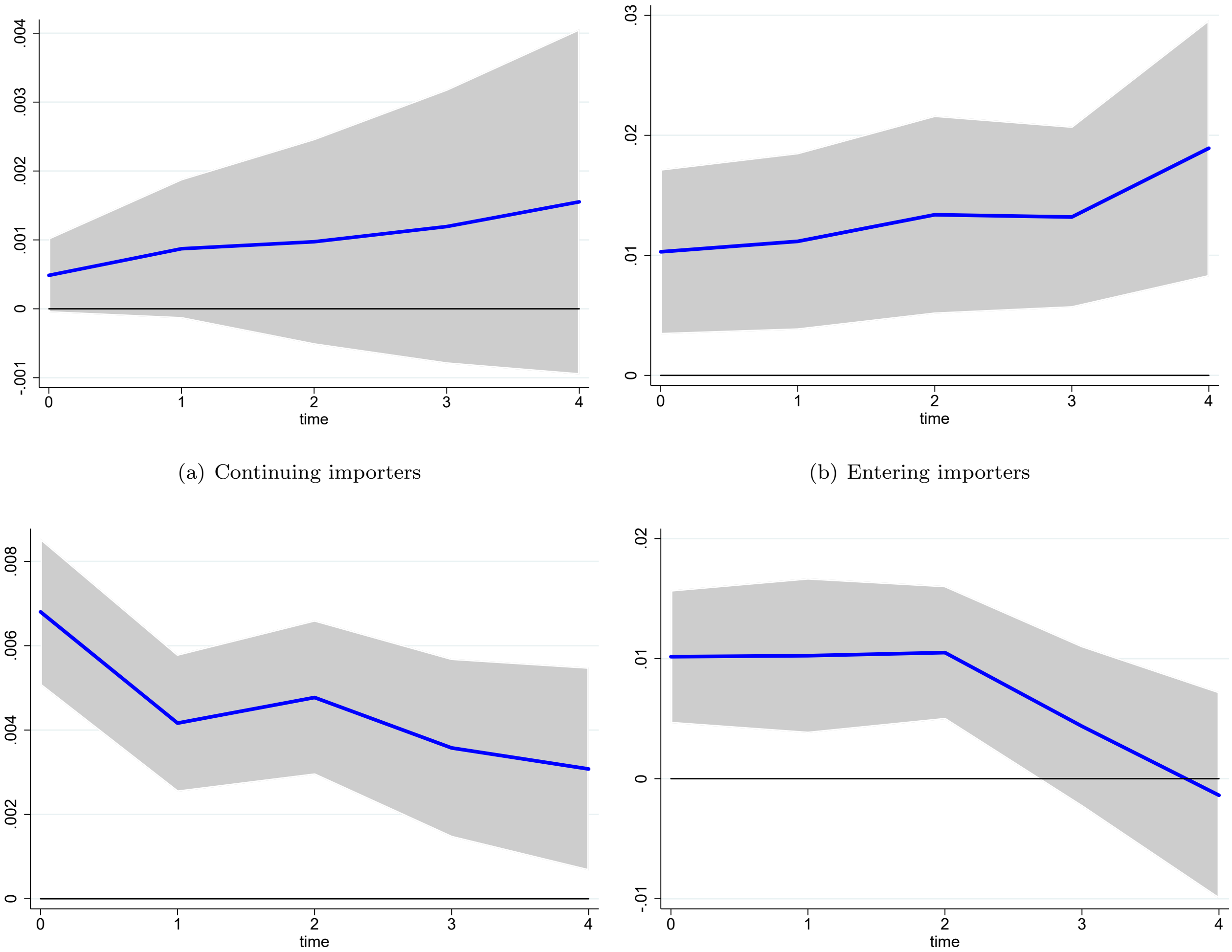
We also estimate equation (14) using the rate of change in TFP as the dependent variable, in line with the *learning-by-importing* hypothesis. With this, we seek to capture the idea that entry into the international market as importer provides firm benefits that result in higher TFP. To support this hypothesis, we expect to find that after a firm entered the international market (entering importer) its TFP growth increass over time. If this view is correct, the TFP gap between entering importers and nonimporters should increase after entry.

