Global Value Chains, Innovation and Industrial Development. Recommendations for Mexico

Heri Oscar Landa Díaz[a]

[a] Universidad Autónoma Metropolitana-Unidad Iztapalapa, México.
Email address: hold77@hotmail.com

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Abstract

This study uses a fixed-effects panel model estimated by Generalized Least Squares (GLS) to examine the impact of participation in and position within global value chains (GVCs) on the productivity and competitiveness of 13 manufacturing subsectors in Mexico from 1995 to 2020. The results obtained indicate the following: i) Increased integration into GVCs contributes positively to industrial development, though the effects are limited when insertion is into sectors of low technological complexity; ii) The effect of foreign direct investment (FDI) is ambiguous, while strengthening absorption and innovation capacities is a determining factor. Therefore, an industrial policy promoting technological investment and strategic cooperation is necessary.

Keywords: industrial development; global value chains (GVCs); economic growth; innovation; panel model.

1. INTRODUCTION

In the mid-1980s, Mexico began a transition toward a new development model based on trade and financial openness. The goal was to correct the economic imbalances resulting from the import substitution industrialization model. This new phase required structural reforms to ensure macroeconomic stability, to boost non-oil exports, to increase manufacturing productivity and to achieve sustained growth.

However, the absence of an integral industrial and technological policy limited the internalization of the gains derived from the openness. While the open economy model (OEM) enabled control of inflation and public finances, as well as accelerated growth in exports and foreign direct investment (FDI), it also generated systematic imbalances in the trade balance, a slowdown in productivity and a loss of industrial linkages. This can be explained by the high content of imported inputs in exports, specialization in intermediate stages of global value chains (GVC) and the nature of the investment strategy of transnational companies, a combination that has created a condition of “outward industrialization.”

While the line of debate in theoretical literature has focused on modeling the positive effects of economic openness on innovation and product dynamics, it has also identified the biases that liberalization can introduce into the pattern of specialization and the nature of expected gains, especially in economies lagging behind in investment, technological development and institutional incentives. Added to this are the proposals of the “new” new theory of international trade, which suggest that offshoring drives economic activity, although these benefits critically depend on the position occupied within the GVCs (Crowe and Rawdanowicz, 2023; Li and Liu, 2018; Aghion and Howitt, 2009; Grossman and Rossi-Hansberg, 2008; Grossman and Helpman, 1991).

In light of the above, this study analyzes the impact of integration into GVCs on productivity, competitiveness and capital formation in the Mexican industrial sector during the period 1995-2020. The hypothesis is that greater participation in global manufacturing increases productivity, although these effects depend on the nature of the tasks performed and the level of local technological development (Crowe and Rawdanowicz, 2023; Li and Liu, 2018; Grossman and Rossi-Hansberg, 2008).

This study makes two contributions. First, it analyzes the impact of openness—via offshoring—on Mexico's manufacturing dynamics, identifying the actual gains that participation and position in GVCs generate in the industrial development of emerging economies. Second, it examines the role of local technological effort in the internalization of the flow of knowledge associated with incorporation into global production chains. The results indicate that Mexico's integration into GVCs has had a limited effect on industrial modernization, suggesting that, in a context of limited local productive capacities, offshoring tends to consolidate disparities in specialization patterns.

Following the introduction, the paper is organized as follows. The second section presents the theoretical discussion of the impact of international trade on productivity, employing a sectoral endogenous growth model. The third section provides a brief review of the empirical literature on the effect of integration in the GVCs on economic performance. The fourth section analyzes stylized facts and compares hypotheses. The fifth section presents the conclusions.

2. TRADE AND INDUSTRIAL EFFICIENCY. THEORETICAL ARGUMENTS

The theory of economic growth distinguishes between immediate and fundamental sources on the supply side. The first case refers to those variables associated with the accumulation of factors that generate externalities (human capital and R&D spending), which affect the productivity of traditional productive inputs and the level of efficiency of production lines (Acemoglu, 2009). In this context, endogenous models based on the ideas argue that, in the long term, product dynamics are determined by technological progress, which is formalized in production as a result of deliberate actions by companies that invest in human and technological capital in order to secure extraordinary profits (monopoly profits) based on product differentiation. This allows for a continuous process of innovation and, consequently, a sustained increase in productivity (Aghion and Howitt, 2009; Grossman and Helpman, 1991).

Meanwhile, fundamental sources are those variables that improve the capacity of economies to accumulate physical capital and factors that generate externalities, as is the case of the financial system, institutions and international trade. In theoretical discussions, the latter will boost productivity and income if and only if they can: *i)* increase the size of markets and the scale of production; *ii)* promote the diffusion of knowledge (producing externalities) from more advanced countries and sectors to less advanced ones, and *iii)* improve competition to the extent that the entry of foreign producers enhances the quality (vertical and horizontal) of goods and services (Aghion and Howitt, 2009; Grossman and Helpman, 1991).

