Journal of Economics and Development Studies
September 2015, Vol. 3, No. 3, pp. 87-104
ISSN: 2334-2382 (Print), 2334-2390 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jeds.v3n3a8
URL: http://dx.doi.org/10.15640/jeds.v3n3a8

Productivity Determinants: The Impact of Structural Change in Mexico (1990-2012)

Lilia Domínguez-Villalobos[1] & Flor Brown-Grossman[2]

Abstract

This paper aims to explain productivity as a product of macro and microeconomic factors.between 1990 and 2012 in labor productivity growth. We have estimated a dynamic panel model for 62 sectors in Mexico's economy, using the methodology developed by Arellano and Boyer (1995) and Blundell and Bond (1998). We compare Mexico to a selected group of countries having a similar level of development in the mid-1970s and having now advanced toward the new technological paradigm, and we show that structural change has been slow in Mexico and its economic structure continues to be based on previous technological paradigms, with particular emphasis on supplier-dominated and scale-intensive sectors, despite some promising but still incipient changes. Our econometric results demonstrate the importance of investment in physical and human capital as well as the influence of the macroeconomic environment with a noticeable impact of trade opening in the manufacturing productivity. From a microeconomic point of view our results show that the effect of science based and specialized suppliers is important for productivity increase, while that of supplier dominated branches which account for a one third share is negative. Another relevant result is that using information and comunication technologies technologies is not significant while producing them is. Colleagues

Keywords: Productivity, structural change, technical change and dynamic panel

JEL: O11, O11, O33, C5

1. Introduction

Following the debt crisis in 1982, and under the guidance of what would eventually be referred to as the Washington Consesus, Mexico underwent a change in economic policy in order to foster more competitive market behavior and efficiency, shifting emphasis away from industrial policy measures. After 1988, but even more so after 1994, foreign trade expanded rapidly, consolidating a trade pattern in which the proportion of manufacturing exports in relation to total exports rose from 24.3% in 1982, to 85% in 1997, then slightly decreasing to around 80% in 2012 (INEGI). However, the growth of both labor productivity (LP) and total factor productivity (TFP) has been disapointing: while LP increased by more than 3% between 1960 and 1980, its average growth rate has been around 1% during the last 20 years, andthe average TPF was a dismal -0.39 between 1991 and 2011. This paper aims to explain productivity growth determinants in Mexico following a micro-macro approach. From a macroeconomic point of view,most analyses of productivity determinants tend to neglect demand, the prime benefit of which may be the stimulation of investment and technological change (Cornwall & Cornwall, 2002; Saviotti & Pyka,2013).Evidence of the importance of demand has been provided by many researchers, including Venables and van Wijnbergen (1993), Cornwall and Cornwall (2002), andCaballero and Lopez (2013). Trade, however, has received more attention as a determinant of productivity.

[1]Faculty of Economics, National Autonomous University of Mexico(UNAM), Olivarito 39, Alvaro Obregón, México DF 01780. Email: ldv@unam.mx
[2]Faculty of Economics, National Autonomous University of Mexico(UNAM),Fujiyama 98-3, Alvaro Obregón, México DF 01710. Email: brown@unam.mx

Consideration is given, on the one hand, to this variable that reflects the institutional system (Chen & Dahlman, 2004), a carrier of knowledge or technology (Isaksson, 2002) and a means of technology transfer (Cameron, Proudman & Redding, 1999). On the other hand, analysis for developing countries emphasizes the degree of openness from the removal of obstacles to market functioning(Eslava, 2004).A number of analyses have explained productivity determinants in the case of Mexico, depicting variables that are essential as explanations for the growth of productivity. Some have assessed the role of trade liberalization (Clavijo, 1992; Fragoso, 2003; Venables & Van Wijnbergen 1993). Others have examined the effects of the quality of labor, labor conditions and human capital on productivity (Brown, Domínguez & Mertens 2007; Casanueva & Rodríguez, 2009) or have highlighted the profile of high-productivity establishments. And still others have evaluated whether or not NAFTA has resulted in a productivity catch-up for Mexico in relation to the United States (Easterly, Fiess & Lederman, 2003; Tadashi, 2010). Indeed, the opening in trade is an important factor to consider, together with human and physical capital. However, the role of structural change in productivity has been neglected, most likely due to the limited number of years studied. An exception to the latter is a recent paper by Cruz (2014), who analyzes the impact of the deindustrialization of the Mexican economy on the growth process and an increase in productivity. On the supply side, we are particularily interested in analyzing structural changes and the role of technical innovations between 1990 and 2012 in labor productivity growth. There are some questions that have not yet been answered with regard to the sources of productivity growth. First of all, during a period of consolidation of economic reforms, we are interested in examining the impact on productivity by branches with higher technological content. In order to identify economic structures from the perspective of the new technological paradigm based on information and comunication technologies (ICTs) and science (Dosi, 1982), we classified economic sectors in accordance with the taxonomies developed by Tidd, Bessant and Pavitt.We are also intrigued by the influence exerted by new high-tech services and industrial branches, for which we have classified sectors according to the share of ICT capital in total capital and have distinguished ICT producers from ICT users.

A number of articles published recently have analyzed productivity determinants using dynamic panels for a group of countries, and the results are clearly of great interest. However, in our opinion, due to the heterogeneity of the countries studied, the implications from the findings cannot be translated into policies for all of the countries. In fact, conducting a more in-depth analysis of a single country may provide more insight for making policy recommendations. Using methodology developed by Arellano and Bover (1995) and Blundell and Bond (1998), we have estimated a dynamic panel model with two samples: the first for 62 sectors in Mexico's economy, and the second for 22 sectors in the manufacturing industry. From a detailed observation of Mexico's economic structure, we observe that an internal readjustment in the country's industries and services has occurred, and is consistent with the emergence of new activities detected by several studies (Brown & Domínguez, 2013; Carrillo & Hualde, 2013; Casalet, 2013). Nevertheless, our results show that when Mexico is compared to a selected group of countries having a similar level of development in the mid-1970s and having now advanced toward the new technological paradigm, structural change has been slow in Mexico and its economic structure continues to be based on previous technological paradigms, with particular emphasis on supplier-dominated and scale-intensive sectors, despite some promising but still incipient changes. Our econometric results demonstrate the importance of investment in physical and human capital as well as the influence of the macroeconomic environment with a noticeable impact of trade opening in manufacturing productivity. From a microeconomic point of view our results show that the effect of science based and specialized suppliers is important for productivity increase, while that of supplier dominated branches which account for a one third share is negative. Another relevant result is that using ICs technologies is not significant while producing them is.After this introduction, we will now present a brief overview of the literature, followed by a characterization of Mexico's economic structure, in a comparison with a group of other countries and an analysis of stylized facts. The fourth section of this paper presents the results of our dynamic panel analysis, followed by our conclusions.

2. Productivity and Structural Change: An Overview of the Literature

In the study of economic growth, two schools of thought can be distinguished with regard to the role of the sectoral composition of economies. On the one hand, the neoclassical view traditionally ignored the relationship between output sectoral composition and growth (Solow, 1956). Instead, it considered economic structure as something already established, and thus examined its equilibrium trajectory over time. Thus, macroeconomic and microeconomic interactions, or the process of the creation and destruction of capacities for productive organization, have been disregarded(Jorge Katz, 2007).

On the opposite side, another line of research investigating the role of economic structure seeked to explain the development process through successive changes from the predominance of agriculture to industrialization and tertiarization due to demand and supply factors (Salter, 1960; Pasinetti, 1981). Authors such as Hirshman (1987), as well as the Latin American school of thought headed by Raul Prebish at the Economic Commission for Latin America (ECLAC), maintained that changes in the economic structure of economies are an important ingredient for growth. In particular industrialization was considered as a propeller of the growth process because of the input-output linkage effects of manufacturing within itself, among other reasons. As a corollary, deindustrialization would simply reverse the chain of events (Cripps & Tarling, 1973; Kaldor, 1966).In the mid-1970s interest in development waned as attention turned to the search for efficiency in economies and the need to allow the market to do its job in order to have sustained growth. The neoclassical perspective mostly overshadowed other approaches, with some exceptions such as the endogenous models of growth identified by Romer (1990) and Aghion and Howitt (1992), and the emergence of the neo-Schumpeterian school of thought, as expressed by Nelson and Winter (1982), Dosi (1982), Freeman (1997) and Saviotti and Gaffard (2004). The slow-down in productivity in the European Union and disenchantment with neoliberal policies in emerging economies have brought about a revival of interest in analysis of economic structure, evident in Dietrich (2012), Fagerberg (2000), Katz (2007), Rowthorn and Ramswami (1997), Ros and Moreno (2009), Timmer, Inklaar, O'Mahony and Van Ark (2010), Cruz (2014) and Wood (1995).

