WHAT IS THE IMPACT OF STRUCTURAL CHANGE ON PRODUCTIVITY? THE CASE OF MEXICO'S ECONOMY: 1990-2012

Flor Brown
Universidad Nacional Autónoma de México. Posgrado en Economía. México
brown@unam.mx

Lilia Domínguez
Universidad Nacional Autónoma de México. Posgrado en Economía. México
ldv@unam.mx

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

1. INTRODUCTION

After 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 economic growth of both total factor productivity (TFP) and labor productivity growth has been disapointing: while labor productivity increased grew by more faster than 3% between 1960 and 1980, its average growth rate has been around 1% during the last 20 years, while average TPF was a dismal -0.39 between 1991 and 2011.

This paper aims to explain productivity as a outcome of demand and supply forces. Most analysis of productivity determinants are focused on supply factors (Cornwall and Cornwall, 2002). As Saviotti and Pyka (2013) point out, no innovation could have had an impact on economic growth if no one had purchased it. Given the relatively low rate of GDP growth and especially its instability, it is especially important to identify the procyclical effect on productivity (Jimenez and Marchetti, 2002). Evidence of the importance of the demand has been provided by many researchers, including Venables and van Wijnbergen (1993), Tybott (1994), Cornwall and Cornwall (2002), and Caballero and Lopez (2013).

On the supply side, we are interested in analyzing structural changes and the role of technical change between 1990 and 2012 in labour 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).

A number of analyses have explained the determinants of productivity in the case of Mexico. Most of them cover periods of eight years at the most, occurring at different times in recent history. Initially, during the first eight years of reforms, a number of studies analyzed productivity determinants with a micro-macro approach. Some aimed to assess the role of the trade liberalization (Clavijo 1992, Venables and Van Wijnbergen 1993, Fragoso 2003). Others examined the effects of the quality of labour, labour conditions and human capital on productivity (Casanueva and Rodríguez, 2009, Brown, Domínguez and Mertens 2007) or highlighted the profile of high-productivity establishments. And others evaluated whether or not NAFTA has resulted in a productivity catch-up for Mexico in relation to the United States (Easterly, Fiess and Lederman, 2003, Tadashi 2010). None of these analyzed the role of structural change in productivity, most likely due to the limited number of years covered. 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 a productivity increase.

From a detailed observation of Mexico´s economic structure, we observe that output composition diminished their participation, there was also an internal readjustment in the country's industries and services. There are some questions that need to be answered in the regards to the sources of productivity growth. First of all, during a period where the revolution of microelectronics and information and communication tecnologies (ICTs) is spreading to many countries, we are interested in measuring the extent to which information-intensive and technology-led branches in Mexico have increased their contribution to and influence on labor productivity. In order identify economic structures from the perspective of the new technological paradigm (Dosi 1982), we classified the economic sectors in accordance with the taxonomies developed by Tidd, Bessant and Pavitt (2005). We are also intrigued by the influence exerted by the new high-tech services and industrial branches for which we have clasiffied the sectors according to the share of ICT capital in total capital and distinguish ICT producers from users.

Many 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.

Through a descriptive statistics analysis, we show that, structural change has been slow, in comparison with 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 fully entered into the new paradigm. Mexico's economic structure is still based on previous technological paradigms, with particular emphasis on supplier-dependent and scale-intensive sectors, despite some promising but yet incipient changes. Our econometric results demonstrate the importance of employing skilled personnel in companies, as established in other analyses of productivity determinants but, as expected, we found important differences in Mexico's structural characteristics when compared to those of advanced and emerging countries in which labor productivity is associated with high-skill, science-based, specialized supplier and ICT-producing sectors in both services and manufacturing.

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. 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 in equilibrium, and thus examined its expansion over time. Thus macroeconomic and microeconomic interactions, or the process of the creation and destruction of capacities for productive organization have been left aside (Katz 2007). On the opposite side, other line of research investigating the role of economic structure seeked to explain the development process by successive changes from the predominance of agriculture to industrialization and tertiarization due to demand and supply factors (Pasinetti ((1981), Salter (1960). Authors such as and 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 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 and 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 and Wood (1995).