This study is analytically based on an extended version of Aghion and Howitt's (2009) model of vertical innovation, trade openness and growth. In this respect, it begins by considering two countries: one local (semi-industrialized) and one foreign (industrialized) that differ in terms of population size and innovation promotion policies. It also assumes that the global market is monopolized by the innovative economy. By definition, the production function of the economy outside the technological frontier ( ) and of the industrialized country ( ) is represented by expressions (1) and (2), respectively:

$$Y_{it} = (A_{it}L_{it})^{1-\alpha} z_{it}^{\alpha} \qquad (1)$$

$$\bar{Y}_{it} = (\bar{A}_{it}\bar{L}_{it})^{1-\alpha} \bar{z}_{it}^{\alpha} \qquad (2)$$

Where Y, $\bar{Y}$, L, $\bar{L}$, z, $\bar{z}$, A and $\bar{A}$ represent the level of production of final goods, total labor employed (assumed to be constant) and the volume of intermediate inputs and average productivity (quality)[1] in sector *i* of the semi-industrialized and industrialized country during period *t*, respectively; while α captures the taste for variety (0 < α < 1). For simplicity, it is assumed that the degree of technological development of the local economy lags behind the technological frontier, such that $\bar{A}_{it} > A_{it}$.

Construction-wise, the average productivity level of sector *i* during period *t* of the semi-industrialized economy (A_{it})[2] is defined as follows:

$$A_{it} = \eta_{it}\varepsilon_{it}A_{it-1} + (1-\varepsilon_{it})A_{it-1} \qquad (3)$$

According to this expression, the current capacity for innovation in sector *i* will be defined by the size of the innovation (*η*),[3] the average productivity of the previous period (A_{t-1}) and the probability of its occurrence $(\varepsilon \in [0,1])$, which is assumed to be defined by:

$$\varepsilon_{it} = \left(\frac{(\delta_{it}\tau_{it}H_{it}I_{it})}{A_{it}^{*}}\right)^{\sigma} \qquad (4)$$

Where δ, τ, I, H and A_{it}^{*} represent, respectively, the efficiency of research activities, national policies that promote innovation, R&D spending, human capital and target productivity;[4] while $\sigma\ (\in [0,1])$ constitutes the aggregate sensitivity of the probability of innovating to changes in endogenous resources (positive elasticity) and technological difficulty (negative elasticity). As can be deduced, the probability of innovating is determined by the evolution of local capacities for technological absorption and innovation, the deepening of which will be the result of deliberate actions by companies and the market incentive framework (industrial/technological policy).

Solving the maximization problem for a local producer of differentiated inputs,[5] we find that, under conditions of trade liberalization, the equilibrium national income of the local economy (the sum of total wages, Wt, and profits, P t, in the economy) can be expressed as follows:

$$N_t = W_t^* + \Pi_t^* = \phi \int_0^1 A_{it} L_{it} z_{it}^{\alpha} + \theta \int_0^1 \gamma_{it} (A_{it} L_{it} + \bar{A}_{it} \bar{L}_{it}) \qquad (5)$$

As shown in equation 5, national income will increase as a result of greater availability of resources and access to the technological frontier; however, this effect will depend on the local industrial capacity to absorb and generate new knowledge (γ_{it} = 1). In other words, greater installed and technological capacity will allow for higher dynamic gains; otherwise, if γ_{it} = 0, the impact will be zero.

Furthermore, the expected net benefit of the research costs for the local industry (in the event of innovation) will be determined by:

$$\Gamma_{it} = \varepsilon_{it} \Pi_{it} - I_{it} = \varepsilon_{it} \theta \gamma_{it} (A_{it} L_{it} + \bar{A}_{it} \bar{L}_{it}) - \frac{\varepsilon_{it}^{\frac{1}{\sigma}} A_{it}^*}{\delta_{it} \tau_{it} H_{it}} \qquad (6)$$

According to equation 6, the share of profits derived from economic openness will be determined by the capacity for innovation of the local entrepreneur. Therefore, to the extent that they succeed in incorporating technological improvements, they will be able to appropriate an increasing share of the dynamic gains. In contrast, the absence of innovation will limit the benefits to the revenue generated in the domestic market, promote losses in competitiveness and restrict its effects on productivity.

Solving the optimization problem[6] of the local producer, we find that in the long term, the growth rate of per capita output[7] (g_y) will be determined by:

$$g_{y_{it}} = \left[\sigma \theta \gamma_{it} \left(L_{it} + \frac{\bar{L}_{it}}{a_{it}} \right) \delta_{it} \tau_{it} H_{it} \right]^{\frac{\sigma}{1-\sigma}} (\eta_{it} - 1) \qquad (7)$$

As formula 7 warns, in the long-term, the effect of international trade on the dynamics of output per worker will depend on the efficiency of R&D activities (δ), the stock of human capital (*H*), the magnitude of innovation η > 1, the distance to the technological frontier (a) and institutional incentives to innovate (τ). In other words, the effective internalization of productivity gains (technology spillovers) derived from trade openness requires the strengthening of local capacities for absorption, innovation and technological collaboration. Otherwise, when y_{it} = 0, the effect will be limited and pecuniary, generating biases in specialization patterns and industrial linkage capacity.

At this point, it is important to note that, since the 1990s, the impact of offshoring on productivity and the labor market has been a widely discussed topic in the theoretical literature. In this respect, the central hypothesis of the “new” new theory of international trade is that companies relocate or transfer part or all of their production line in order to adjust their cost structure, access natural resources and take advantage of the characteristics of the labor market, the flexibility of fiscal and trade policy, the size of the market and the technological development of the host economies. Consequently, offshoring tends to boost trade in intermediate inputs (which are cheaper and more technologically advanced and of higher quality),[8] export diversification, job creation, capital mobility (foreign direct investment (FDI)), diffusion of knowledge and specialization in specific GVC activities (Szymczak, 2024; Li and Liu, 2018; Grossman and Rossi-Hansberg, 2008).