Some authors have distanced their work from a traditional three-sector (primary, industry and services) approach to economic structure, in favor of more detailed analyses pondering more specific differences within them(Fagerberg, 2000; Katz, 2007; Aravena, Fernandez Hofman and Mas, 2014; Silva and Teixeira,2010). Specifically, in the neo-Schumpeterian approach, the specific practices of innovation and technological trajectories of each sector are considered to be key aspects behind these differences in long cycles identified under technological paradigms. The technological paradigm emerging from the 1970s is based on advances in microelectronics and information and communication technologies and innovations characterized by strong interactions with science. An enlightening study was conducted by Silva and Teixeira (2010), who attempted to provide evidence for the role of technology-led branches in relation to the emergence of the microelectronic and ICT paradigm. The study specifically considered less-developed countries that could catch up and benefit from adopting new technologies. The authors analyzed the characteristics of the economic structure in 21 countries, during a period between 1979 and 2003, using three taxonomies as references. The first taxonomy is the modified Pavitt`s taxonomy which distinguishes five sectoral categories according to the competences of innovating firms and their gradual scale of technological opportunities: supplier-dominated refers to traditional sectors such as the footwear and textile sectors, firms in these sectors innovate through the renewal of equipment or machinery; in scale-intensive sectors their innovation implies taking advantage of scale economies (mass production industries like the chemical, food or cement industries), specialized suppliers include capital goods where innovation implies a close relationship between producers and customers, science-based sectors exploit new scientific discoveries; information-intensive sectors[3] have as their source of innovation advanced data processing for example banking, insurance or retailing (Archibugi, 2001).

The next taxonomy(Peneder, 2007) classifies sectors of the economy by their skill requirements as very low, low, intermediate low, intermediate, intermediate high and high. And the last taxonomy (Robinson, 2003) classifies sectors as goods and services producing, or ICT using or none.[4] The authors found a high level of robustness in many of the variables used to reflect the direction of structural change according to the selected technological and skill industry categories. The increase in the share of high-skill industries results in a productivity growth bonus, whereas the opposite occurs with respect to low-skill industries. The positive effect from skills and technology-intensive industries on productivity growth, controlling for the influence of other variables that might also influence growth, and particularly its strong impact, provides empirical support for their assumption, according to which substantial benefits have been obtained by countries that successfully changed their structure toward more technologically-advanced industries.

[3]The last two categories were introduced by Tidd, Bessant & Pavitt, 2005

[4] Non ICT other, non ICT manufacturing, non ICT services, ICT producing in the manufacturing sector, ICT using, manufacturing sector, ICT producing in the service sector, and ICT using in the service sector.

Moreover, the fact that ICT-producer industries in the manufacturing sectors have a strong impact on productivity growth seems to be in global agreement with the conceptualizations of the techno-economic paradigm developed within the neo-Schumpeterian streams of research. In summary the literature on structural change is characterized by differing proposals for analyzing economic structures, ranging from the traditional classification of agriculture, industry and services, to classifications that seek to grasp the evolution of technological change, whether in terms of the skills required, or the opportunities for innovation, or the relationship with information technologies. One point in common in these analyses is evidence on the importance of structural change for growth. Nevertheless, most of these analyses tend to be focused on supply—but this is unacceptable, particularly when analyzing extended periods of time, in which case it is essential to consider demand as a determining factor in productivity. We have chosen to follow this neo-Schumpeterian line of research in our work detailed here. While it has already been applied in Mexico by several authors (Capdevielle, 2004; Dutrénit, 2010; Dutrénit, 2000; Dutrenit & Capdevielle,1993; Vera-Cruz, 2004), it has not received enough attention in the analysis of productivity determinants.

3. Mexico's Economic Structure, 1990-2012

We intend in this section to examine the characteristics of Mexico's growth process and the evolution of its economic structure *vis a vis* various groups of countries for which we use the valuable information on 21 countries from Silva and Teixeira (2010) for the period between 1979 and 2003 for our analysis. In spite of the difference in periods, we think this exercise is justified since as is well known, the 1980s were years of hard economic adjustments and low growth for Mexico and other Latin American countries, leading some scholars to refer to the 1980s as the "lost decade" (González, 1986). Thus it was only after the 1990s that changes in economic structures took place in the region, much later than in other emerging countries. Silva and Teixeira separated a cluster of 12 highly-developed countries, specifically Germany, the UK, Belgium, Australia, Canada, Sweden, the United States, Denmark, Sweden, France, Norway and the Netherlands (referred to as Cluster II), characterized by high levels of education and per capita income as well as relatively higher shares of innovative and high-skill industries, and then a more heterogeneous cluster formed by relatively less-developed countries, specifically Portugal, Spain, South Korea, Greece, Austria, Ireland, Finland, Italy, Taiwan and Japan (referred to as Cluster I). As the authors say, there is greater dispersion within Cluster I, most particularly with regard to the ICT-producing categories and to the per capita income variable. Countries in Cluster I such as Austria, Finland, Italy and Japan present considerably higher values for the income variable, close to the average value found for the countries included in Cluster II. Nevertheless, the economic structure of one subgroup (a) in Cluster I is characterized by greater reliance on supplier-dominated industries and weaker relevance of high-skill industries comparatively to the highly-developed countries. The second subgroup (b) within Cluster I, that is, Spain, Ireland, Portugal, Greece, South Korea and Taiwan, was far behind at the outset of the period, but most of these countries were involved in a catching-up process. So the question is what is the standing of Mexico in front of these groups in relation to education, income per capita, productivity growth and structural change.

First of all, it is important to note that at the beginning of the period under analysis, Mexico started out with only six years of schooling on the average, below all the countries in the sample.[5] The education gap was -4.6 years on average in relation to developed countries (Cluster II). In 2011 average schooling increased by 37.5% and the gap diminished to a level of -2.9 years with an improvement of 1.7%, above that for nearly all the countries analyzed. Nevertheless, this effort was not sufficient to close the gap in relation to other countries (-0.4 years for subgroup (a), and 2.5 years for subgroup (b)).

[5]In addition the illiteracy rate decreased by nearly half, from 12.4% to 6.4%, in the population between 25 and 64 years of age.

Table 1: Average number of years of formal education in the working age population (25–64 years): Mexico (1990-2011), selected countries (1979–2003)

	Average years			Education gap		
	1979	2003	%	1979	2003	%
Cluster II						
Average Cluster I	10.60	12.3	16.0			
subgroup a						
Austria	10.3	12.2	18.4	-0.3	-0.1	0.2
Finland	9.5	12.5	31.6	-1.1	0.2	1.3
Italy	7.3	10.4	42.5	-3.3	-1.9	1.4
Japan	10.1	12.7	25.7	-0.5	0.4	0.9
Average	9.3	12.0	29.6	-1.3	-0.4	0.9
subgroup b						
Greece	7.9	10.4	31.6	-2.7	-1.9	0.8
Ireland	8.4	10.9	29.8	-2.2	-1.4	0.8
Korea	6.8	10.8	58.8	-3.8	-1.5	2.3
Portugal	6.9	8	15.9	-3.7	-4.3	-0.6
Spain	6.3	9.7	54.0	-4.3	-2.6	1.7
Taiwan	6.4	8.8	37.5	-4.2	-3.5	0.7
Average	7.1	9.8	37.9	-3.5	-2.5	0.9
Mexico*	6	9.4	37.5	-4.6	-2.9	1.7

Source: Silva and Teixeira (2010), p. 479, and estimates by authors with data from INEGI, Mexico Klems, 2011.

