The Roles of Trade and Technology Diffusion on Growth: A Policy-Making Perspective in Latin America Amid the COVID-19 Crisis

Executive Summary

The sudden drop in trade due to the COVID-19 pandemic was a determinant of Latin America's growth decrease for 2020 and part of 2021. And beyond growth, the region's efforts to mitigate the spread of the virus have been significantly diminished by its reliance on trade and international cooperation to acquire medical supplies —like the sophisticated equipment needed to treat patients, and more recently, vaccines. Despite all this, closing to trade is hardly the answer. In fact, as a channel of technological adoption and innovation, trade is an important driver of growth.

This essay explores the relation between trade and technology adoption to explain why the region has to set its economic rebound with an outward-oriented focus. From a theoretical point of view, it analyzes the firm-level and aggregate productivity increases that derive from technology diffusion through trade interactions. Evidence regarding the Latin American case is reviewed, while discussing normative and practical considerations in light of the pandemic. Also, emphasis is put on past experiences and related literature, touching the subjects of regional integration and development.

1 Introduction

Trade was one of the most important economical activities to suddenly collapse by the surge of the COVID-19 pandemic. Initial measures taken by governments around the world were majorly composed of export prohibitions and restrictions, with the particular intention of stopping exports of medical supplies. At the same time, international trade was disrupted by the shutdown promoted by health authorities to stop the spread of the disease. Through a reduction in the supply of exportable goods, a lower demand for primary goods, a restricted factor mobility and an accentuated slump in oil prices, critical sources of foreign exchange and income for developing economies were put on a standstill.

As noted on a World Trade Organization report, the developing economies were the most struck by these policies because of their dependence over a handful of markets that generate income through exports. The decline on export earnings resulting from the restrictions contributed to the decrease in economic growth during the early stages of the pandemic, with the reduction of trade interconectedness playing a significant role (Vidya & Prabheesh, 2020). The same WTO report notes even further that developing countries will face the formidable challenge of appropriately setting their economic rebound with the substantial lack of resources to do so[1].

The consequences of discriminating trade policies are far from being only economical. Export curbs deprived some developing countries of much needed medical supplies, like ventilators, which they cannot produce internally due to to a lack of technology. By March 2020, 54 countries had implemented export curbs denying foreign buyers the possibility to acquire life-saving equipment (Evenett, 2020). This aggravated the situation of some Latin American countries (LACs), all while facing an unprecedented demand for intensive care.

Things improved with time. Some restrictions did not last long and the gradual reopening of markets relieved some pressure on LACs' economies. Consequently, a load of stimulus packages and government interventions to re-take economic activities have allowed for what could be a steady but slow recovery. Moreover, the literature has widely regarded the effect of the

[1] See https://www.wto.org/english/tratop_e/covid19_e/ldcs_report_e.pdf

COVID-19 on international trade as a short-run impact, varying widely across sectors and being at a peak during the beginning of the pandemic. E-commerce, internet and mobile services, along with certain physical retail sectors (like household essentials and medical supplies) had a sudden increase in consumer sales when the pandemic started; some business-to-business (B2B) sectors also benefited from e-commerce and a transition to online services[2].

However, most recently, the region faces a similar problem to that of discriminatory trade which runs deeper at the core of a longstanding debate about development and technological advancement in Latin America. As of May 2021, the COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University, registers that every country in the region (besides Chile, Uruguay and Dominican Republic) has partially vaccinated less than 22% of their population[3]. As reference, most developed economies have administered at least one dose of the vaccine to more than 40% their population. Moreover, 86% of the confirmed total number of doses purchased as of May 2021 belong to high and upper-middle income economies through bilateral deals, with high income countries alone holding 66% of the total[4]. Forecasts show that vaccine coverage in Latin America will not be completely widespread until late 2022 or early 2023[5], and although the COVAX initiative[6] is expected to offset some of this inequality in vaccine distribution, it is evident that bilateral agreements between rich countries and vaccine manufacturers will likely slow down the eradication of COVID-19.