As shown in Table 12, the coefficient of entering importers is positive and statistically significant; this suggests that after entry into the import market, TFP growth increases 0.3%. Notably, after entry, the productivity growth of entering importers is significantly different than that of firms remaining outside the import market (Fariñas and Martín-Marcos, 2007); this pattern is quite similar in all the desegregated industries analyzed. Kasahara and Rodrigue (2008) and Girma Abreha (2019) found similar results for the Chilean and Ethiopian manufacturing firms, respectively; according to these authors, there are long-run effects of importing that predict a firm productivity improvements. In general, we find evidence in favor to the *learning-by-importing* hypothesis for Ecuadorian formal manufacturing firms, also when we group the industries by Pavitt taxonomy and Technological intensity classifictaion (See Table 15 and 16 in Annexes).

Finally, we use a dynamic approach to estimate equation (14) with lags of the productivity and the import decision to obtain the effect (after the impact). We use the local projections estimator of Jordà (2005) to calculate recursively the effect of exogenous variable X in dependent variable Y at time h after (Teulings and Zubanov, 2014); in other words, this estimator obtains Impulse-Response function (IRF)[17]. In our case, we estimate the accumulated

[17]In contrast with other methods (e.g. Vector Autoregressive), the local projection estimates the robust IRF mitigating the mis-

effect of import decision in the productivity of the firms[18]. Here, we compare each strategy (continuing, entering, exiting and switching) to the nonimport decision. In the estimation we include industries, time and region fixed effects. In contrast with Table 12, the local projection estimator allows us obtain the dynamic causal relationship between imports and productivity.



(a) Continuing importers

(b) Entering importers

(c) Switching importers

(d) Exiting importers

Figure 3: Cumulative effects in Productivity by Import Decision

Figure 3 shows the effect of each import decision. In panel (b) we observe that firms that do not import and begin importing in t (entering) have a statistically significant higher productivity than their nonimporter counterparts. For instance, at the time of the import decision ($t = 0$), entering into the import market increases productivity by 1% and after ($t + h > 0$) it reaches a 2% increase. This result supports the existence of learning by importing of the entering firms as we tested before.

The switching and exiting importers (panels c, d) present also higher productivity than nonimporter firms. For the first strategy this increases the TFP by 0.7% at the moment of the import strategy decision; for the $t + h > 0$ the TFP decreases being a plausible explanation that these firms import only transitory as no accumulate gains in productivity is found. For the exiting importers, this strategy rises 1% in the TFP, but these firms do not learn about their import decision, as we expected, because as seen in the figure, at $t + 4$ we get a negative value for the cumulative TFP.

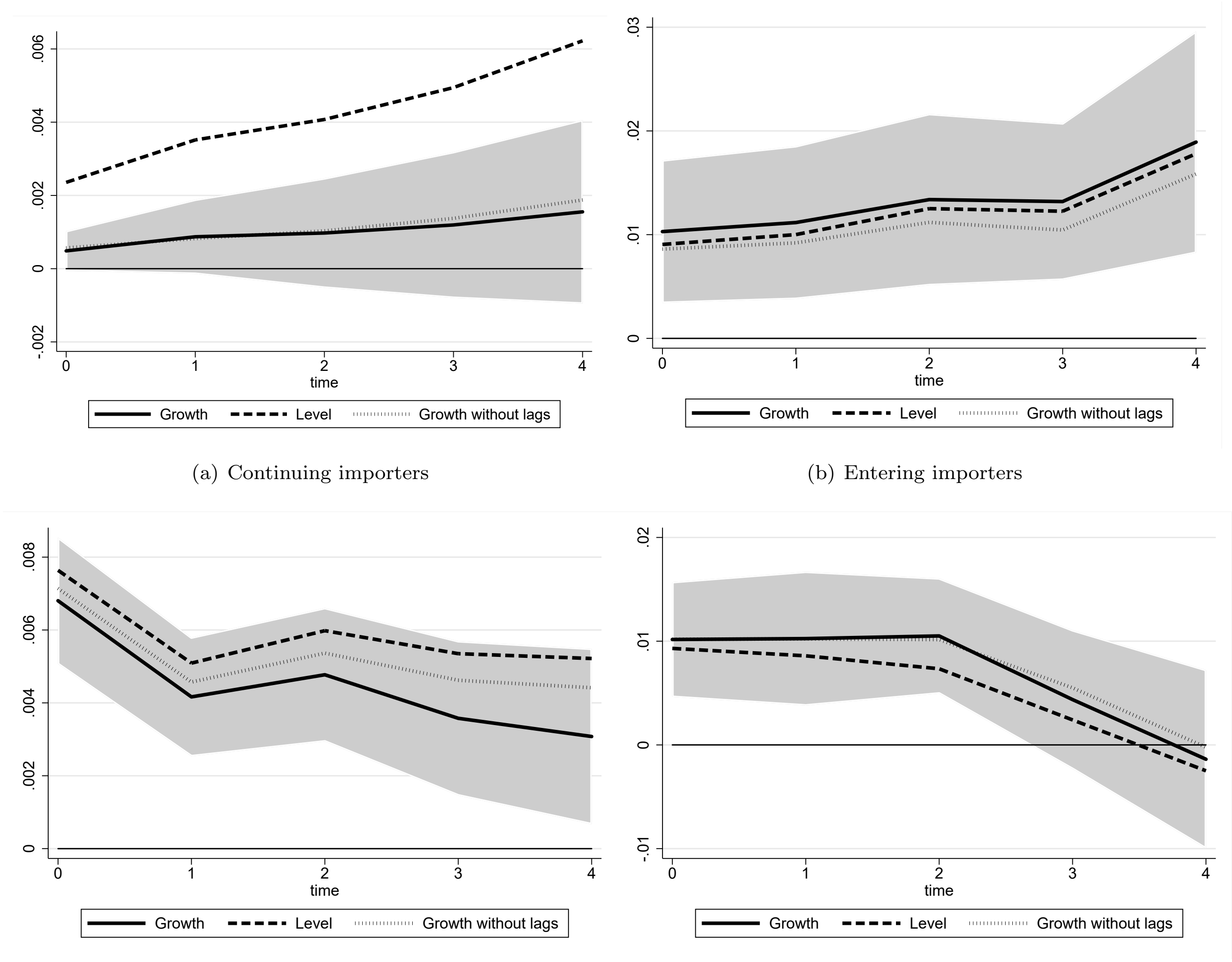
In contrast, the continuing importer firms, in panel a, do not present higher productivity than the nonimporters in this dynamic approach. The estimation is positive, 0.2%, but no significant. The fundamental difference with