Secondly, as we can see in Table 2, growth in Mexico's GDP (2.6%), slightly higher than that of subgroup (a) (2.3%), is below that of all the countries in subgroup (b) (4.4%), with the exception of Greece, and with a notable difference in comparison to Taiwan, South Korea and Ireland (8%, 7% and 5%, respectively). The country's growth rate in per capita GDP has an annual increase lower than that of the two sub groups. As for Mexico's structural change index, we can see by way of the modified Lilien index that it ranks the lowest among the countries considered to be lagging behind at the beginning of the period covered in this study.[6] As pointed out by Silva and Teixeira (2010), this index tends to be higher among countries with significant growth during this period. The low level of this index for Mexico is understandable, given its low growth rate of 2.6% during the period from 1990 to 2011. We can also see a relationship between Mexico's index and its growth in labor productivity, which is the lowest among all the countries included in this analysis. A comparative analysis of Mexico's structural changes in relation to those of the countries in the two clusters demonstrates some notable differences.

[6]The Lilien index measures the degree to which labor demand is affected by sectorial shifts in the composition of output. The index measures the standard deviation of sectorial growth rates of employment from period s to period t. A weighting is carried out through the shares ofemployment in the most recent period. The modified index increases it with the weighting by the shares of the sectors in both periods.

Table 2: Structural change index and selected indicators for the period

	Lilien index	GDP	GDP per capita	Labor productivity
Subgroup a		%	%	%
Austria	0.527	2.2	4.9	2.6
Finland	0.735	2.4	5.1	3
Italy	0.505	1.8	4.8	1.6
Japan	0.463	2.3	5	3.4
Average	0.5575	2.2	5.0	2.7
Subgroup b				
Greece	0.475	2	4.3	1.6
Ireland	0.885	5	7.4	5
Korea	0.882	7	9.1	5.7
Portugal	0.601	3	5.8	2.7
Spain	0.472	3	5.5	2
Taiwan	0.807	6.5	8.6	6.9
Average	0.7	4.4	6.8	4.0
Mexico (1990-2012)	0.445	2.6	4.7	1

Source: Silva and Teixeira (2010), p. 479, and estimates by authors with data from INEGI, Mexico Klems, 2011.

In Table 3, which analyzes economic structures by categories of innovation, we can see that during the initial year of our analysis, two thirds of the aggregate value was contributed by industries whose technology is classified as supplier-dominated, at 34.5% (not very different from the other countries, with 30% and 35.4% of the subgroups in Cluster I, and 33.5% of the countries in Cluster II). However, the difference in the proportion of employment is very significant, since in Mexico this category employs 64.5% of the total hours worked, in relation to 41% and 51% in Cluster I and 31% in Cluster II. Thus it can be inferred that the work force in supplier-dominated industries has very low productivity. Next in line are branches with scale-intensive technology, with 23.9% of the aggregate value, or nearly 1.8% more than that of the countries in this comparison. The others correspond to information-intensive branches (16.5% of the aggregate value), specialized suppliers (4.9%) and science-based branches (3.5%).[7]The evolution of the economic structures of countries in subgroups (a) and (b) between 1979 and 2003[8] is very different from that observed in Mexico between 1990 and 2012. In the first group there is a significant decline in participation in the aggregate value by the branches with supplier-dominated technology (13.4%), and relatively small reductions in the scale-intensive branches (2.1%) and in the science-based branches (0.3%). In contrast participation increases in the cases of information-intensive industries (10%) and specialized-supplier industries (4%).Structural change is more notable in subgroup (b), in which progress is made in catching up with the more complex technologies.

[7]This category of innovation is quite possibly over-estimated due to the level of aggregation.
[8] We do not have such detailed information for countries in Cluster II for 2003.

Table 3: Composition of economic structure in Mexico and selected countries,according to innovation categories

Value added and hours share (%)

	Supplier-dominated		Scale-intensive		Specialized-supplier		Science-based		Information-intensive		Non-market. services	
	1979	2003	1979	2003	1979	2003	1979	2003	1979	2003	1979	2003
Cluster II												
Average (VA)	**21.5**		**16**		**8.1**		**3**		**32.3**		**19.1**	
Average (Hours)	***31.0***		***11.9***		***7.4***		***2.2***		***27.4***		***19.5***	
Cluster I subgroup (a)												
Austria VA	28.2	24.3	14.8	10.1	6.1	10.8	2.4	1.9	31.9	35.9	16.6	16.0
hours	*42.8*		*11.7*		*6.5*		*1.9*		*22.6*		*14.6*	
Finland VA	33.4	22.2	13.2	8.7	6.3	13.2	2.0	2.2	30.0	35.2	15.1	18.5
hours	*43.2*		*8.6*		*5.6*		*1.4*		*23.5*		*17.6*	
Italy	29.9	22.8	13.4	10.2	9.3	11.1	3.7	2.2	31.0	38.1	12.7	15.6
	40.4		*11.8*		*6.9*		*2.7*		*22.3*		*16.0*	
Japan	29.1	23.5	13.4	10.3	6.5	8.0	3.9	2.7	37.7	44.7	9.4	10.8
	45.7		*8.5*		*7.0*		*2.4*		*29.1*		*7.3*	
Average (VA)	**36.6**	**23.2**	**11.9**	**9.8**	**6.8**	**10.8**	**2.6**	**2.3**	**28.5**	**38.5**	**13.7**	**15.2**
Average (hours)	***43.0***		***10.2***		***6.5***		***2.1***		***24.4***		***13.9***	
subgroup (b)												
Greece VA	38.9	31.5	9.5	8.4	2.9	3.1	0.9	0.8	34.7	38.8	13.0	17.3
hours	*55.6*		*9.8*		*3.3*		*0.9*		*20.6*		*16.0*	
Ireland VA	35.8	21.3	13.8	8.2	11.3	16.8	3.1	14.7	24.3	24.5	11.8	14.6
hours	*42.7*		*13.0*		*5.1*		*1.9*		*21.2*		*16.0*	
Korea VA	41.7	24.2	12.5	17.1	4.8	9.5	4.3	3.7	27.1	32.1	9.5	13.3
hours	*59.7*		*7.8*		*4.2*		*2.3*		*19.6*		*6.3*	
Portugal VA	33.4	24.9	11.7	9.9	6.1	4.6	2.2	1.5	33.8	35.7	12.8	23.5
hours	*54.4*		*9.6*		*2.4*		*1.6*		*19.9*		*12.1*	
Spain VA	32.1	30.4	14.8	10.5	5.3	7.1	2.9	2.2	31.9	33.5	13.0	16.3
hours	*46.3*		*11.0*		*3.9*		*2.0*		*23.7*		*13.1*	
Taiwan VA	30.3	15.3	18.0	12.3	6.5	10.7	5.0	4.7	29.4	43.9	10.8	14.7
hours	*47.7*		*9.4*		*8.2*		*4.7*		*21.5*		*8.4*	
Average (VA)	**42.8**	**24.6**	**12.0**	**11.1**	**5.1**	**8.6**	**2.5**	**4.6**	**26.0**	**34.8**	**12.2**	**16.0**
Average (hours)	***51.1***		***10.1***		***4.5***		***2.2***		***21.1***		***12.0***	
	1990	2012	1990	2012	1990	2012	1990	2012	1990	2012	1990	2012
Mexico*	**35.0**	**34.4**	**23.9**	**21**	**4.4**	**7.6**	**3.5**	**2.5**	**16.1**	**19.8**	**16.8**	**14.6**
hours	***65.1***		***9.7***		***3.8***		***1.6***		***5.2***		***14.4***	
Gaps												
subgroup a (VA)	-1.6	11.2	12.0	11.2	-2.4	-3.2	1.0	0.3	-12.4	-18.7	3.1	-0.6
subgroup b (VA)	-7.8	9.8	11.9	9.9	-0.7	-1.0	1.0	-2.1	-9.9	-15.0	4.6	-1.4
subgroup a (hours)	*22.1*		*-0.4*		*-2.7*		*-0.5*		*-19.2*		*0.5*	
subgroup b (hours)	*14.0*		*-0.4*		*-0.7*		*-0.6*		*-15.9*		*2.4*	
cluster II (VA)	13.5		7.9		-3.7		0.5		-16.2		-2.3	
Cluster II (hours)	*34.1*		*-2.2*		*-3.6*		*-0.6*		*-22.2*		*-5.1*	

Developed by authors based on information from INEGI, Mexico Klems, and Silva and Teixeira (2010), p. 477.
* The figures for the hours share are in italics.