However, theoretical debate also acknowledges that the magnitude and nature of the impact of offshoring on the economic activity of the host country will depend, among other factors, on its location within the GVC, its level of technological development, its industrial linkage capacity and the structure of its institutional incentives (Crowe and Rawdanowicz, 2023). The effects associated with international trade will be limited (of a pecuniary nature) to the extent that participation is concentrated in activities with low value added; in addition to promoting significant imbalances in the labor market and in the pattern of specialization (outward industrialization).

Based on the above, equation (7) is rewritten as follows:

$$\begin{aligned} ln y_{it} - ln y_{it-1} = \Omega_0 + \Omega_1 ln\kappa_{it} + \Omega_2 ln\delta_{it} + \Omega_3 ln\tau_{it} \\ + \Omega_4 lnH_{it} + \Omega_5 ln(\eta_{it} - 1) \end{aligned} \qquad (8)$$

According to equation 8, in the long term, greater integration into GVCs (k_{it}) will tend to positively affect sectoral output (y_{it}). It also suggests that sectors with high technological efficiency (δ_{it}; η_{it}), dynamic accumulation of human capital and strong institutional incentives to innovate (H_{it}) will tend to experience greater industrial growth.

3. GLOBAL VALUE CHAINS AND PRODUCTIVITY: A BRIEF REVIEW OF THE EMPIRICAL LITERATURE

Empirically, the prevailing hypothesis suggests that greater participation in GVCs generates significant productivity gains, diversification and sophistication, as a result of the accelerated commercial flow of inputs and capital. However, the results in the literature are mixed, partly due to measurement difficulties and the use of aggregate indicators that may under- or overestimate the actual effects of participation and position within GVCs.

In their analysis of 101 economies during the period 2003-2015, Coveri *et al.* (2024) identified an inverse relationship between offshoring and development, in which greater participation in GVCs deepens income inequality, especially in low- and middle-income countries. They also found a positive link between FDI and economic dispersion, but they noted that only FDI geared toward knowledge-intensive activities, human capital formation and technological infrastructure promotes industrial modernization.

In a study of 25 industries in 31 Chinese provinces during 2012, 2015 and 2017, Lu *et al.* (2024) found that greater integration into GVCs negatively effects wages, labor demand and labor productivity. In contrast, they observed that strengthening internal value chains (provincial and interprovincial) has a positive impact, as does investment in R&D and exports.

In another industry-level study for China covering the period 2000-2014, Fu (2023) shows that greater participation in GVCs generates significant commercial benefits, especially in capital- and technology-intensive industries. This same effect is observed when industries have high productivity and specialize in the initial stages of GVCs. The author also points out that increased FDI tends to drive industrial modernization.

Meanwhile, in an industry-level study of Indonesia, the Philippines and Vietnam between 2009 and 2015, Baek and Urata (2023) found that participation in GVCs only boosts productivity when local companies simultaneously strengthen their local links (both backward and forward). They also found that company size and quality certification are key determinants of total factor productivity (TFP), as well as evidence in favor of the self-selection hypothesis.

In a study of 40 countries in Africa, Latin America and Asia during the period 1993-2015, Rohit (2023) found inconclusive evidence on the effects of participation in GVCs on the production structure. Nevertheless, he identifies the accumulation of physical and human capital as a central factor in structural change and productivity growth. He also warns that persistent overvaluation of the real exchange rate leads to the reallocation of labor toward low-productivity activities.

In an analysis of 35 subsectors in 40 countries during the period 1995-2011, Tian *et al.* (2022) found that greater participation in global production networks has a positive effect on productivity and innovation, especially in dynamic manufacturing industries. Nevertheless, the results show that developing economies benefit more from backward participation in GVCs, whereas in industrialized countries, gains are greater with forward participation.

In a study of 3,090 Indian companies, Banga (2022) confirms that the deepening of GVCs promotes productivity, especially among firms with greater access to credit, higher levels of investment in R&D and greater capital accumulation. They also identify that business age and FDI boost TFP, while increased debt reduces it.

In another analysis, at the company level, of 18 emerging economies during the period 2006-2016, Rigo (2021) argues that participation in GVCs facilitates access to technology through licensing and promotes productivity gains, which drives industrial modernization, noting that offshoring generates greater dynamic benefits than simple forms of trade.

In a sectoral study for the Organization for Economic Cooperation and Development (OECD) covering the period 1995-2015, Yanikkaya and Altun (2020) found that integration into GVCs has a positive impact on value added and productivity dynamics, especially through backward linkages. They also point out that institutional quality is also a relevant factor in industrial development.

In a panel comprising 13 manufacturing industries and 40 countries during the period 1995-2011, Constantinescu *et al.* (2019) confirm that greater participation in GVCs and an increase in foreign value added incorporated into local production positively impact productivity. Their results also show that increased capital stock, together with increased imports of inputs and exports, stimulates industrial dynamics.

Empirical evidence based on data from 12 Italian industries during the period 2008-2013, provided by Brancati *et al.* (2017), confirms that the participation of local companies in GVCs tends to increase the probability of innovation, particularly in the case of non-innovative firms. Similarly, their results suggest that exports, human capital, company size and membership of corporate groups increase the likelihood of undertaking R&D projects.

After analyzing 39 subsectors in Mexico for the years 2003, 2008 and 2012, Dougherty and Reynaud (2017) concluded that the increase in exports of differentiated products strengthens backward linkages, though their impact on productivity is limited. They also found that industries with the highest integration into GVCs are technology-intensive sectors where FDI is positively associated with productivity. They also note that high backward participation, low forward linkage and regulatory barriers hinder industrial development.