specification of the data-generating process (Teulings and Zubanov, 2014)

[18]To obtain the accumulated effect use the dependent variable as $y_{it+h} - y_{it-1}$ for each horizon h recursively.

the estimation of Table 12 is that this dynamic regression include the before productivity behavior (lag of TFP) of the firms. This estimation shows that the decision of always import in the sample improve the productivity but maybe relax the firms in time. However, this result is not conclusive because we run the local projection with different specification to test the robust the effect. Also, when we analyze only the continuing importers vs. nonimporters, we only get conclusions of the self-selection hypothesis and this issue has been analyzed in three different forms to get a holistic perspective of our results.

Figure 4 presents the dynamic estimations of the accumulated change in the productivity before plot (figure 3), one without lags and the log level of the TFP[19]. In the continuing decision, we find that importer firms have a statistically significant higher productivity of 0.2% in $t = 0$ and a 0.6% after the importer decision between $t + 1$ and $t + 4$. The estimation for the other strategies shows that the effect is very similar compared to the baseline (accumulated growth with lags). The estimation of figures 3 and 4 supports the *learning-by-importing* hypothesis for entering firms, but no effect for exiting firms and a transitory benefit for the switching importer firms is found.



(a) Continuing importers

(b) Entering importers

(c) Switching importers

(d) Exiting importers

Figure 4: Cumulative effects of Productivity by Import Decision with different specifications

7 Conclusions and Discussion

It is well known that there is a positive relationship between imports and firm productivity. However, there is scant evidence that this holds true for emerging market and development economies, and nule evidence for Ecuadorian

[19]See Teulings and Zubanov (2014) and Sims et al. (1990) to understand the stationary condition to use the level or log variables.

manufacturing (to the authors' knowledge). Particularly, for a small open economy international trade can be a major channel for productivity growth (Zaclicever and Pellandra, 2018). This lack of availability of studies in Latin American manufacturing, has been mainly due to the lack of data availability.

To address this issue, in this paper we give new evidence for a small developing country, Ecuadorian manufacturing firms, during 2007–2018. We analyze the way in which imported intermediates affect firms' productivity, exploring the impact of the use of foreign intermediate inputs not only in the whole manufacturing sector but also by two industry classifications (Pavitt Taxonomy and industries according to their technological intensity following the OECD classification). We estimate an augmented production function using the traditional inputs and three different measures of imported intermediates inputs such as: a categorical variable of imports, and two continuous measure of import intermediates. In this path, we use the theoretical model proposed by Kasahara and Rodrigue (2008) that use the ratio of total intermediate inputs to domestic intermediates (a measure of the use of imports) to capture the effect of imported intermediates with productivity. As a complementary analysis, we also use the intensity (share) of imported intermediates to get evidence of how intensive is the use of foreign varieties among importing firms, showing that these two measures lead to similar results. Finally, we estimate the effect of many firms' import strategies on TFP, to test the self-selection and *learning-by-importing* hypotheses.