As in the first group, we can observe a significant decline in the value added participation by supplier-dominated branches (18.2%) and a much smaller decline in scale-intensive branches (0.9%). However, participation by information-intensive industries increases by nearly 9 percentage points, as compared to 3.5 points for specialized-supplier industries, and 2.1 points for science-based industries. The countries particularly notable in subgroup (a) are Finland and Japan. Especially worth mentioning in subgroup (b) are Ireland, South Korea and Taiwan. Mexico's economic structure, for its part, registers a 3.7% increase in participation in information-intensive branches, and a 2.5% increase in the case of specialized suppliers. Nevertheless, in contrast with countries in the second subgroup, over half of aggregate value (55%) and nearly three-quarters of hours worked are maintained in less complex technologies.

There are no changes in branches with supplier-dominated technology, with 34% participation, and there is a 2.9% decline in participation by scale-intensive branches, contributing 21% of the total aggregate value. Regarding the industries classified as non-market, there is a tendency in the two groups to increase their participation in a relatively significant proportion, at 3 or 4 percentage points. However, in Mexico, the contribution by these branches to total value added has tended toward a decline of two percentage points. Given that education and health sectors contribute a set of external economies to the economy, this decline is concerning.

4. Determinants of Productivity: Dynamic Panel Model

After analyzing the scope of structural change in Mexico's economy during the period from 1990 to 2012, and the major differences in relation to emerging countries, we will proceed to examine the role played by structural change in economic performance as measured by the GDP per hour worked. Before presenting our results, we will briefly address our methodology, sources of information and descriptive statistics.

4.1. Methodology

We have three sets of variables: i)those referring to the accumulation of physical and human capital, fundamental to economic growth; ii) variables that capture the role of demand and international trade, which we would expect to be positively associated; and iii) changes in the structure of the economy—the expected impact of which we will address in a moment. These are lagging variables, to demonstrate the direction of the causality.

The panel model with 62 sectors in Mexico's economy for the period from 1990 to 2012 is as follows:

$$\text{Labor Productivity}_{i,t} = \alpha + \beta\,(\text{capital investment}_{i,t}) + \omega(\text{education}_{i,t}) + \gamma\,(\text{trade opening index}_{t}) + \varphi(\text{demand}_{t}) + \zeta(\text{sector-based participations in consideration of Pavitt's and ICTs taxonomies}_{i,t}) + \eta_i + \lambda_t + \varepsilon_{i,t} \;\ldots\ldots (1)$$

where: the subscript i refers to the sector, t is time (1990-2012), η_i are unobserved sector-specific effects, λ_t are time- fixed effects, $\varepsilon_{i,t}$is an idiosyncratic error term, β and γ are vector parameters for the explanatory variables and control variables, respectively.

We employ an advanced estimation method known as System GMM for our productivity model as in Equation (1). System GMM was developed by Arellano and Bover, (1995) and Blundell and Bond (1998), and this method is considered to be superior to Difference GMM. Blundell, Bond and Windmeijer (2001) show that this method is able to correct unobserved sector heterogeneity, omitted variable bias, measurement error, and potential endogeneity that frequently affect this type of model.

Specifically, let y be the logarithm of labor productivity and X be a set of explanatory and control variables:

$$y_{i,t}-y_{i,t} = (\alpha - 1)\, y_{i,t-1} + \beta' X_{i,t} + \eta_i + \lambda_t + \varepsilon_{i,t} \;\ldots\ldots(2)$$

The existence of sector-specific effects η_i makes the within-group estimators inconsistent even if $\varepsilon_{i,t}$ is not serially correlated, because η_i is correlated with the lagged dependent variable $y_{i,t}$. Thus, to eliminate productivity-specific effects, we take the first difference of Equation (2) to obtain:

$$y_{i,t}-y_{i,t-1} = (\alpha-1)\,(y_{i,t-1} - y_{i,t-2}) + \beta'(X_{i,t} - X_{i,t-1}) + (\lambda_t - \lambda_{t-1}) + (\varepsilon_{i,t} + \varepsilon_{i,t-1}) \;\ldots\ldots(3)$$

In order to control for unobserved heterogeneity and omitted variable bias, as well as for the time-invariant component of the measurement error and endogeneity bias (time-varying component), we used the System GMM technique that combines regressions expressed in first-differences and in levels in a system. We used lagged explanatory variables ($y_{i,t-1}$ and $X_{i,t-1}$) in the first-differencing because the instruments available for the first-difference equation are weak instruments when the explanatory variables are persistent over time. As proposed by Arellano and Bover (1995) and Blundell and Bond (1998), we combined an equation in differences and an equation in levels as a system. The instruments for the equation in levels are the lagged differences of the explanatory variables. The main source of information is Mexico's National Institute of Statistical and Geographic Information (Instituto Nacional de Información Estadísticay Geográfica—INEGI), particularly Mexico Klems, which provides a very complete database for sectors during the period from 1990 to 2012, at constant 2008 prices. A major advantage of this series is that it specifies capital assets that are associated with information technologies, distinguishing them from all the rest, as well as hours and wages by education level for each sector. It is important to take into account that information technologies here do not include software, since information was lacking, as mentioned in the INEGI document (2014).Unlike the different cross-country panels that use average years of schooling for each country, this information is not available by economic branch, and thus we use wage bill classified by level of schooling that are available in the database.

The basic level corresponds to an average of approximately six years of schooling; the medium level, to an average of nine years of schooling; and the high level, to an average of 16 or more years of schooling. Table 4 describes the variables in our model.

Table 4: Variables in the Model

Labor productivity	Aggregate value / hours worked	LP_{it}
Capital- labour ratio	Investment in equipment and accessories for information and communication technologies per hour	$ICTKL_{it}$
	Investment in facilities, machinery and equipment, and transportation equipment per hour	$NonICTKL_{it}$
Human capital	Payroll by high level of education	$High\text{-}ed_{it}$
	Wage bill by medium level of education	$Med\text{-}ed_{it}$
	Wage bill by low level of education	$Low\text{-}ed_{it}$
Level of demand International trade	Natural rate of urban open unemployment Trade opening index Exp+IMP/GDP	$Unemp_t$ $Trade_t$
Economic structure in line with Tidd, Bessant&Pavitt, 2005 classification (value added share)	Supplier-dominated	$Sup.Dom_{it}$
	Scale-intensive	$ScaleInt_{it}$
	Information-intensive	$InfInt_{it}$
	Specialized suppliers	$Specialized\text{-}sup_{it}$
	Science-based	ScB_{it}
	Non-market	$NMKT_{it}$
ICT technologies(value added share)	ICT using /sectors with above average percentage of I	$ICT\ using_{it}$
	ICT producers	$ICT\ prod_{it}$

We expect a positive association between higher levels of education, capital per hour and trade opening index and labor productivity. In relation to our demand proxy, we expect a negative association for the urban open unemployment rate. Regarding the composition of economic structure, if Mexico's economy would move toward the technological paradigm of micro-electronics, we would expect the positive variables to be the science-based and specialized suppliers, given their high rates of growth in productivity and their indirect effects on other industrial branches. A positive sign would also be expected with respect to ICT-related industries, given their role within the current techno-economic paradigm and the high-skill sectors. As pointed out by Silva and Teixeira (2010, p. 485): "More precisely, products and innovations originating in skills and technology-intensive sectors are likely to be conducive to productivity gains in other industries which use these products or find new applications for the innovations developed, and therefore increase productivity." Inversely, a negative sign is expected when low-skill, supplier-dominated industry shares are considered. In Mexico's economy, in light of the analysis of descriptive statistics provided here, it is not likely that we would find these results in high-skill sectors. In terms of the innovation categories, given the economy's specialization demonstrated by the analysis in the previous section and the economy's extreme tendency toward importing, we would expect that the indirect effects generated for other industrial branches would be minimal. Nevertheless, beyond figures and data, we might mention that we would anticipate a positive relationship between branches with scale-intensive technology (which include the most important industrial branch—the automotive industry) and possibly specialized suppliers (which include electronic and telecommunications suppliers) and labor productivity. Also, given the reduced magnitude of structural changes, the differences in these variables may not necessarily be significant.

4.2. Results of the Econometric Model

The econometric results are satisfactory. All the regressions meet the requirements imposed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998), specifically: 1) no second-order self-correlation was found in the first differences in the errors; and 2) the equations are over-identified, which guarantees the instruments' validity. Compliance with these restrictions is noted in all of the regressions, as demonstrated in the p-value that is greater than 0.05 for the second-order self-correlation test and for the Sargan test of over-identifying restrictions.In addition the estimated coefficients demonstrate stability in all of the estimates, as can be observed.