In this realm, the bioethical literature [see, for example, Jecker et al. (2021)] argues that with only a handful of countries having the capacity to manufacture vaccines on their own, a person's country of residence is the most important factor determining vaccine accessibility, and it shouldn't —which is why the COVAX program exists. And with the WTO chief making a call to vaccine manufacturers to share patents and technological know-how to combat vaccine

[2]See https://www.wto.org/english/tratop_e/covid19_e/ecommerce_report_e.pdf

[3]See https://ourworldindata.org/explorers/coronavirus-data-explorer

[4]See https://launchandscalefaster.org/covid-19/vaccineprocurement

[5]See https://www.economist.com/graphic-detail/2021/01/28/vaccine-nationalism-means-that-poor-countries-will-be-left-behind

[6]The United Nation program for equality access to vaccines in low and middle income countries.

inequality[7], more pressure has been put on developed nations, particularly the US and members of the EU, to reduce the gap by waiving patent protections. Nevertheless, only a handful of LACs would be immediately available for vaccine production[8].

It is important to note that vaccine nationalism is related to the much general economical concept of unequal technical progress. A purely theoretical standpoint would explain the fact that only some countries are able to produce vaccines because they possess the human capital and technology needed for it. Unequal economic growth and differences in technological endowments would also determine which countries are able to produce the sophisticated medical equipment needed for COVID-19-related hospitalizations.

Hence, the inability of LACs to combat the pandemic and its economical consequences was shaped to some extent by the lack of technological progress. For this reason, the region's rebound will necessarily involve some kind of policy innovation that triggers firm-level research and development (R&D). And a big part of the challenge will be to institute agendas that include major investments in scientific research, education, infrastructure and social services, —for these are usually acknowledged to generate paths to sustainable growth through rises in productivity. But with all these being more or less evident for policy makers in the long run, a significant part of the problem comes down to finding policies that generate large social returns and robust economic environments as quickly as possible.

The rapid negative consequences of trade shocks on Latin American economies unveil both a structural weakness and a potential source for policy-induced gains. Furthermore, the region is not unfamiliar with the application of trade policies that try to generate growth —it being widely known as an adopter of the import substitution industrialization model (ISI) in the second half of the 20th century. However, recent literature suggests that protectionism may not be the only way to get diversification and productivity increases. New models show that export sectors may generate positive externalities under trade liberalization if firms have the incentives to adopt better

[7] https://www.wto.org/english/news_e/news21_e/dgno_21may21_e.htm
[8] https://investmentmonitor.ai/covid-19/covid-vaccine-regions-left-behind

technologies. In this light, this essay explores the relation between trade and technological progress as a means of attaining short and medium-run increases in productivity through *technology diffusion*. Section 2 provides a short review of the literature on this matter.

Section 3 describes empirical findings regarding technology diffusion and productivity increases deriving from trade in Latin America. It analyses competition and trade openness as a way to generate both aggregate and firm-level gains, while it describes the role Foreign Direct Investment (FDI) in manufacturing and its practical considerations for LACs given the COVID-19 crisis.

Section 4 concludes and recapitulates.

2 Background

2.1 Innovation and technology in contemporary trade theory

Comparative cost theory[9] is an unsatisfactory framework for explaining the disparities in growth between countries that separately specialize in industrial and primary goods. By emphasizing that trade under comparative advantage leads to increases in total welfare through specialization, it eludes the empirical observation that industrialized countries consistently end up with higher improvements in per capita income[10]. The productivity increases on primary exporters are far from those of industrialized ones; the technological progress on primary activities is low and this puts underdeveloped economies on an adverse, seemingly inescapable, situation.

An influential view for Latin American policy was that of Prebisch (1959). He would attribute disparities in productivity to the *income elasticity of demand* of each type of export. In what has come to be known as the Prebisch–Singer

[9] A usual term to refer to both Ricardian and Hecksher-Ohlin trade theories, the latter considered to be an extension of the former.

[10] Although the Ricardian and H-O frameworks can be adapted [see Dornbusch et al. (1977) for the inclusion of technology in a Ricardian model], recent models were developed to avoid assumptions like the existence of representative agents and perfect competition.

hypothesis, Latin American imports on an industrialized country face a lower elasticity than that of industrial imports in Latin America. Thus, as the region slowly increases its per capita income with time, it also faces the need to substitute consumption of domestic primary goods into imported industrial goods. Prebisch would further argue, that intervening to increase consumption of domestic goods offsets the differences in elasticities. This is the notion of *import substitution*, and its elasticity correction would also affect the patterns of employment in such a way that it would shelter internal industrialization. A detailed historical review of the ISI model adoption in Latin America can be found in a paper by Baer (1972).