The neo-Schumpeterian line of research has emphasized the importance of structural change, but they have distanced from a traditional three sectors (primary, industry and services) approach in favor of pondering more specific differences within them. Their specific practices of innovation and technological trajectories are considered key aspects behind these differences in long cycles they identify under technological paradigms. The technological paradigm emerged from the seventies is based on the advances in microelectronics and information and communication technologies and innovations with strong interactions with science.

An enlightening study is that of Silva and Teixeira (2010), who attempt to provide evidence for the role of technology-led branches in relation to the emergence of the microelectronic and ICT paradigm, specifically taking into account less developed countries which could cath-up and benefit more from adopting new technologies. The authors analyze the characteristics of the economic structure of 21 countries, during a period between 1979 and 2003, using three taxonomies as references: a refinement of Pavitt's (1984) four-sector categories from Tidd, Bessant and Pavitt (2005)[1], identifying five categories according to a gradual scale of technological opportunities, and the taxonomies of Peneder (2007), classifying the sectors of the economy by their educational requirements[2], and Robinson (2003)[3].3 They 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 lowskill 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. 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. An interesting result is that ICT-related industries are strategic branches of economic activity, but only when producing industries (in the present case, producing manufacturing industries) are considered. This underlines the fact that most spillovers from advanced industries, and particularly ICT-producing industries are local and national in character, and therefore "buying" is not the same as "producing."

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 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 (Dutrénit 2010, Capdevielle 2004, Dutrénit 2000, Dutrenit and Capdevielle,1993, Vera-Cruz 2004), it has not received enough attention in the analysis of productivity determinants.

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[1] Supplier-dominated, scale- scale-intensive, specialized suppliers, science-based, information-intensive (Tidd et al., 2005).

[2] Very low, low, intermediate low, intermediate, intermediate high and high.

[3] 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.

3. MEXICO'S ECONOMIC STRUCTURE, 1990-2012

In our analysis of Mexico's economic structure during the period from 1990 to 2012 we will also refer to other countries, aiming ay demonstrating that more than 20 years after economic reforms were made (what?). As is well known, the eighties were for Mexico and other Latin-American countries years of hard economic adjustments, and low growth leading some scholars to refer to the 1980s as the "lost decade" (González 1986). Thus it is only after the nineties that changes in the economic structure took place, much later than in other emerging countries. We will use some valuable information of 21 countries from Silva and Teixeira (2010) for the period between 1979 and 2003 for our comparative analysis.

Silva and Teixeira (2010) worked with a sample of 21 countries, and by applying a cluster analysis, they 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 and relatively higher shares of innovative and high-skill industries, and 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 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, is far behind, and Mexico may be closer to these countries. We will now present the characteristics of Mexico's growth process and the evolution of its economic structure *vis a vis* the countries analyzed by Silva and Teixeira (2010).

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.[4] The education gap was -4.6 years 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)).

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[4] 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
Structural change index and selected indicators for the period

	Lillien 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	4.75	1

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

Secondly, as we can see in the Table 1, 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 is not very positive either, with an annual increase lower than that of the two groups. As for Mexico's structural change index, we can see by way of the 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. 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 that of the countries in the two clusters demonstrates some notable differences

In Table 2, which analyzes economic structures by categories of innovation, we can see that during the initial year of our analysis, two thirds of the added value is contributed by industries whose technology is classified as supplier-dependent, 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 the supplier-dependent 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%).[5]

The evolution of the economic structures of countries in subgroups (a) and (b) between 1979 and 2003[6] is very different from that observed in Mexico between 1990 and 2012. In the first group there is a significant decline in the participation in the value added by the branches with supplier-dependent technology (13.4%), and relatively small reductions in the scale-intensive branches (2.1%) and in the science-based branches (0.3%). In contrast the participation increases in the cases of information-intensive industries (10%) and specialized-supplier definer industries (4%). Structural change is more notable in subgroup b, in which progress is made in catching up with the more complex technologies.