The coefficient of the lagged productivity variable is always positive and inferior to 1, thus guaranteeing conditional convergence. Since the estimated coefficients are not comparable, we estimated the short and long-term elasticities in order to establish the magnitude among them. We will present the results, first of all, for the overall economy (62 sectors) in Table 5, and then for industry (22 sectors) in Table 6.With regard to the control variables, the results for human capital are significant with two lags in the high levels of schooling with a long-term elasticity of 0.34.[9] In other words, a 10% increase in the payroll of employees or workers with 16 or more years of schooling is associated with a 3.4% increase in labor productivity.[10] This points to the need for entrepreneurs to invest in human capital, and suggests that even if the impact is not noted immediately, there is a positive effect on productivity. Among the results for physical capital, it is especially noteworthy that when the capital-labor relationship is separated according to ICT capital and non-ICT capital, significant results were never found in the first case. This was not expected, however, because the use of these technologies can involve fewer hours of administrative work or savings in re-working, since computerized equipment generates fewer errors. A possible explanation is that investment in ICT capital is still insufficient for having an impact on productivity per hour, plus software is not included in the database, signifying an underestimation of value.

Thus, our variable for the capital labor ratio considers only non-ICT capital that is significant. While long-term elasticity is positive, as expected, it is necessary to ask why a negative result with a lag is obtained. A possible explanation is the presence of atypical sectors with a high degree of investment and low productivity (real estate services, for example).In regards to macroeconomic variables, the demand proxy was not significant, in either of the two models. A possible explanation for the latter is that, because there is no unemployment benefit paid in the country, a considerable portion of the economically-active population functions in the informal market. Thus, the urban open unemployment rate is not useful for this analysis. However, the dummy for the year 1995 was significant, with a negative sign in the year of the “Tequila crisis” with -0.04 and -0.35 short and long-term elasticities respectively. The rest of the dummies for other years were not significant. We expected a similar result for 2009, the year of the global financial crisis, which was significant in the following model for the manufacturing industry, as will be seen below. The trade opening coefficient was not significant as well. The results of structural change in line with technological categories are not significant in the case of supplier-dominated branches—which, as we will recall, employ nearly two-thirds of the population and correspond to a third of aggregate value—nor are they significant in the case of science-based and information-intensive branches. In contrast, consistent with Mexico’s pattern of specialization in transportation equipment in the global market, and as expected, participation by scale-intensive branches has a positive impact on the level of labor productivity, but a negative impact in the long run. Science-based and information-intensive branches were not significant, but specialized suppliers, which, as we will recall, increased their participation by 3.6% in the total aggregate value, exhibit a positive association. According to the long run elasticity, a 10% increase in participation by these sectors in the economy’s aggregate value increases labor productivity by 1.1% in the long term. The latter result is interesting, given that this sector includes branches such as the manufacturing of electric machinery and equipment, electronics, telecommunications and other capital goods. While Mexico lags behind other countries to a considerable degree, the results indicate that it has significant potential in productivity. Finally, the specific measurement of the impact from the sectors most closely associated with ICTs did not turn out to be significant in the case of ICT-using sectors, which is consistent with our results for information-intensive sectors (including the banking, insurance and trade sectors). The interpretation of this result may be an insufficient diffusion of new ICT technologies, particularly among small firms. However, a positive impact was noted for ICT-producing sectors, specifically that a 10% increase in participation by these sectors in the economy’s aggregate value increases labor productivity by0.2% in the long term, in a similar fashion to the results from the study by Silva and Teixeira for the 21 countries.

---

[9]According to the specification of the dynamic models, and following Arellano and Bond (1995), we have two effects from the independent variables on the dependent variable. The first effect (short-run or contemporaneous effect) is given by the coefficient of the current dated variables. The second effect (long-run effect) is given by the coefficient of the current dated variable, plus the coefficients of the same lagged variable and divided by the convergence factor, or in other words: 1- the coefficient of the lagged dependent variable. Since the dependent variable is in logarithms, we calculate the elasticities as:$\hat{\beta} * X$

[10]The variable for the wage bill for workers with low education was not significant.

Table 5: Results from the econometric model for 62 sectors in Mexico's economy

Variable	Base	Supplier-dominated	Scale-intensive	Specialized-Supplier	Science- based	ICT-using	ICT-producing
lprod							
L1.	0.886	0.882	0.877	0.872	0.886	0.883	0.867
s.e.	0.028	0.027	0.027	0.030	0.028	0.028	0.026
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000
High-ed	-0.003	-0.002	-0.003	-0.003	-0.003	-0.003	-0.003
s.e.	0.002	0.002	0.002	0.002	0.002	0.002	0.002
p. value	0.12	0.18	0.11	0.12	0.12	0.12	0.16
High-ed$_{(t-1)}$	-0.001	-0.001	-0.001	-0.002	-0.001	-0.001	-0.002
s.e.	0.002	0.002	0.002	0.002	0.002	0.002	0.002
p. value	0.54	0.52	0.67	0.40	0.56	0.52	0.34
High-ed$_{(t-2)}$	0.005	0.004	0.004	0.005	0.004	0.005	0.005
s.e.	0.002	0.002	0.002	0.003	0.002	0.002	0.003
p. value	0.06	0.09	0.06	0.04	0.06	0.06	0.05
Short run elasticity	0.04		0.04	0.05	0.04	0.04	0.04
Long run elasticity	0.34		0.31	0.31	0.33	0.34	0.34
Low-ed	-0.0005	-0.0005	-0.0004	-0.0003	-0.0005	-0.0006	-0.0009
s.e.	0.002	0.002	0.002	0.002	0.002	0.0020	0.0018
p. value	0.79	0.78	0.84	0.88	0.80	0.78	0.63
Low-ed$_{(t-1)}$	0.003	0.003	0.003	0.003	0.003	0.0033	0.0034
s.e.	0.002	0.002	0.002	0.002	0.002	0.0021	0.0021
p. value	0.11	0.15	0.14	0.10	0.12	0.11	0.10
Low-ed$_{(t-2)}$	-0.003	-0.003	-0.003	-0.003	-0.003	-0.0031	-0.0029
s.e.	0.002	0.002	0.002	0.002	0.002	0.0019	0.0019
p. value	0.11	0.19	0.11	0.08	0.12	0.10	0.14
NonICTKL	0.18	0.18	0.19	0.16	0.18	0.18	0.19
s.e.	0.09	0.09	0.10	0.08	0.09	0.09	0.09
p. value	0.06	0.05	0.05	0.05	0.06	0.06	0.04
short run elasticity	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NonICTKL$_{(t-1)}$	-0.145	-0.142	-0.137	-0.130	-0.147	-0.143	-0.138
s.e.	0.05	0.05	0.05	0.05	0.05	0.046	0.046
p. value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
short run elasticity	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Long run elasticity	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Trade	0.061	0.064	0.056	0.061	0.060	0.061	0.061
s.e.	0.054	0.053	0.055	0.055	0.054	0.054	0.054
p. value	0.27	0.23	0.31	0.27	0.27	0.26	0.25
Trade$_{(t-1)}$	-0.072	-0.075	-0.071	-0.071	-0.072	-0.073	-0.072
s.e.	0.071	0.070	0.072	0.071	0.071	0.071	0.071
p. value	0.31	0.28	0.32	0.32	0.31	0.30	0.31
yr1995	-0.043	-0.043	-0.042	-0.043	-0.043	-0.043	-0.043
s.e.	0.014	0.014	0.014	0.014	0.014	0.014	0.014
p.value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Short run elasticity	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Long run elasticity	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35
yr2009	0.002	0.004	0.005	0.003	0.002	0.003	0.004
s.e.	0.047	0.046	0.046	0.046	0.046	0.046	0.046
p. value	0.96	0.94	0.91	0.95	0.96	0.95	0.94
Supplier-dominated$_{(t-1)}$		1.28					
s.e.		1.34					
p. value		0.34					
s.e.		1.27					
p. value		0.58					
Scale-Int$_{(t-1)}$			8.84				
s.e.			4.14				
p. value			0.03				
Scale-Int$_{(t-1)}$			-17.84				