Noting that the insufficient framework of comparative advantage had forced authors to "formulate new concepts in order to explore issues such as the strengths and limitations of import substitution in the development process", Vernon (1966) deviated attention instead to the effects of innovation and economies of scale on international trade. He posed the idea that manufactured products have "life cycles": invention and innovation occur in a developed economy, the North, and trade with the South would lead to technology transfer or imitation (in other words, *technology diffusion*). Then, those manufactured goods would end up being predominantly produced in the South thanks to production standardization and increasing economies of scale. Invention and innovation are only carried out in the North because it possesses the R&D capabilities required for it. Krugman (1979) would formalize this by introducing innovation, technological transfers, and the "North-South" narrative into a model of international trade. Dollar (1986), and Jensen & Thursby (1986, 1987) would expand the modeling of Vernon's life cycle building upon Krugman's approach.

The inclusion of innovation and technology motivated study of the effects of trade on long-run growth using an endogenous growth[11] framework. An important assumption on Krugman's paper had been that the rate of innovation at the North and the rate of technology transfer to the South are *exogenously* determined in the system. Grossman & Helpman (1991) would present a cycle

[11] Referring to body of economical literature that regards growth as an outcome generating from within an economic system, not as the result of outside forces. Romer (1994) documents the origins of the term as not being well defined.

model featuring both rates as endogenous, arriving at interesting conclusions. They predict that the larger the resource endowment and the better the imitation ability of the South, the faster its long-run growth will be. Romer (1990) had arrived at a similar implication on a macroeconomic model with growth being driven by technological advancement. His results were presented by comparing the equilibrium between two identical economies under autarky and under *integration* —trade of goods being part of a much broader construct which includes the flow of ideas and people as well. Romer's main conclusion was that the larger the human capital stock in an economy the faster it would grow, and a significant source of human capital is technology diffusion. So, unrestricted international trade can increase growth rates in the long run, as Grossman and Helpman's paper had worked out assuming two different economies[12].

Endogenous technological change as in Romer (1990) and Grossman & Helpman (1991) is defined by two important notions. First, technology is different from human and physical capital. The marginal costs associated with any technology are zero for those that have not incurred in the investment to develop it —marginal costs are not zero only for the inventor. In other words, a country that takes on a foreign technology has no domestic opportunity costs for the adoption. Second, the return of technological investment leads to positive *externalities* that are both private and public. Namely, if the inventor gets sufficiently large returns for the innovation so that he puts it in the market, then other individuals could also get benefits. An innovative product can, for instance, promote more innovation because other firms in the market could study it to develop a competing product. These externalities are also referred to as *spillovers*.

Besides the effects of innovation and technology on different economies, product differentiation and allowing for heterogeneous firms are important deviations from comparative cost theory. Notably, Krugman (1980) motivated development away from the traditional framework by presenting a model with imperfect (monopolistic) competition, product differentiation and economies of

[12]It is relevant to mention an interesting result by Rivera-Batiz & Romer (1991). They use an endogenous growth framework to convincingly show that the integration between two developed economies could be beneficial for the long-run, worldwide, rate of growth.

scale. And Melitz (2003), on a very cited paper, would provide a dynamic extension on Krugman's allowing for heterogeneous firms. It formalizes the empirical observation that, in between industries, firms that export are more productive than those who do not. The mechanism through which this works, is that exposure to trade "selects" the most productive firms in the industry after the least productive ones are forced to exit. This *intra-industry* reallocation leads to aggregate productivity gains.

Not surprisingly, by the end of the 20th century a bigger part of the international economics field would favor trade openness, and the consensus seems to not have changed over the past two decades.

2.2 Theoretical and practical considerations

Having referenced a small but relevant portion of literature on the matter, I will not discuss if international trade is in fact beneficial for growth. The old and still ongoing debate of whether it is true can be found elsewhere —a good starting point is the work of Rodriguez & Rodrik (2001) and the literature cited there.