Using the ratio of total intermediates to domestic intermediates, our results suggest that there is a positive impact of an increase in the share of imported intermediates on productivity in all the manufacturing sector, inclusive when we divided it by two industry classification. In addition, the relationships between gross revenue and capital, labor, and total intermediates consumption differ among the sectors, implying heterogeneity in consumption of inputs between industries. We also determine the elasticity of substitution between foreign and domestic intermediate inputs, and find that these intermediates are substitutes inputs. This conclusion is similar to Kasahara and Rodrigue (2008) findings in Chilean manufacturing plants, but contrary to Zhang (2017) results for Colombian manufacturing plants; we argue that in a dollarized developing economy intermediates are subject to the condition of the international exchange rate with respect to the main suppliers of raw material, so an increase in the price of imported inputs would generate a decrease in the demand for domestic inputs, given that the great majority of products depend on imported inputs to produce output. Furthermore, the elasticity of substitution in all the manufacturing sector and in each industry classification is small, meaning that the input variety effect of the imported inputs is small; this result could occur due to the different import restriction policies taken by the Ecuadorian Government during the analyzed period.

Also, when we use the import intensity as a key variable affecting firm productivity; this new variable suggests a positive effect between foreign intermediates and firm productivity, it is not possible to capture the elasticity of substitution between domestic and foreign intermediates. Since the use of the two import measures suggests similar results, a more robust analysis is used to determine not only the association of imports in production but also the causal effect of this variable on productivity. Given that the use of the two import measures suggests similar results, we could conclude that there is significant and robust evidence that demonstrates that import intermediates increase the firms productivity.

Finally, and similar to most of the research done for developed countries and to the few studies on developing countries, we get robust evidence that importer firms have greater productivity levels than their counterparts. In addition, we find evidence in favor of selection on the entry side of the market (self-selection hypothesis) since the entering importers have a higher productivity level than nonimporter firms in all the sectors, also our results confirm selection on the exit side of the market in all manufacturing sector since continuing importers have higher productivity levels than exiting importers; these results are very similar in all the industry classification, meaning that more productive firms self-select into importing. Likewise, and according to the *learning-by-importing* hypothesis, robust evidence is found since the entering importers have a positive effect on TFP growth in all the manufacturing sector and in the different industries desegregation. Our findings also suggest that firms that enter import markets increased their productivity significantly.

Our results are important not only for firms (managerial and/or production strategy) that conclude the access

to imports boosts production and productivity, but also for policy makers (government policy), for the same reason. Our evidence that the foreign and domestic intermediate inputs are substitute imply that restrictions on imports such as increasing duties to the maximum limits or tariff safeguards, could harm production, because the majority of the firms that import combine foreign inputs with domestic ones even if the elasticity of substitution is very small which imply that input variety effect of the imported inputs is small and if there are different quality effect between imported intermediates and domestic intermediates this will be interpreted with caution[20]. Moreover, policy makers should be careful not to implement policies that act as disincentives to the import decision, because it could reduce productivity, affecting growth in the long run. In this sense, and with the results obtained in this study, public policy makers should consider tariff liberalization and particularly that of productive input tariffs, since they play an important role in productivity. Also, in promoting intersectoral networks and promoting external supply from countries that have higher quality inputs so that the product can have high quality standards and then be exported. Thus, policy makers should not examine only the macroeconomic balance. In contrast, the government could encourage firms to export more with better quality and gross value added and so improve the national trade balance.

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[20]Imports may make available to domestic firms higher-quality inputs, which would allow them to increase the efficiency of the production process (Eaton and Kortum, 1999). In this sense, Zaclicever and Pellandra (2018) argues that these variety and quality effects are specially relevant for developing countries, where the range/quality of domestically produced inputs can be limited.

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8 Annexes

Table 13: Correspondence between ISIC codes and Pavitt Taxonomy

Industry	Subsectos	ISIC codes
Scale-Intensive industry	Food, beverages and tobacco	10 + 11 + 12
	Editing and printing	18
	Coke manufacturing and oil refining	19
	Manufacture of other non-metallic mineral products	23
	Mineral-based products	24
	Metal products	25
	Motor vehicles	29
Science-Based industry	Chemical industry and pharmaceutical products	20 + 21
	Agricultural and industrial machines	28
	Other transport material	30
Specialized-Suppliers industry	Manufacture of computer, electronic, and optical products	26
	Machinery and electrical equipment	27
	Repair and installation of maquinary and equipment	33
Supplier-Dominated industry	Textile and clothing	13 + 14 +15
	Wood Products	16
	Paper Manufacturing	17
	Manufacture of rubber and plastic products	22
	Furniture and Other manufacturing industries	31 + 32