The findings of Kummritz *et al.* (2017), from a study of 20 industries and 61 countries during the period 1995-2011, indicate that integration into global production networks tends to boost industrial dynamics. At the same time, they confirm that institutional quality (through economic regulation and intellectual property protection), FDI, financial deepening, local technological development and geographical proximity are relevant factors that explain the expansion of value added.

In their estimates in a study covering 19 eurozone countries during the period 1995-2011, Gunnella *et al.* (2017) found that offshoring generates technological knock-on effects on industrial activity, with dynamic subsectors acting as the diffusion channel. Furthermore, greater participation in GVCs has resulted in an increase in skilled labor and wages.

In a study of Argentina, Brazil, Chile and Mexico, calculations by Montalbano *et al.* (2016) found that participation and position in GVCs positively impact productivity. In this respect, they identify that if specialization occurs in the initial stages of the supply chain, the effect is more intense. They also found that FDI, local innovation capacity and fixed capital stock are important factors in determining the evolution of efficiency.

In their estimates based on data from 2,624 Canadian companies during the period 2002-2006, Baldwin and Yan (2014) show that offshoring generates significant productivity gains, especially in medium- and high-tech industries. Furthermore, they observe that while exports promote a permanent positive impact on efficiency, imports generate monetary gains.

4. SPECIALIZATION IN PRODUCTION, TRADE AND VALUE CHAINS

Industrial dynamics after opening up

During the 1980s, following the debt crisis of 1982, Mexico reformulated its economic growth and development strategy, which would be based on trade and financial liberalization. In general terms, it was projected that the OEM would allow for a sustained increase in productivity and, therefore, in output, and ensure an environment of macroeconomic stability, as it was assumed that increased exports and greater inflows of FDI, through the diffusion of knowledge and economies of scale, would lead to increased efficiency, strengthen the labor market and boost the investment rate, with the export manufacturing sector as the driving force behind this beneficial process.

However, after just over three decades of operation of the OEM, the results have fallen short of the projected goals. Although exports and FDI inflows grew significantly during this period, particularly during the early years of the North American Free Trade Agreement (NAFTA), it is also true that, during this same period, the Mexican economy was caught in a slow growth trap, characterized by declining productivity, stagnant investment rates and low innovation capacity. This has led to competitiveness being based more on wage deflation than on increased efficiency. Added to this is the systematic trade deficit, a consequence of the increase in the share of foreign value added in export production (see Table 1).

Table 1. Efficiency, trade and macroeconomic stability

Indicator	1990-2000	2001-2010	2010-2023
Gross Domestic Product 1/	3.6	1.2	1.7
Total Factor Productivity 1/	-0.4	-1.3	-0.2
Unit Labor Cost 1/	0.1	-2.3	-4.7
Capital Formation (% GDP) 2/	22.2	22.2	23.1
Exports 1/	12.9	3.4	4.7
VADX (% Exports) 2/	67.2	65.4	64.5
VAFX (% Exports) 2/	32.8	34.6	35.5
Trade Balance (% GDP) 2/	-1.5	-1.6	-1.4
Foreign Direct Investment (% GDP) 2/	1.8	2.7	2.6
R&D Expenditure (% GDP) 2/	0.3	0.4	0.4
Human Capital 1/	2.8	0.2	0.7
Triadic Patents 2/	8.6	17.1	20.5
Consumer Price Index 1/	18.3	4.7	4.4
Fiscal Balance (% GDP) 2/	-2.2	-2.1	-3.3
Public Debt (% GDP) 2/	29.9	24.0	42.9
Nominal Exchange Rate 1/	12.8	2.9	2.6

Notes: 1/ Average annual growth rate; 2/ Average value of the indicator; VADX: domestic value added incorporated into exports as a proportion of total exports of the economy; VAFX: foreign value added incorporated into exports as a proportion of total exports of the economy.

Source: Prepared by the author using information from the National Institute of Statistics and Geography (INEGI) (2024), the Ministry of the Economy (SE) (2024) and the Organization for Economic Cooperation and Development (OECD) (2024).

Indeed, during the period mentioned, Mexico has successfully controlled inflation, achieved fiscal discipline, reduced interest rate volatility and brought about an orderly adjustment of the foreign exchange market. However, it is also true that, over the last 10 years, the Mexican economy has experienced a progressive deterioration in its fiscal balance and debt size, which could significantly affect expectations regarding the benchmark interest rate, the price of financial assets, the cost structure and, consequently, inflationary dynamics.

The dynamics of the manufacturing sector exhibit characteristic patterns similar to those observed at the macroeconomic level, such as: *i)* slow growth in production and industrial efficiency; *ii)* limited expansion of capital investment; *iii)* restricted development of technological absorption and innovation capacity; *iv)* predominance of price competitiveness as an adjustment mechanism; *v)* limited incorporation of skilled labor, and *vi)* concentration of FDI inflows and export activity. These results are incomprehensible insofar as sectoral performance is mainly sustained by technology-intensive industries (automotive, computer equipment, electrical appliances, machinery and equipment, and chemicals), which, due to their operational nature, would lead to the appearance of gains in productivity and strengthen productive chains (see Table 2).