I will establish as the framework for this essay's analysis the model used in Keller (2004) [which is based on Eaton & Kortum (1999)] and closely follow his derivation of its implications. The need to do so relies in the fact that the mechanisms of technology diffusion and R&D have to be clearly defined for the empirical discussion of section 3.

Leaving aside the formalities of the model, the following are connotations when international trade is possible[13]:

1. Foreign innovation increases domestic productivity through the inflow of imports and consequently the spillover effect. This holds in both the short and long run.

2. Receiving technology from abroad through imports has varying degrees of changes in productivity. Specifically, the faster a country can advantage from the spillover effect, the greater the domestic productivity increase.

[13]The mathematical derivation of all points can be seen in Keller's (2004) paper, or in more detail and with varying assumptions in Eaton & Kortrum's (1999).

3. Product quality innovations on one country become available to others at a variable rate, defined to be its rate of technology diffusion. Additionally, we shall regard the world's R&D as the total of labor and capital dedicated to research from all countries together.

4. The bigger the share of the world's R&D a country (or an integrated region) has, the more important the country is for the world's rate of growth. When this happens we say that the country has a high rate of technology diffusion.

It is important to remark that point 1 does not make any assumptions about the particular effect of technology adoption for any country; spillover may not create equal levels of knowledge for all countries.

There can be several reasons for technology advancement to remain unequal under trade. For instance, an inventor may decide, for any reason, to keep his technology secret to the point were he might spend additional resources to have it as such. Plus, patenting is not negligible in our framework, and this in fact may prohibit others from appropriating technology. Profiting from own innovation is in fact an incentive to R&D. Additionally, we do not make any assumptions over mobility costs: multinationals may have to incur in transference costs to pass knowledge to their subsidiaries (this would be the case of teaching through person-to-person demonstrations).

An important implicit characteristic of technology that has to be pointed out, is that it usually cannot be fully codified, and if it is, it would be very costly to do so. This simply means that the technology cannot be put into explicit terms to be completely transferred to others, even if both parties wanted to do so. This nature of partial codification means that technology diffusion will always be, at the very least, incomplete, and technology stocks will be varied between countries. Hence, it is expected to have diffusion as a geographically localized phenomenon.

From a practical standpoint, we will not take measurements of technology diffusion, partly because of data availability and partly because externalities are very difficult to measure quantitatively. Specifically, R&D expenditures and patent numbers measure innovation, not technological transfer, and a big part of knowledge spillovers is related to a learning effect that cannot be measured. It is better to focus on the international *channels* of technology diffusion instead.

Before proceeding to the discussion about the Latin American case, we should mention a mechanism that is not a direct consequence from our theoretical framework, but that has been given importance in Latin American policy and was mentioned in the Introduction: *export diversification*. This can have a positive relation to growth, not through productivity directly but as a result of development.

By still relying on specialization (on an intra-industry level), the theory covered here does not explicitly take into account the possibility of a negative effect deriving from dependence aggregate over a few products. Having export diversification simply means that GDP growth is less volatile. In other words, growth is less likely to be significantly diminished by external shocks because having an expanded product catalog offsets losses on average. This reduction in volatility is usually referred to as the *portfolio effect*.

Observational data often suggests that the poorer countries tend to be the most specialized ones, and this is something that has not gone under the radar of Latin American policy. Agosin (2007) documents a positive effect of export diversification on growth in Latin America and a review on the matter. Moreover, it is a recurring thought in the policy-maker's mind that Asia has been way more successful in attaining export diversification. The Asiatic region went through its own period of import substitution with much better results and the reasons as to why, have been (and still are), discussed in the literature[14].

With exports being a part of GDP, it is clear that strong international shocks are reflected on output —this is something that holds by definition. The COVID-19 crisis shows this very clearly, with the predicted total exports volume (of both goods and services) having a decline in Latin America on 2020 (see Figure 1).