Variable	Base	Supplier-dominated	Scale-intensive	Specialized-Supplier	Science- based	ICT-using	ICT-producing
s.e.			4.09				
p. value			0.00				
Short run elasticity			0.012				
Long run elasticity			-0.9				
Specialized-sup$_{(t-1)}$				3.83			
s.e.				1.88			
p. value				0.04			
Specialized-sup$_{(t-1)}$				-0.44			
s.e.				1.66			
p. value				0.79			
Short run elasticity				0.01			
Long run elasticity				0.11			
Science-based$_{(t-1)}$					2.855		
s.e.					7.60		
p. value					0.71		
Science-based$_{(t-1)}$					5.588		
s.e.					24.14		
p. value					0.82		
ICT-using$_{(t-1)}$						0.75	
s.e.						1.06	
p. value						0.48	
ICT using$_{(t-1)}$						-1.61	
s.e.						2.70	
p. value						0.6	
ICT-prod$_{(t-1)}$							6.87
s.e.							3.01
p. value							0.02
ICT prod$_{(t-1)}$							19.67
s.e.							13.61
p.value							0.15
Short run elasticity							0.002
Long run elasticity							0.02
N	1218	1218	1218	1218	1218	1218	1218
Arellano-Bond test for AR(2) in first differences	0.827	0.831	0.944	0.838	0.866	0.860	0.787
Sargan test of overid. restrictions	0.768	0.744	0.778	0.724	0.785	0.745	0.745

*1. time dummies are included in all equations.

Among the control variables in the case of manufacturing (Table 6), a negative result is that the capital-labor coefficient was not significant. A possible explanation is that there are sectors characterized by both a disproportionate amount of investment in relation to other sectors and a low level of productivity (for example, extraction and production of oil, oil derivatives and coal). One option was to eliminate these sectors, but we decided against this option, since these sectors play an important role in the economy. In any case, this issue deserves further study. The results in relation to education variables that is the pay roll corresponding to workers with high levels of schooling, is significant and negative with one lag and positive in the long run. The long-term effect is negative. A 10% increase for workers with high levels of schooling decreased labor productivity by 1.4%. In a review of this matter, Isaksson (2002) concluded that, in the results associating human capital with growth, there is a tendency toward a change between negative and positive over time and toward a weakening in association with the long term. Nevertheless, this is a matter that deserves further research.

With regard to remunerations for low-skill workers, the negative impact on labor productivity is notable in the long run: a 10% increase in the payroll of workers with low levels of schooling diminishes labor productivity by 4%.The trade opening coefficient is positively associated with labor productivity, as would be expected since most of tradable goods are in this sector. In fact this demonstrates the greatest long-term elasticity in the model (2.9) and suggests that trade is a factor in technology transfer and learning. The dummies for the “tequila crisis” and the “world financial crisis” are negatively associated. The interpretation of these results is that when demand falls sharply, as it happened in those events, the labor hoarding effect has a negative effect on productivity.

This indicates that the manufacturing industry is particularly vulnerable to this type of macroeconomic event. The results for structural change have some important differences from those mentioned for the 62-sectors model. With respect to the taxonomy of innovation categories, the participation by supplier-dominated sectors corresponds to a negative impact on productivity. In line with elasticity, a 10% increase in participation in the industry's aggregate value by the supplier-dominated sectors decreases labor productivity by 1.4% in the long term. As expected, the scale-intensive category has a positive sign and greater elasticities than for the 62-sectors model with an elasticity of 0.15. Science-based branches are also positively associated with labor productivity in this case, with an elasticity of 0.02. Lastly, for the innovation categories, the coefficient associated with the first differences for specialized suppliers is statistically significant, with a long-term elasticity of 0.29.In the case of branches that have a higher percentage of ICT capital but are not ICT-producing; a negative association with productivity is noted. This is consistent with the earlier results on ICT capital and information-intensive branches, and requires further research. In contrast ICT-producing sectors have a considerable positive effect on labor. A 10% increase in their value added share would result in a 6.7% increase in labor productivity in the long run.

Table 6: Results of the econometric model for the 22 manufacturing sectors

Variable	Base	Supplier-dominated	Scale-intensive	Specialized-Supplier	Science-based	ICT-using	ICT-producing
LP $_{(t-1)}$	0.842	0.852	0.833	0.832	0.835	0.867	0.840
s.e.	0.046	0.045	0.047	0.050	0.047	0.037	0.049
p. value	0.00	0.00	0.00	0.00	0.000	0.00	0.00
High-ed$_{(t-1)}$	0.004	0.001	0.005	0.006	0.005	0.003	0.004
s.e.	0.007	0.008	0.008	0.006	0.000	0.007	0.007
p. value	0.6	0.9	0.5	0.4	0.5	0.6	0.6
High-ed$_{(t-1)}$	-0.017	-0.016	-0.018	-0.018	-0.018	-0.016	-0.017
s.e.	0.009	0.009	0.009	0.009	0.000	0.009	0.009
p. value	0.05	0.10	0.05	0.04	0.05	0.07	0.06
Short run elasticity	-0.10		-0.10	-0.11	-0.10		-0.10
High-ed$_{(t-2)}$	0.013	0.014	0.014	0.013	0.014	0.012	0.013
s.e.	0.007	0.007	0.007	0.007	0.000	0.007	0.007
p. value	0.06	0.03	0.05	0.06	0.05	0.08	0.05
Short run elasticity	0.08	0.08	0.08	0.08	0.08		0.08
Long run elasticity	-0.2		-0.1	-0.1	-0.2		-0.1
Low-ed	-0.006	-0.005	-0.007	-0.008	-0.007	-0.006	-0.006
s.e.	0.006	0.006	0.006	0.005	0.000	0.006	0.006
p. value	0.27	0.36	0.25	0.11	0.25	0.29	0.29
Low-ed$_{(t-1)}$	0.016	0.017	0.017	0.017	0.0167	0.016	0.016
s.e.	0.007	0.007	0.007	0.007	0.0000	0.007	0.007
p. value	0.01	0.01	0.01	0.01	0.015	0.02	0.02
Low-ed-ed $_{(t-2)}$	-0.010	-0.012	-0.011	-0.010	-0.0111	-0.010	-0.010
s.e.	0.005	0.005	0.005	0.005	0.000	0.005	0.005
p. value	0.05	0.02	0.04	0.04	0.045	0.06	0.04
Short run elasticity	-0.06	-0.07	-0.07	-0.06	-0.07	-0.06	-0.06
Long run elasticity	-0.4	-0.46	-0.43	-0.39	-0.43	-038	-0.39
NonICTKL $_{t-1)}$	0.029	0.030	0.012	0.079	0.012	-0.004	0.051
s.e.	0.223	0.222	0.237	0.224	0.236	0.224	0.206
p. value	0.90	0.89	0.96	0.72	0.96	0.99	0.81
NonICTKL$_{t-1)}$	-0.185	-0.201	-0.220	-0.210	-0.224	-0.231	-0.204
s.e.	0.286	0.285	0.273	0.282	0.272	0.286	0.275
p. value	0.52	0.48	0.42	0.46	0.41	0.42	0.46
Trade	-0.091	-0.091	-0.089	-0.089	-0.091	-0.095	-0.096
s.e.	0.060	0.059	0.061	0.064	0.061	0.062	0.061
p. value	0.13	0.13	0.14	0.16	0.14	0.13	0.12
Trade $_{t-1)}$	0.447	0.447	0.448	0.444	0.447	0.449	0.449
s.e.	0.141	0.141	0.142	0.143	0.142	0.144	0.142
p. value	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Short run elasticity	0.45	0.45	0.45	0.44	0.45	0.44	0.44
Long run elasticity	2.87	2.86	2.87	2.84	2.87	2.88	2.88
yr1995	-0.129	-0.128	-0.127	-0.129	-0.127	-0.128	-0.129
s.e.	0.037	0.036	0.037	0.036	0.037	0.036	0.037
p. value	0.000	0.000	0.001	0.000	0.001	0.000	0.000
Short run elasticity	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-012
Long run elasticity	-077	-0.77	-0.76	-0.78	-0.76	-0.77	-0.78