Table 2. Mexico: industrial dynamics, investment and competitiveness, 1990-2023

Industry	*VA*[1/]	*PL*[1/]	*K*[1/]	*CLU*[1/]	*I+D*[2/]	*CH*[1/]	*TIC*[1/]	*IED*[2/3]	*TX*[1/]	*PO*[1/]	*RM*[1/]
Food		1.7	1.7	-0.5	10.8	0.2	3.8	20.1	6.5	1.0	1.2
Textiles		1.5	-4.7	-1.0	3.5	-2.2	4.4	1.9	2.0	-1.8	0.5
Wood and paper		2.5	0.2	-1.1	2.0	-0.5	8.6	2.0	4.6	-1.3	1.4
Chemicals		1.5	-1.8	-0.4	20.7	-1.5	5.7	12.1	3.7	-1.2	1.1
Plastics and rubber		0.4	-0.6	1.3	3.4	2.4	3.7	4.7	6.1	1.8	1.7
Non-metallic minerals		2.5	2.6	-1.5	4.9	-0.5	4.3	2.3	5.0	-1.0	1.0
Base metals		1.5	5.7	-0.6	4.7	-0.5	9.2	6.1	7.2	-0.5	0.9
Metal products		0.9	0.3	1.5	7.5	0.5	6.9	1.8	5.9	0.5	2.4
Machinery and equipment		-0.7	3.9	0.9	3.7	2.1	7.9	3.7	5.9	1.9	0.2
Computers		0.3	-3.3	2.1	4.0	1.2	0.2	8.2	5.6	1.5	2.3
Electrical appliances		-0.2	2.2	2.5	9.3	0.1	4.5	4.7	5.0	0.7	2.2
Automotive		2.5	3.7	-1.2	23.7	2.5	3.4	29.4	9.3	3.4	1.3
Other manufacturing	2.3	1.7	-2.8	0.9	0.9	0.6	6.2	2.8	5.8	0.4	2.6

Notes: [1/] Average annual growth ratel; [2/] Share of total manufacturing; [3/] Data available from 1999 onwards. VA: value added; PL: labor productivity; K: net fixed capital stock; CLU: unit labor cost; R&D: research and development expenditure; CH: employed highly educated personnel; ICT: capital formation for Information and Communication Technologies; FDI: foreign direct investment (information available from 1999); TX: net taxes; PO: total personnel employed; RM: average real wages.

Source: Prepared by the author using data from the INEGI (2024), the Ministry of the Economy (2024), and the OECD (2024).

Undoubtedly, economic liberalization enabled the rapid expansion of the export manufacturing sector. However, this process has been insufficient to generate effective productivity gains, among other reasons, due to the high content of imported inputs in production lines and the sectoral position within GVCs (intermediate phases focused on assembly or maquila), especially in the case of dynamic industries (see Tables 2 and 3).

Table 3. Patterns of trade specialization in Mexican manufacturing

	Exports (1993-2023)		VADX		VAFX		GVC Participation		GVC Position	
	IC[1/]	PC[2/]	1995	2020	1995	2020	1995	2020	1995	2020
Food		4.8	67.0	75.9	33.0	24.1	33.4	24.4	-0.281	-0.213
Textiles		3.0	70.2	68.5	29.8	31.5	30.0	31.6	-0.259	-0.273
Wood and paper		0.9	66.5	61.4	33.5	38.6	33.7	38.7	-0.287	-0.326
Chemicals		3.8	73.9	55.0	26.1	45.0	26.6	45.5	-0.227	-0.366
Plastics and rubber		2.1	65.9	60.3	34.1	39.7	34.2	39.8	-0.293	-0.333
Non-metallic minerals		1.2	65.9	67.8	34.1	32.2	34.2	32.3	-0.292	-0.278
Base metals		4.4	62.5	72.2	37.5	27.8	37.9	28.6	-0.314	-0.237
Metal products		3.3	60.2	56.8	39.8	43.2	39.9	43.4	-0.334	-0.357
Machinery and equipment		7.7	59.9	55.6	40.1	44.4	40.6	45.0	-0.332	-0.361
Computers		22.7	38.6	29.3	61.4	70.7	62.5	71.4	-0.468	-0.528
Electrical appliances		8.6	60.3	55.2	39.7	44.7	39.9	45.0	-0.333	-0.367
Automotive		33.1	51.4	53.1	48.6	46.9	50.1	48.7	-0.381	-0.367
Other manufacturing	8.0	4.3	65.9	57.8	34.1	42.2	34.2	42.4	-0.292	-0.350

Notes: [1/] Average annual growth ratel; [2/] Average value of the indicator; IC: trade intensity; PC: trade composition; VADX and VAFX represent, respectively, the domestic and foreign value added incorporated in exports as a proportion of total exports in the subsector; PACGV and POCGV measure, in that order, participation and position in GVCs. Data available in the OECD's Trade in Value Added only up to 2020 at the time of the analysis. Source: Prepared by the author using data from the INEGI (2024) and the OECD (2024).

While the stylized facts show that trade and financial liberalization promote export activity and macroeconomic stability, they also show that this dynamic steers the national productive apparatus toward a process of outward industrialization. This process is characterized by the dismantling of internal linkage capacity, wage deflation as the basis for competitiveness and a significant lag in the rate of innovation (associated with low private-sector investment). Factors explaining this shift in the manufacturing sector include the ineffectiveness of industrial policy in creating effective market incentives, the nature of the FDI corporate strategy, trade concentration (export destination) and credit restrictions on investment in intangible assets.