The thing about diversification is that having a diversified export structure does not mean having a manufacture-oriented one. Nor it implies that technological advancement is being promoted behind the observed output growth that results from diversification. However, it can be regarded as a result from technological advancement and human capital accumulation. So, in some

[14] Agosin (2007) also discusses why Asia has grown faster than Latin America through exports providing specific measures and estimation.

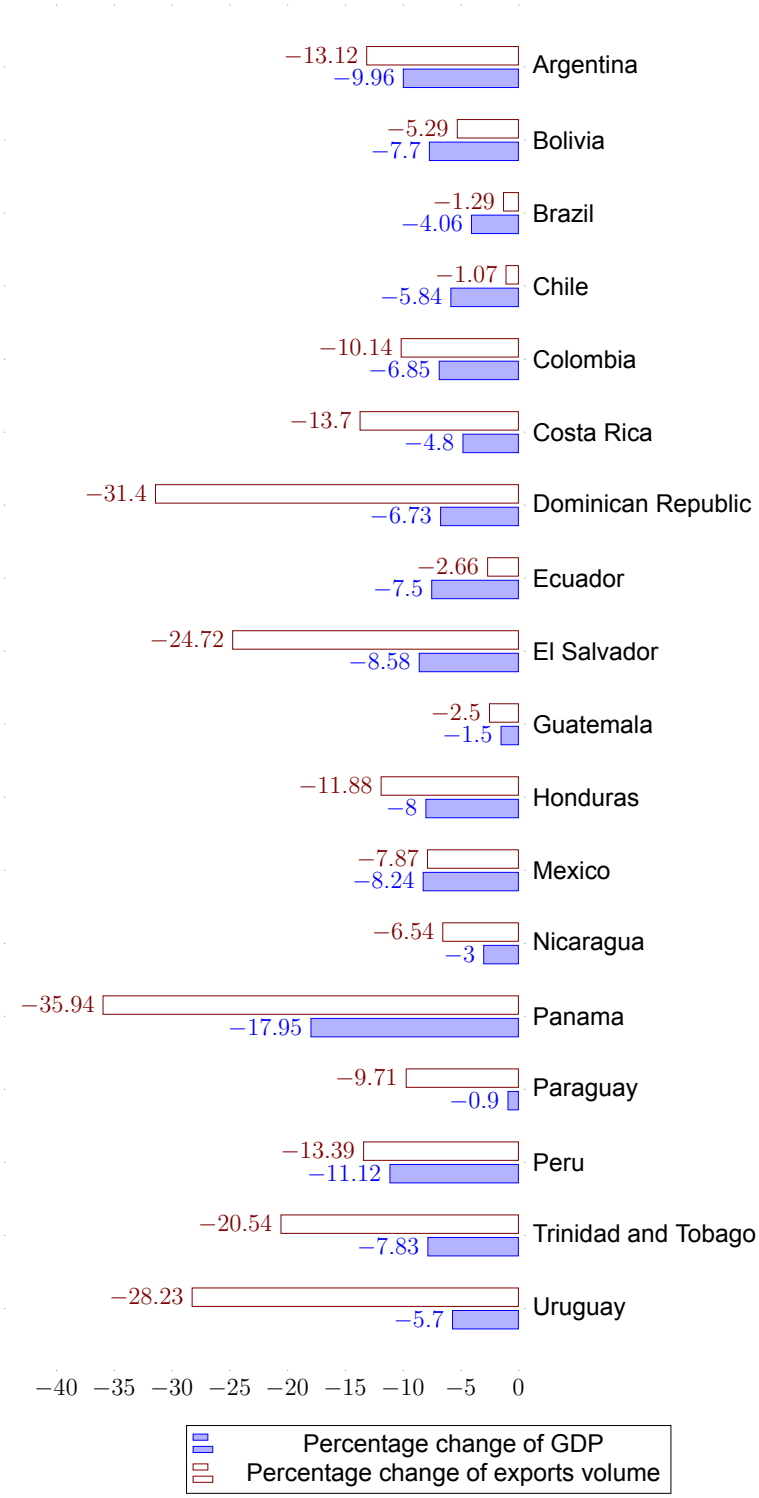

Figure 1: Predicted percentage change of GDP and exports volume on LACs for 2020 (not all listed). Source: IMF's World Economic Outlook database, April 2021.

way, one likely observable characteristic of a country that is moving away from primary exports could be diversification. Hence, in what follows we shall not directly address policies involving this mechanism. We will instead assume that development through technological advancements and trade competition (and a number of other externalities that we will not address) yield export diversification.