Variable	Base	Supplier-dominated	Scale-intensive	Specialized-Supplier	Science-based	ICT-using	ICT-producing
Yr2009	-0.516	-0.518	-0.511	-0.519	-0.516	-0.508	-0.517
s.e.	0.132	0.134	0.131	0.132	0.134	0.131	0.134
p. value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Short run elasticity	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-04
Long run elasticity	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6
Sup-dom $_{t-1)}$		0.21					
s.e.		3.37					
p. value		0.95					
Sup-dom$_{(t-1)}$		-2.95					
s.e.		1.65					
p. value		0.07					
Short run elasticity		-0.02					
Long run elasticity		-0.14					
Scale-Int$_{(t-1)}$			8.29				
s.e.			3.72				
p. value			0.03				
Scale-Int$_{(t-1)}$			-11.60				
s.e.			4.43				
p. value			0.01				
Short run elasticity			0.02				
Long run elasticity			0.15				
Specialized-sup$_{(t-1)}$				2.27			
s.e.				3.54			
p. value				0.52			
Specialized-sup $_{(t-1)}$				42.23			
s.e.				6.84			
p. value				0.00			
Short run elasticity				0.5			
Long run elasticity				0.29			
Science-Based$_{(t-1)}$					8.466		
s.e.					3.587		
p. value					0.018		
Science-Based$_{(t-1)}$					-12.585		
s.e.					3.982		
p. value					0.002		
Short run elasticity					0.02		
Long run elasticity							
ICT using$_{(t-1)}$						-6.90	
s.e.						1.21	
p. value						0.00	
ICT-using $_{(t-1)}$						-0.11	
s.e.						8.56	
p. value						0.99	
Short run elasticity						-0.015	
Long run elasticity						-0.1	
ICTprod$_{(t-1)}$							-2.82
s.e.							2.97
p. value							0.34
ICT prod$_{(t-1)}$							49.80
s.e.							3.79
p. value							0.00
Short run elasticity							0.1
Long run elasticity							0.7
N	480	480	480	480	480	480	480
Arellano-Bond test for AR(2) in first differences	0.056	0.111	0.143	0.098	0.069	0.161	0.50
Sargan test of overid. restrictions	0.069	0.064	0.059	0.058	0.081	0.069	0.066

*1. Time dummies are included in all equations.

Looking at our results from the variables for the selected industry groups, and in a similar fashion to the results from Silva and Teixeira for the 21 countries, we find that the influence on productivity growth stems mostly from the share variables and not from changes in the shares. However, unlike their results, when differences were significant, they did not always reinforce the results in levels, as in the case of scale-intensive sectors. Another factor that may explain why the differences are not significant in most cases is the very slow rhythm of structural change in Mexico throughout the 22 years studied.

5. Conclusions

According to the neo-Schumpeterian perspective, the evolution of technical change has resulted in the emergence of a new paradigm in which knowledge, science and new Information and Communication Technologies (ICTs) are crucial and leave their mark on economic structure. There is evidence regarding a catch-up process during the 1970s in a group of countries such as Ireland, Korea and Taiwan, all lagging relatively behind in this aspect. A change in economic structure occurred in these countries, leading to greater participation by sectors associated with this paradigm and also greater economic growth. This paper explores the determinants of labor productivity in Mexico's economy during the period from 1990 to 2012, with special emphasis on the impact of structural change. As is well known, a radical shift in economic policy took place in Mexico following the 1982 debt crisis. Guided by what is referred to as the Washington Consensus, reforms were carried out with the aim of generating greater competition and efficiency in order to create a competitive economy, with an opening in the economy and in the financial sector, eliminating subsidies and deregulating foreign investment, and lastly, disregarding the need for industrial policies. These reforms were implemented predominantly during the 1980s, and consequently the period under study may be considered to be one in which the trade opening and the new policy scheme were in a process of consolidation. Through a descriptive statistics analysis, we demonstrate that Mexico's economy has achieved improvements in schooling, diminishing the gap with advanced countries. However, after more than 20 years of reforms, structural change has been slow, in comparison with the Lilien indexes for a sample of developed and emerging countries. A significant lag is evident in Mexico's economic structure, unlike what can be observed in smaller emerging and developed countries that have entered into the new paradigm.

Mexico's economic structure is still based on previous technological paradigms, with particular emphasis on relatively low-skill sectors as well as supplier-dominated and scale-intensive sectors, despite some minimal changes. In other words, economic reforms have not led to a catch-up process that would tend toward the paradigm of information and communication technologies in which knowledge of science and the interaction of science with industry are essential. One important result from our dynamic panel for the 62 sectors that merits being highlighted refers to the investment in human capital, employing skilled personnel in companies, as established by Romer (1990). The fact that the effect is not immediately apparent may disappoint some entrepreneurs who are not aware of its role in increasing capabilities for innovation.

The exercise of estimating two models, one for the overall economy and the other for the manufacturing sector, created an opportunity to observe differences in terms of the impacts from both macroeconomic variables and variables associated with economic structure. The results from the economic opening suggest it has an impact on productivity only in the case of the industry. In other words, the impact from lessons learned is not transmitted to other sectors. In addition, the negative results from the dummy variables for both 1995 and 2009 indicate the industry's higher degree of vulnerability to an adverse macroeconomic context. An analysis of productivity determinants at the level of the economy demonstrates that labor productivity is positively associated with sectors having lagging participation and scale-intensive technology—consistent with the specialization pattern characterizing Mexico's economy in the international market—and with much lower elasticities by specialized suppliers and ICT-producing sectors. In other words, other variables do not demonstrate a significant association. Nevertheless, the results for the manufacturing industry model are clearer with regard to the importance of economic structure and its changes. The change toward supplier-dominated branches is negatively associated with productivity. The scale-intensive branches maintain the same results as for the overall economy, but the negative coefficient of the difference suggests a loss of dynamism in this relationship. In contrast, the difference in the case of specialized suppliers is positive—which can be considered to be an interesting index of change. Lastly, within the Pavitt taxonomy, the science-based branches are positively associated with productivity, although with low elasticity. If we look at the distinction between ICT-using and ICT-producing branches, we find a positive relationship between the latter and productivity, which was expected. To the contrary, the negative relationship with ICT-using branches might be indicating a lack of capacities and an insufficient investment in human capital. In any case more analysis is required in this regard. Finally, going back to the results obtained by Silva and Teixeira (2010), we can see that after nearly 30 years of the trade opening, Mexico has not managed to catch up to the new technological paradigm that would allow its economy to compete on the basis of knowledge and aggregate value.

New economic policies will be necessary at both the macroeconomic level and for individual companies in order to achieve a virtuous circle between productivity and structural changes, leading to an increasing tendency in productivity.

Acknowledgments

We are indebted for the valuable comments received at the Seminar of the Institute of Applied Economic and Social Analysis in the University of Alcalá de Henares and at the Seminar of the Department of Economic Analysis at the Autonomous University of Madrid in Spain. We also thank our colleagues Julio Lopez, Fidel Aroche and Jaime Ros at the Faculty of Economics, UNAM for their observations. Finally, we must recognize the support by PAPIIT-UNAM project IN305914 and PASPA-UNAM. The responsibility of mistakes remains our own

Bibliography

Aghion, Philippe &Peter Howitt, (1992). “A model of growth creative destruction” Econometrica, núm. 60, pp. 323-351.

Aravena Claudio, Fernandez Juan, Hofman André & Matilde Mas. (2014). Structural change in four Latin American countries An international perspective. In United Nations publication (Ed.), Macroeconomics of Development (Vol. 150). Santiago, Chile: ECLAC.

Archibugi, Daniele (2001). Pavitt´s Taxonomy Sixteen Years On: A Review Article. Economy, Innovation, New Technology, 10, 415-425.

Arellano, Manuel &Olympia Bover,(1995). Another look at the instrumental estimation of error-components models. Journal of Econometrics, 68(1), 29-51.

Blundell, Richard &Stephen Bond, (1998). Initial Conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87, 115-143.

Blundell Richard, Bond Stephen & Frank Windmeijer. (2001). Estimation in Dynamic Panel Data Models: Improving on the Performance of the Standard GMM Estimators (Vol. WP 00/12). London: The Institute for Fiscal Studies.

Brown Flor, Lilia Domínguez & Leo Mertens (2007). La importancia del capital social en la mejora de la productividad: Caso de la industria manufacturera mexicana. Revista Mexicana de Sociología.

Brown Flor & Lilia Domínguez. (2013). ¿Tiene la industria aeronáutica mexicana las condiciones para integrarse a la cadena de valor internacional de alto valor agregado? In Ravenna Mónica Casalet (Ed.), La industria aeroespacial. Complejidad productiva e institucional. México: Flacso.