Methodological Aspects

Hypothesis testing regarding the impact that the deepening of GVCs has on industrial dynamics is carried out using a panel data model. Thus, the stochastic specification of equation (8) is expressed as follows:

$$y_{it} = \alpha_{it} + \beta h_{it} + \varepsilon_{it} \quad (9)$$

Where y_{it} represents the dependent variable for each specification (*pl*: labor productivity; *TFP*: total factor productivity; *clu*: unit labor costs; *k*: fixed capital stock), while h_{it} constitutes a vector of *k* x 1 explanatory variables (*pacgv* and *pocgv*: participation and position in GVCs; *agid*: technological capital stock; *ch*: highly educated workers; *aied*: FDI stock; *tx*: net taxes). α_{it} and ε_{it} represent the vectors of the intercept—of *n* parameters—and random disturbances, respectively. The sub-indices *i* and *t* represent the subsector and time, respectively (see the description of variables in Table A5 of the Appendix).

According to the literature (Baltagi, 2021), models based on panel data information are interpreted based on their error component (*one-way* or *two-way*), which is broken down as follows:

$$\varepsilon_{it} = v_i + \Theta_t + u_{it} \quad (10)$$

In this expression, v_i represents the unobservable heterogeneity that varies only between study units; Θ_t represents unobservable effects that change only over time and u_{it} is the purely random error term. Assuming that ($\Theta_t = 0$, function (9) is restricted to the following specifications: *i)* grouped data, *ii)* fixed effects, and *iii)* random effects. Finally, the Hausman contrast is used to determine the most appropriate panel specification.

Meanwhile, according to Baltagi (2021), if regressions produce non-spherical errors (i.e., if the variance and covariance matrix is no longer scalar), then function (9) will be estimated using the Generalized Least Squares for Panel (GLSP) method, which is consistent with the assumptions and properties of the classic linear regression model, i.e.:

$$\hat{\beta}_{MCGP} = \left[X^T \hat{\Omega}^{-1} X\right]^{-1} X^T \hat{\Omega}^{-1} y \qquad (11)$$

Empirical evidence suggests that the parameters associated with participation and position in GVCs are positive and statistically significant, which would validate our approach based on endogenous growth theory. According to this theory, economic openness via offshoring drives industrial efficiency and competitiveness. This occurs to the extent that incorporation into global manufacturing production improves the capacity of businesses to accumulate factors that generate externalities, promotes technological diffusion and economies of scale, facilitates access to new varieties of (higher quality) inputs and guarantees modern management mechanisms. Similarly, domestic accumulation of human and technological capital is expected to stimulate industrial dynamics, which would validate the hypothesis that economic liberalization does not generate automatic gains. This is because the effective internalization of the international flow of knowledge will depend on the development of local absorption and innovation capacities (Aghion and Howitt, 2009; Grossman and Rossi-Hansberg, 2008; Keller, 2004; Grossman and Helpman, 1991).

Analysis and interpretation of results

The study compiles annual data from 13 manufacturing subsectors in Mexico during the period 1995-2020 regarding value added, hours worked, TFP in R&D, net capital stock, domestic and foreign value added contained in exports, remuneration, domestic value added incorporated into exports from third countries to a second destination, highly educated workers, FDI and exports. The information was compiled using statistical databases from the National Institute of Statistics and Geography (INEGI), the Ministry of the Economy (SE) and the Organization for Economic Cooperation and Development (OECD).

Analytically, first, the best panel specification was determined using the Hausman procedure. Second, the residuals of the estimated models were checked for problems of heteroscedasticity, serial correlation and/or autocorrelation using Wald, Pesaran and Wooldridge contrasts, respectively. Third, the MCPG method was used to ensure efficient and consistent parameters (see Appendix Table A1).

Overall, the estimates indicate that offshoring has had a positive impact on industrial efficiency and competitiveness in Mexico, as well as on physical capital accumulation (see Table 4). These results are consistent with the argument that joining global production networks promotes productivity modernization in host countries, insofar as this process favors: *i)* the diffusion of knowledge (by learning through practice, the acquisition of technology licenses or technical assistance), *ii)* access to new varieties of inputs, *iii)* increased inflow of FDI, and *iv)* specialization in specific activities within GVCs (Li and Liu, 2018; Grossman and Rossi-Hansberg, 2008).

Table 4. Impact of GVCs on industrial dynamics, 1995–2020

Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
	$pl^{1/}$	$pl^{1/}$	$ptf^{1/}$	$ptf^{1/}$	$clu^{1/}$	$clu^{1/}$	$k^{1/}$	$K^{2/}$
Constant	6.6647	4.5641	2.9922	3.0988	5.0881	6.9593	13.4068	6.3707
	[0.000]*	[0.000]*	[0.000]*	[0.000]*	[0.000]*	[0.000]*	[0.000]*	[0.000]*
pl_{t-1}	0.1219	-0.1329	-	-	-	-	-	-
	[0.298]	[0.316]						
ptf_{t-1}	-	-	0.3672	0.3386	-	-	-	-
			[0.000]*	[0.000]*				
clu_{t-1}		-	-	-	0.1162	0.0692		-
	-				[0.230]	[0.538]	-	
pacgv	0.1135	0.1212	0.0065	0.0109	-0.0611	-0.0597	0.0859	0.1218
	[0.000]*	[0.000]*	[0.001]*	[0.062]**	[0.011]*	[0.013]*	[0.006]*	[0.000]*
pocgv	0.1602	0.1727	0.0089	0.0145	-0.0847	-0.0868	0.1089	0.1627
	[0.000]*	[0.000]*	[0.002]*	[0.095]**	[0.012]*	[0.012]*	[0.013]*	[0.000]*
ch	-	-0.0590	-	0.0576	-	-0.1406		0.1380
		[0.518]		[0.027]*		[0.117]	-	[0.037]*
agid		0.1034	-	0.0019	-	-0.0569	-	0.2000
	-	[0.000]*		[0.834]		[0.038]*		[0.000]*
aied	-	-0.0470	-	-0.0083	-	0.0413	-	0.0828
		[0.195]		[0.155]		[0.179]		[0.060]**
tx	-	0.0706	-	0.0374	-	-0.0996	-	-0.0468
		[0.000]*		[0.001]*		[0.000]*		[0.228]