3 Latin America

Some empirical works suggest the existence of technology diffusion and a positive associated effect on productivity in Latin American countries on a general level (Blyde, 2004; Schiff & Wang, 2010; Koengkan et al., 2020). In this section we will review evidence on the ways trade policy has yielded productivity increases in Latin America. But, contrary to the positive arguments regarding trade that have been mentioned so far, we must now acknowledge normative connotations in a policy-making perspective. It is specially important to mention that without adequate compensatory measures, trade liberalization or any policy involving openness can lead to a greater inequality, with global evidence backing up the need to focus in equity as well as efficiency [see Engel et al. (2021)].

As it was alluded earlier, positive effects from trade come from two not mutually exclusive mechanisms: (i) higher aggregate productivity resulting from intra-industry reallocations due to foreign competition exposure, and (ii) productivity improvements on firms (firm-level productivity). When a country opens to trade, domestic firms face a greater foreign competition that could induce aggregate productivity gains by forcing the less productive firms to exit the market. Which is clear from our framework, is that at the same time openness induces technological transfers through competition. To stay in the market, the less productive firms have to step up their manufacturing process to match international standards.

These effects of trade and competition on productivity can be estimated through statistical methods beyond simple correlation under the adequate circumstances and assumptions. Particularly, there is a portion of empirical literature that has exploited the presence of historical shocks to get causality

measures, some regarding LACs. Probably the most notable to do so is Pavcnik (2002).

With Chile undergoing a massive process of trade liberalization throughout the 1980's, Pavcnik estimates the effect on productivity of the increased exposure of Chilean firms to international competition. She finds evidence suggesting that observed industry productivity gains can be attributed to trade openness.

On a similar note, Muendler (2004) and Schor (2004) find that foreign competition asserts pressure on domestic firms to increase their productivity, in this case studying Brazil's own trade liberalization period starting on the late 1980's. Muendler also considers the country's partial reversal of the policy in 1995.

Iacovone et al. (2011) analyze the effect of the Chinese market penetration in Mexico, instead using product quality as the interest variable. Interestingly, they find that the Chinese competition results in higher manufacturing quality in firms that were the most productive before the shock. Teshima (2009) studies the Mexican case regarding changes in trade tariffs. He focuses on R&D expenditure, innovation and productivity, finding that the effect is positive for R&D and insignificant to the other variables. Fernandes & Paunov (2012) and Medina (2018) focus instead on the effects of trade liberalization on Chile and Peru respectively, documenting a positive effect as well. Medina's paper finds similar evidence to that of Iacovone et al., with positive effects for large firms. See Table 1 for a summary.

Shocks that generate intra-industry reallocations like the ones in these empirical studies are likely to generate equity concerns. Iacovone et al. (2013) expands further on the Mexican case between 1994 and 2004, finding that the associated reallocation coming from exposure to Chinese competition pushes out the smaller firms from the market. That is, competition by itself does not necessarily drive the less productive firms to catch up to international standards; larger firms could advantage from economies of scale and greater capital dispositions. This concern suggests that policy-induced shocks should be planned to incentive the small and less productive firms to match international performance as well.

	Country, period	Trade shock	Variable	Findings
Pavcnik (2002)	Chile, 1979-1986	Trade liberalization	Productivity	Positive effect
Muendler (2004)	Brazil, 1990-1995	Liberalization, tariffs	Productivity	Positive effect, negative for reversal
Schor (2004)	Brazil, 1986-1998	Tariffs	Productivity	Positive effect (medium and large firms)
Teshima (2009)	Mexico, 2000-2003	Tariffs	R&D, innovation, productivity	Positive for R&D expenditure
Iacovone et al. (2011)	Mexico, 1998-2004	Chinese market penetration	Product quality	Positive for productive firms
Fernandes & Paunov (2012)	Chile, 1997-2003	Transportation costs	Product quality	Positive effect
Medina (2018)	Peru, 2000-2012	Chinese market penetration	Quality control	Positive for large firms

Table 1: Impact of import competition on some Latin American countries. See Shu & Steinwender (2019) for a review on global evidence.