Source: Pavitt (1984); Superintendencia de Compañías, Valores y Seguros

Table 14: Correspondence between ISIC codes and industries according to technological intensity

Industry	Subsectos	ISIC codes
Low-tech industry	Food, beverages and tobacco	10 + 11 + 12
	Textile and clothing	13 + 14 +15
	Wood Products	16
	Paper Manufacturing	17
	Editing and printing	18
	Furniture and Other manufacturing industries	31 + 32
Medium-low tech industry	Coke manufacturing and oil refining	19
	Manufacture of rubber and plastic products	22
	Manufacture of other non-metallic mineral products	23
	Mineral-based products	24
	Metal products	25
	Repair and installation of maquinary and equipment	33
Medium-high and High tech industry	Chemical industry	20
	Machinery and electrical equipment	27
	Agricultural and industrial machines	28
	Motor vehicles	29
	Other transport material	30
	pharmaceutical products	21
	Manufacture of computer, electronic, and optical products	26

Source: Eurostat indicators on High-tech industry and Knowledge; Superintendencia de Compañías, Valores y Seguros

Table 15: Productivity performance by import decision: Results by industries according to Pavitt Taxonomy

Variables	**Scale-Intensive**	**Science-Based**	**Specialized-Suppliers**	**Supplier-Dominated**
		TFP level: Self-Selection		
Continuing Importers	0.04***	0.03***	0.04***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)
Entering Importers	0.01***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
Switching Importers	0.02***	0.02***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Exiting Importers	0.02***	0.02***	0.03***	0.01***
	(0.00)	(0.00)	(0.0)	(0.00)
No. of obs.	15,619	5,741	4,343	10,358
		TFP growth: Learning by Importing		
Entering Importers	0.03***	0.01	0.04**	0.02***
	(0.01)	(0.01)	(0.02)	(0.01)
No. of obs.	12,502	4,558	3,343	8,196

Notes: Numbers in parentheses are robust standard errors using equation (14) in the text
We include Year, Industry (two digits of ISIC Rev. 4.0), size and region Fixed Effects
$*p < .10$, $**p < .05$, $***p < .01$.

Table 16: Productivity performance by import decision: Results by industries according to technological intensity

Variables	**Low-tech**	**Medium-low tech**	**Medium-high and High**
		TFP level: Self-Selection	
Continuing Importers	0.04***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)
Entering Importers	0.01***	0.02***	0.03***
	(0.00)	(0.00)	(0.00)
Switching Importers	0.01***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)
Exiting Importers	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.0)
No. of obs.	17,908	10,570	7,583
		TFP growth: Learning by Importing	
Entering Importers	0.03***	0.03**	0.04***
	(0.01)	(0.01)	(0.01)
No. of obs.	14,225	8,376	5,996

Notes: Numbers in parentheses are robust standard errors using equation (14) in the text
We include Year, Industry (two digits of ISIC Rev. 4.0), size and region Fixed Effects
$*p < .10$, $**p < .05$, $***p < .01$.

Table 17: OLS regression of TFP on import, export and traders dummies:
Results by industries according to Pavitt

Variables	**Scale-Intensive**	**Science-Based**	**Specialized-Suppliers**	**Supplier-Dominated**
Imports	0.02***	0.02***	0.03***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
Exports	0.01***	0.01	-0.001	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Traders	0.04***	0.03***	0.04***	0.04***
	(0.00)	(0.00)	(0.01)	(0.00)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Size FE	Yes	Yes	Yes	Yes
No. of obs.	15,619	5,741	4,343	10,358

Note: Standard errors in parentheses.
*$p < .10$, **$p < .05$, ***$p < .01$.

Table 18: OLS regression of TFP on import, export and traders dummies:
Results by industries according to technological intensity

Variables	**Low-tech industry**	**Medium-low tech industry**	**Medium-high and High tech industry**
Imports	0.02***	0.02***	0.03***
	(0.00)	(0.00)	(0.00)
Exports	0.01***	0.01***	0.01**
	(0.00)	(0.00)	(0.00)
Traders	0.04***	0.05***	0.05***
	(0.00)	(0.00)	(0.00)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
Size FE	Yes	Yes	Yes
No. of obs.	17,908	10,570	7,583

Note: Standard errors in parentheses.
*$p < .10$, **$p < .05$, ***$p < .01$.