Notes: $^{1/}$ fixed effects panel specification; $^{2/}$ random effects panel specification; estimates based on Generalized Least Squares for Panel; regressions are based on a balanced panel and under the assumption of heterogeneity of individual units; indicators are expressed in natural logarithms: pacgv, participation in GVCs; pocgv, position in GVCs; ch, human capital; agid, technological capital; aied, FDI stock; tx, net taxes; *significant at 5%; **significant at 10%; p-values are reported in parentheses.

Source: Prepared by the author using data from the OECD (2024), SE (2024) and INEGI (2024).

While participation in and position within GVCs promote a positive effect on industrial development, the estimated coefficients are not elastic. One possible explanation for this result lies in the characteristics of the modernization and trade integration process of the manufacturing sector, namely: *i)* specialization in tasks with low value added contribution; *ii)* a decline in innovation capacity (in terms of size and efficiency); *iii)* low participation of local supply networks (limited production chain power); and *iv)* restricted absorption of skilled labor. The combination of these conditions not only limits the effective internalization of technological externalities derived from economic liberalization but also places price-based competitiveness as the determining factor of productive and commercial specialization.

Meanwhile, the regressions reveal that the accumulation of technological capital stimulates the performance of productivity and gross fixed investment in the manufacturing sector. This is consistent with the hypothesis that economies (industries) with high rates of innovation will tend to experience rapid growth in output and investment rates as the variety of available goods and inputs increases due to higher R&D spending, particularly on applied and experimental research activities (Grossman and Helpman, 1991). One relevant aspect of these calculations is the reduced value of the obtained parameters, which could be explained by the low investment (and participation) of the private sector in technological development. On average, manufacturing industries invest only 0.36% of their value added in R&D. Although this represents around 65.3% of national investment made by companies, it also constitutes only 30% of the country's total expenditure on innovation. These conditions demonstrate that the expansion of the manufacturing sector relies on price competitiveness, relegating product differentiation—both vertical and horizontal—as an industrial development strategy.

In terms of absorption capacity, estimates suggest a positive (albeit partial) relationship between highly educated labor and industrial development indicators. This result is consistent with the proposition that industrial sectors that progressively integrate highly skilled workers will tend to experience a sustained increase in the rate of innovation and product growth, to the extent that the accumulation of human capital allows for efficient processing (decode, assimilate and apply) of the flow of knowledge and the creation of new technological combinations (Vandenbussche *et al.*, 2006). However, the low participation of skilled workers (10.7% of total personnel employed in the manufacturing sector) not only helps to explain the marginal effect on industrial dynamics but also allows for debate on the inadequacy of the productive network to internalize the dynamic gains associated with economic openness.

Regarding capital flow, regressions show that FDI has a limited effect on industrial development because there is no evidence of productivity gains. One possible explanation for this result could be the nature of the corporate strategy of transnational companies and in the type of investment, which focuses on tasks with low added value, establishing export platforms and acquiring pre-existing assets.

Finally, although the calculations suggest the persistence of a positive relationship between tax policy and the efficiency/competitiveness of the manufacturing sector, they also show that the magnitude of the effect is reduced. This result indicates that the operation of a disjointed fiscal scheme tends to slow productivity and the rate of innovation by reducing the return on investment. Consequently, companies take fewer risks in acquiring infrastructure and capital assets, particularly technological ones.

Overall, these estimates align with the results of other studies suggesting that participation in GVCs has limited effects on productivity and industrial development when recipient countries engage in low-tech activities and lack institutional incentives (Coveri *et al.*, 2024; Lu *et al.*, 2024; Rohit, 2023). In this respect, Dougherty and Reynaud (2017) emphasize that insertion into GVCs does not automatically generate positive effects. They explain that offshoring also tends to consolidate productive structures based on wage deflation with excessive dependence on imported inputs, greater vulnerability to external shocks and limited technology transfer.

5. CONCLUSIONS

This paper examines the effect of integration into the GVCs on industrial dynamics in 13 manufacturing subsectors in Mexico during the period 1995-2020. To this end, the analysis is based on the propositions of the trade liberalization and vertical innovation model developed by Aghion and Howitt (2009), as well as the “new” new international trade theory (Li and Liu, 2018; Grossman and Rossi-Hansberg, 2008).

The analysis of stylized facts reveals that, despite sustained growth in exports and rapid integration into global manufacturing production, Mexico’s manufacturing sector faces a systematic decline in productivity, accompanied by low productive chain power and a significant lag in its capacity for innovation. This combination of factors has consolidated a pattern of outward-oriented industrialization. The results of the empirical comparison confirm that greater integration into GVCs positively affects industrial efficiency and competitiveness. Nevertheless, the magnitude of these effects is limited, probably due to the position of Mexican manufacturing within GVCs, predominantly in tasks of low technological complexity—intermediate stages of the production process.