The displacement of the smallest and less competitive firms can be addressed with export promotion. Public funds can be directed to mitigate firm-level fixed and/or sunk costs, leveling the playing domestic field. This can be paired with additional incentives to promote export entrepreneurship. A recent paper by Sørensen (2020) provides a theoretical framework supporting this notion, finding that gains from export promotions are shared by both the exporter and the importer abroad through the selection mechanism.

Besides intra-industry reallocations, a way to promote firm-level productivity through technology adoption and spillover effects is Foreign Direct Investment (FDI). FDI in general can be of four distinct types with respect to the type of industry: FDI for extractive industries; FDI in manufacturing; FDI in infrastructure and FDI in the services industry. The idea is that by attracting inflows from foreign firms that have a strong R&D capabilities, these would bring new technologies and know-how into the country. A special characteristic of such firms, is that their success in other markets is not likely to have been determined by codified technologies in their manufacturing processes (unlike managerial strategies, for example, which can be highly codified).

The usual perception is that FDI on manufacturing should be targeted at low-wage plants, which is misleading. Developing countries can attract FDI associated with high-tech manufacturing by combining friendly operating conditions, proactive investment promotion, infrastructure improvements and vocational training support Moran (2012). Probably the most noted regional example taken in the literature about attracting this type of investment is Costa Rica and its Intel's semiconductor plant [Spar (1998) provides a detailed analysis].

We should, however, point out a number of cons to FDI that have to be addressed, specially for Latin America. First, there is no clear evidence that the mechanism through which productivity is attained depends on the type of product. Even though Latin America should not target low-wage investments, FDI by itself does not incentive domestic firms to overcome the difficulties and specialize in high-tech goods. In other words, the speed of foreign innovation adoption, which we defined earlier, has to be directly taken into account. A

common exemplification of this is Brazil in the 1980s, seeking to develop its information technology sector through joint venture requirements to foreign investors. The policy would not work, not so much because of the way it was set, but because its industry was not able to compete with North America's Silicon Valley.

Second, FDI can also be counterproductive if not appropriately planned. Measures directed to this objective have usually included operational requirements (such as forcing joint ventures with domestic entities like the Brazil example above) that can disincentive technology transfers (UNCTAD, 2007; Karabay, 2010). And, it must be noted, that such a specific policy measure is not directly derived from observational evidence. In fact, the opposite has been suggested, with studies supporting the fact that technology transfers are more likely to occur when foreign investors have complete or majority ownership stakes (Karabay, 2010).

Third, the pandemic crisis shows that huge reductions in FDI inflows (for all types of industries) can cause imbalance problems and put more pressure on governments. Moreover, besides expecting a significant shrinkage of foreign investment due to the crisis, LACs see themselves in the need to attract FDI on specific sectors that could lead to structural changes —namely, the reorganization of global value chains [p. 58, ECLAC (2020)].

The importance of FDI has been acknowledged with much detail for the region. The World Bank report and policy proposal for Argentina's trade integration by Martinez-Licetti et al. (2018) emphasizes the need to increase FDI inflows on particular sectors, citing the mechanism through which it can generate technology diffusion as a main reason. With current situation of the COVID-19 pandemic and with investment inflows expected to had shrunk as much as 55% in 2020[15], the region as a whole will now have to sharpen its focus into attracting the *correct* types of investment.

We can remark the following:

[15]See ECLAC (2020) for a detailed report on Latin American FDI on a general level with case studies.

- In focusing on trade as a way to increase intra-industry productivity, by implementing policies that increase foreign competition, we are faced with the need to level the playing field for the smallest and least-productive domestic firms. Meaning that we must look for competition from two perspectives: we want domestic firms to be competitive between themselves, and we want them to compete with foreign firms.

- When talking about FDI, we should be concerned with the speed of domestic technology adoption, the sector where the foreign investment is placed, and the adequate requirements to put on foreign investors.