Caballero Urdiales Emilio & Julio López Gallardo. (2013). Demanda efectiva y distribución del ingreso en la evolución reciente de la economía mexicana

. Investigación Económica, 72(285), 50-70.

Cameron, G., J. Proudman & S. Redding. (1999). Technology Transfer, R&D, Trade and Productivity Growth. London School of Economics. London.

Capdevielle, Mario. (2004). El Desarrollo Productivo Mexicano Ante la Apertura: Heterogeneidad estructural y crecimiento económico Proceedings: El Reto de Acelerar el Crecimiento en América Latina y el Caribe. Santiago de Chile: CEPAL.

Carrillo Jorge & Alfredo Hualde Alfaro. (2013). ¿Una maquiladora diferente? Competencias laborales profesionales en la industria aerospacial en Baja California. In La industria aeroespacial. Complejidad productiva e institucional.edited by Mónica Casalet Ravenna. México: Flacso.

Casalet, Ravenna Mónica. (2013). Actores y redes públicas y privadas en el desarrollo del sector aeroespacial internacional y nacional: el cluster de Querétaro, una oportunidad regional. In La industria aeroespacial. Complejidad productiva e institucionaledited by Mónica Casalet Ravenna. México: Flacso.

Casanueva, Cristina & Rodríguez, Cid (2009). La productividad en la industria manufacturera mexicana: calidad del trabajo y capital humano. Comercio Exterior 59(1).

Chen, D.H.C. & C.J. Dahlman (2004). Knowledge and Development: A Cross-Section Approach. Policy Research Working Paper. World Bank. Washington, DC.

Clavijo, Fernando. (1992). La eficiencia productiva del sector manufacturero Mexicano. Mimeo, 1992.

Cornwall John, & Wendy, Cornwall (2002). A demand and supply analysis of productivity growth. Structural Change and Economic Dynamics, 13, 203-229.

Cornwall, John & Wendy Cornwall. (2002). A demand and supply analysis of productivity growth. Structural Change and Economic Dynamics, 13, 203-229.

Cripps, Francis &Roger Tarling. (1973). Growth in Advanced Capitalist Economics, 1950-70 Cambridge: Cambridge University Press.

Cruz, Moritz. (2014). Premature de-industrialisation: theory, evidence and policy recommendations in the Mexican case. Cambridge Journal of Economics, 39, 113-137.

Dietrich, Hans. (2012). Youth unemployment in Europe. Theoretical considerations and empirical findings. Friedrisch Ebert Stiftung.

Dosi, Giovanni. (1982). Technological paradigms and technological trajectories: a suggested interpretarion of the determinants and directions of Technical change (Vol. 11, pp. 147-162).

Dutrénit, Gabriela. (2010). Introduction to special issue: Interactions between public research organisations and industry in Latin America: Study on channels and benefits from the perspective of firms and researchers. Schience and Public Policy, 37(7).

Dutrénit, Gabriela (2000). Learning and Knowledge Management in the Firm: From Knowledge Accumulation to Strategic Capabilities. Cheltenham:: Edward Elgar.

Dutrenit, Gabriela &Mario Capdevielle. (1993). El perfil tecnológico de la industria mexicana y su dinámica innovativa en la decada de los ochenta. El Trimestre Económico, 239, 639-674.

Easterly, William; Norbert Fiess &Daniel Lederman. (2003). NAFTA and Convergen in North America: Hogh Expectations, Big Events, Little Time. Economia, 4(1).

Eslava, M., J. Haltiwanger, A.Kugler & M. Kugler. (2004). The Effects of Structural Reforms on Productivity and Profitability Enhancing Reallocation: Evidence from Colombia. Journal of Development Economics, 75, 333-371.

Fagerberg, Jan. (2000). Technological progress, structural change and productivity growth: a comparative study. Structural Change and Economi Dynamics, 11, 393-411.

Fragoso, Edna C. (2003). Apertura comercial y productividad en la industria manufacturera mexicana. Economía Mexicana, XII(1), 5-38.

González, Norberto. (1986). Reactivación y desarrollo: el gran compromiso de América Latina y el Caribe. Revista de la CEPAL, 30, 7-17.

Hirschman, Albert. (1987). The Political Economy of Latin American Development: Seven Excercises in Retrospection. Latin American Research Review, 22(3), 7-36.

Isaksson, Anders. (2002). Human Capital and Economic Growth: A Survey of the Empirical Literature from 1990 to the Present. UNIDO Vienna: .

Jimenez, Miguel, Domenico& J. Marchetti. (2002). Interpreting the procyclical productivity of manufacturing sectors: can we really rule out external effects? Applied Economics, 34(7).

Kaldor, Nicholas. (1966). Causes of the Slow Rate of Growth of the United Kingdom; an Inaugural Lecture Cambridge: Cambridge University Press.

Katz, Jorge. (2007a). Cambios estructurales y ciclos de destrucción y creación de capacidades productivas y tecnológicas en América Latina The Global Network for Economics of Learning, Innovation, and Competence Building System. http://www.globelics.org.

Katz, Jorge (2007b). "Cambios Estructurales y Desarrollo Económico, Ciclos de creación y destrucción de capacidad productiva y tecnológica en América Latina". Revista de Economía Política de Buenos Aires, vol. 1. Year 1, March

Freeman, Chris. &Luc,Soete. (1997). The Economics of Industrial Innovation (third edition ed.).

Moreno-Brid, Juan Carlos & Jaime, Ros. (2009). Development and Growth in te Mexican Economy: a Historical Perspective. New York: Oxford University Press.

Nelson, Richard &Sidney,Winter. (1982). An evolutionary theory of economic change. Cambridge, Massachussets: The Belknap Press of Harvard University Press.

Pasinetti, Luigi. (1981). Structural change and economic growth—a theoretical essay on the dynamics of the wealth of nations. Cambridge: Cambridge University Press.

Peneder, M. (2007). A sectoral taxonomy of educational intensity. Empirica, 34, 189-212.

Robinson, C., L. Strokes, E. Stuivenwold & B. van Ark. (2003). Industry structure and taxonomies. In M. Mahony and B. Van Ark (Ed.), EU productivity and Competitiveness:An Industry Perspective. Can Europe Resume the Catching Up Process? Luxembourg: Enterprise Publications, European Commission.

Romer, P.M. (1990). Endogenous Technological Change Journal of Political Economy, 98(5, part II), S71-S103.

Rowthorn, Robert &Ramana,Ramaswamy. (1997). Deindustrialization: Causes and Implications. 38.

Salter, Wilfred E. (1960). Productivity and Technical Change Journal of Farm Economics, 43(1), 160-163.

Saviotti, Pier &Jean-Luc,Gaffard. (2004). Innovation, structural change and growth. Revue économique, 55(Noviembre).

Saviotti, Pier &Andreas,Pyka. (2013). The co-evolution of innovation, demand and growth. Economic of Innovation and New Technology, 22(5), 461-482.

Silva, Ester &Aurora,Teixeira. (2010). Does Structure Influence growth? A panel data econometric assessment of "relatively less developed" countries, 1979-2003. Industrial and Corporate Change, 20(2), 457-510.

Solow, Robert. (1956). “A contribution to the theory of growth” Quaterly Journal of Economics, vol. 70, núm. 1, pp. 65-94.

Tadashi, Ito. (2010). NAFTA and Productivity Convergence between Mexico and the US Cuadernos de Economía 47(Mayo), 15-55.

Tidd, Joe, John,Bessant&Keith,.Pavitt. (2005). Managing Innovation-Integrating Technological, Market and Organizational Change (2nd edn. ed.). England: Jonh Wiley & Sons Ltd.

Timmer, Marcel, Robert,Inklaar, Mary, O’Mahony& Bart van Ark (2010). Economic Growth in Europe. A Comparative Industry Perspective.

Venables, Anthony & Van , Sweder,Wijnbergen. (1993). Location Choice (Vol. 2099): London School of Economics

Vera-Cruz, Alex O. (2004). How organisational culture shapes firm’s technological learning: the case of two Mexican firms Second Globelics Conference Proceedings. Beijing.

Wood, A. (1995). North-South Trade, Employment, and Inequality: Changing Fortunes in a Skill-Driven World. The Journal of Developing Areas, 30(1), 125-128.