In view of the above, it is essential to implement an industrial policy aimed, among other objectives, at strengthening: *i)* private investment in technological assets, supported by development banks and fiscal mechanisms; *ii)* strategic cooperation between higher education institutions and the production sector, particularly with small and medium-sized businesses; *iii)* the efficiency of national supply chains, through co-investment schemes in infrastructure and information technologies; and *iv)* productive and technological coordination between transnational companies and local firms, taking advantage of localization benefits. The integration of these elements could facilitate a transition process within GVCs toward activities of greater technological complexity and the more efficient internalization of productivity gains resulting from economic openness. Future research should delve deeper into the impact of offshoring on internal linkages and cluster formation in emerging economies.

APPENDIX

Econometric diagnostic tests

Table A1. Hausman test

Statistics	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
chi2	48.03	44.52	31.79	24.69	33.25	31.56	6.35	9.29
prob > chi2	[0.000]	[0.0000	[0.0007]	[0.009]	[0.0000]	[0.0000]	[0.0418	[0.1581]

Note: Ho: The difference in coefficients is not systematic.

Source: Prepared by the author.

Table A2. Heteroscedasticity test

Statistics	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
chi2	795.56	1149.88	483.30	376.55	216.00	490.81	1255.61	1020.00
prob > chi2	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

Note: Ho: Variance is constant for all i.

Source: Prepared by the author.

Table A3. Autocorrelation test

Statistics	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
chi2	185.468	11.847	55.045	45.819	161.211	152.363	688.390	670.978
prob > chi2	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

Notes: Ho: No autocorrelation exists.

Source: Prepared by the author.

Table A4. Contemporary autocorrelation test

Statistics	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
chi2	10.829	11.847	14.283	9.831	17.567	10.228	16.508	3.208
prob > chi2	[0.0001]	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0000]	[0.0013]

Notes: Ho: No autocorrelation exists.

Source: Prepared by the author.

Table A5. Description of variables

Indicator	Formulation	Description
Labor Productivity	$pl = \frac{VA}{HT}$	VA: domestic value added at constant prices. HT: hours worked.
Total Factor Productivity	ptf	The index is constructed based on data reported by INEGI.
Unit Labor Cost	$clu = \frac{RM}{PL}$	RM: average remuneration at constant prices. PL: labor productivity.
Fixed Capital Stock	k	Corresponds to the net capital stock estimated by INEGI (at constant prices).
Participation in GVCs	$pacgv = \frac{VFX + VDXF}{X}$	VFX: foreign value added incorporated into domestic exports. VDXF: domestic value added incorporated into intermediate goods re-exported by the partner country to a second destination. X: total exports. The calculation is carried out following the procedure of Koopman et al. (2014).
Position in GVCs	$pocgv = ln\left(1 - \frac{VDXF}{VFX}\right)$	
Human Capital	ch	The indicator represents the total number of highly educated workers.
Technological Stock	$agid_t = (1 - \delta)agid_{t-1} + gid_t$	agid: measures the stock of investment in R&D (at constant prices). gid: represents expenditure on R&D (at constant prices).
FDI Stock	$aied_t = (1 - \delta)aied_{t-1} + ied_t$	aied: FDI stock (at constant prices). FDI: foreign direct investment flow (at constant prices).
Net Taxes	tx	Net taxes at constant prices.

Source: Prepared by the author.

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[1] In both production functions, technical progress is assumed to be neutral as defined by Harrod, which allows labor productivity to increase while the capital-output ratio remains constant.

[2] According to Aghion and Howitt (2009), the level of productivity at the global technological frontier for industry *i* during period *t* is defined by the following equation: $\bar{A}_{it} = (g_f + 1)\bar{A}_{it-1}$. According to this expression, the capacity for innovation in the industrialized economy will expand at a constant rate, allowing innovative industries to maintain a continuous process of innovation and, with it, their market power (extraordinary profits).

[3] This refers to the impact generated by an innovation (radical or incremental) and the speed of technological progress.

[4] This expresses the productivity of a new intermediate product that will emerge if the research is successful. Its inverse relationship with the probability of innovation is because, as technology advances, it becomes more complex and therefore more difficult to improve; thus, it is not the absolute amount of R&D spending that leads to success in the innovation process (Aghion and Howitt, 2009). In other words, the higher the current productivity (closer to the frontier), the smaller the leaps in innovation, the more costly and risky they are and therefore the lower the expected benefit and probability of innovation. For simplicity purposes, the variable is treated as an observable exogenous process.

[5] This is obtained by optimizing the benefits of the local (foreign) producer with respect to the global demand for intermediate inputs, i.e., we obtain $\frac{\partial \pi_{it}}{\partial z_{it}} = 0$. Therefore, in equilibrium, the aggregate profits of the local economy will be equal to $\Pi_t = \theta(A_{it}L_{it} + \bar{A}_{it}\bar{L}_{it})$, , while the aggregate wage income will be $W_t = \phi A_{it}L_{it}z_{it}^{\alpha}$; with $\theta = \alpha(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}$ and $\phi = (1-\alpha)$

[6] In other words, the combined payment of the production sector for intermediate inputs $\frac{\partial \Gamma}{\partial \varepsilon} = 0$ is maximized to obtain the equilibrium value of the probability of innovating and, thus, approximate the rate of productivity growth $g_A = \frac{A_t - A_{t-1}}{A_{t-1}}$.

[7] In equilibrium, per capita output is equal to $y_{it} = \gamma^{\frac{2\gamma}{1-\gamma}}A_{it}$, therefore its long-term growth rate is equal to $g_y = g_A$.

[8] At least three types of flows can be identified: *i)* imports of inputs that are processed and consumed in the local economy; *ii)* imports of intermediate goods that are processed and re-exported elsewhere; *iii)* exports of inputs to another country for processing and subsequent re-importation by the economy of origin.