3.1 Specific aspects of a rebound through trade

The evidence presented does not allow us to favor particular measures over others. It is clear that allowing for trade in fact has positive effects on the domestic economy through the technology mechanisms we have described. What is not entirely clear, is if we should favor import competition (at the risk of increasing the dominance of large domestic firms), or if we should favor instead FDI on manufacturing (at the risk of not significantly improving internal human capital and technology endowments).

Particularly, the relation between the reduction of FDI inflows on the manufacturing and services industries due to COVID-19 in Latin America, is yet to be studied in greater detail. There are still several reasons as to why FDI-oriented policies can improve the macroeconomic conditions. FDI is a major part of technology transfers. But it should not be implemented lightly as suggested above.

As in the report by Martinez-Licetti et al. (2018) for the Argentinean case, addressing the particularities of a country is crucial to appropriately plan its international integration. Even more so given the fact that the COVID-19 pandemic hit each country in the region differently due to structural variations. Thus, the adequate combination of policy measures seems to be way too broad of a statement for us in order to have any degree of certainty in any proposal. However, getting more specific about why the application of some trade policies

have not worked in the past, can strengthen every combination of future measures. Of what has been discussed throughout this essay, we can identify the following as takeaways.

1. *Local governments should focus even more in incentivizing firms to match international standards.*

   Technological knowledge spillovers appear to be the result of strong and deliberate commitments to learning (Keller, 2004). Some LACs efforts to shelter high-tech industries show that its not a matter of forcing technological specialization, but a matter of improvements in human capital itself. Even though long run measures (on education or other development indicators) are determinants of it, the technological diffusion mechanism suggests incentives to compete internationally can help in the short run. This is a key area of intervention, and it should be addressed individually.

2. *Some countries getting more benefits from trade and technological transfers is not a valid argument against trade.*

   This is due to differences in the rate of technology adoption and the geographical characteristics of it (see section 2.2). Moreover, it is usually an accepted stylized fact by now that outward-focused countries are expected to grow at a higher pace than those that are inward-focused.

3. *With technology being geographically localized, trade openness itself does not imply higher rates technology diffusion.*

   Providing well functioning markets and internal competition incentives are key. Note, however, that this does not rule out intervention when its required. Furthermore, this suggest the need for the region to integrate (i.e. not just lowering tariffs, but the costs of labor and capital mobility as well) to even out the rate of technological adoption.

4 Conclusions

There are several reasons for Latin America to set its economic rebound with a focus on technological diffusion through trade. The COVID-19 pandemic has shown, that without a diversified export structure and the ability to quickly adopt innovation, crises are more detrimental than they should.

A major part of this essay provided a review on the economic literature sustaining technological diffusion is an essential driver of productivity. We have focused on the technological advancement and R&D that happens in foreign firms from developed economies, and described them as being attainable to firms from developing regions through international interaction. We regarded trade openness as a way to promote that linkage, with foreign competition on domestic firms pushing them to either catch up or exit. At the same time, openness allows for foreign firms to pass technological know-how when they have ownership stakes in a country.

Under adequate, particular policies that take equity concerns into account, we can expect to have productivity gains and a more efficient economical environment in the short and medium run. We defined export diversification, a common thread in the more robust economies, as a result from prolonged increases in productivity stemming from this and other mechanisms of development. Diversification is, like development, a long run objective that trade and technology diffusion can speed up.

The policy implications of this trade interaction are not entirely clear, and there is much to be empirically determined in order to support specific measures for all LACs. However, from what has been evidenced in the region, we have seen that intra-industry reallocations can be harsh on the least productive firms and probably increase inequality. It was also seen that when appealing to Foreign Direct Investment, we have to considerate current domestic capabilities, the type of industry, and adequate requirements to investors. Knowing this, the concerns are addressed to some extent by incentivizing competition, implementing compensatory measures and fostering FDI in manufacturing and service industries.

In the long run its not about going from primary to industrial goods, nor

directly into manufacturing and technology. It is about promoting research, improving health and education systems, investing in infrastructure and improving social services. From a trade perspective, its about adapting to the evolution of global value chains [p. 90, ECLAC (2020)]. And beyond just trade, its about finding ways for the region to integrate more. But, in an international framework, starting measures as the ones described in this essay can forge the way into progressively focusing on development indicators.

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