Table 2
Composition of economic structure of Mexico and selected countries, according to innovation categories

Value added and hours share (%)

	Sup-Dominated		Scale-intensive		Spec.supplier		Science-based		Inf. Intensive		Non-market. Serv	
	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

5 This category of innovation is quite possibly over-estimated due to the level of aggregation.

6 We do not have such detailed information for countries in Cluster II for 2003.

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*	
distance												
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 INEGO, Mexico Klems, and Silva and Teixeira (2010), p. 477.
*The information for Mexico is for 1990 and 2011. 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-dependent 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-dependent 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 not only in relation to developed countries, but also to countries that had a similar GDP in the early 1970s, 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

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

Labor Productivity$_{i,t}$ = α + β (sector-based participations in consideration of Pavit's and Peneder's and ICTs taxonomies) + γ (capital investment and education) + φ(demand) + η_i +λ_t + $\varepsilon_{i,t}$ …… (1)

where: the subscript i refers to the sector, t is time (1990-2012), ηi are unobserved sector-specific effects, λt are time- fixed effects, ei.t is an idiosyncratic error term, β and γ are a vector parameters for the explanatory variables and control variables, respectively.

With this specification, the control variables in this model are human capital and growth in investment per worker in each branch of the economy. These variables are indispensable for growth in productivity. The explanatory variables are GDP growth—for measuring the impact of the demand, which we would expect to be positively associated—and 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.
We employ an advanced estimation method known as the System GMM for our productivity model as in Equation (1). The System GMM was developed by Arellano and Bover, (1995) and Blundell and Bond (1998), and this method is considered to be superior to the 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 models.

The main source of information is Mexico's National Institute of Statistical and Geographic Information (Instituto Nacional de Información Estadística y 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 3 describes the variables in our model.

Table 3
Variables in the model

Labour productivity	Aggregate value / hours worked	LP
Capital	Investment in equipment and accessories for information and communication technologies	ICTK
	Investment in facilities, machinery and equipment, and transportation equipment	NonICTK
Human capital	Payroll by high level of education	HighEd
	Wage bill by medium level of education	MedEd
	Wage bill by low level of education	LowEd
Level of demand	Natural rate of urban open unemployment	UNEMP
Economic structure in line with Tidd… classification (VA or hours share per year)	Supplier-dependent	Supp-dependent
	Scale-intensive	Scale-intensive
	Information-intensive	Infint
	Specialized suppliers	Specialized-supplier
ICT technologies (VA or hours share per year)	ICT using /sectors with above average percentage of ICT capital in total capital	ICT using
	ICT producers	ICT producing

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) with 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 orders of magnitude among them.

With regard to the control variables the results for human capital are significant is also with two lags in the high levels of schooling, with a short-term elasticity of 0.04 and a long-term elasticity of 0.34. In other words, for each percentage point increase in the payroll of employees or workers with 16 or more years of schooling, labor productivity increases by 0.04 percent in this period, and 0.34 percent after considering all the iterations with the lag in productivity. There is a negative impact corresponding to employees or workers on the wage bill with low levels of schooling, also with two lags in elasticities, of -0.02 and -0.13. 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, since 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.

With regard to the capital-labor relationship for non-ICT capital, it is significant without lags, with a short-term elasticity of 0.014, and with a lag it is negative with an elasticity of (-0.011). 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).

The open urban unemployment variable was not significant, nor was the GDP growth variable. However, the dummies for the years 1995 and 2009 were significant, with a negative sign: in 1995, the year of the "Tequila crisis" with -0.04 and -0.35 short and long-term elasticities, respectively, and -0.03 and -0.26. The rest of the dummies for other years were not significant. The year 2009 corresponds to the global financial crisis that impacted Mexico more than other Latin American countries, due to its economic relationship with the US market. The interpretation of these results is that when demand falls sharply, the labor hoarding effect has a negative effect on productivity. Under normal situations where fluctuations are smoother this effect is not important. This illustrates the importance of the macroeconomic environment on productivity growth.

The variables that denote the direction of structural change in line with the skill categories are only significant in the high-skill sectors with a positive sign or elasticities of 0.01 and 0.10. The results of structural change in line with technological categories are not significant in the case of supplier-dependent 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 with an elasticity of 0.010, but is negative in the difference, with an elasticity of -0.0004, with which the long-term elasticity is 0.04. In other words there is a negative dynamic effect that denotes less potential in the long term, although it is minimal.

Specialized suppliers, which, as we will recall, increased their participation by 3.6% in the total aggregate value, demonstrate a positive association, with elasticities of 0.011 in the short term and 0.11 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 a 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, while a positive impact was noted for ICT-producing sectors, with an elasticity of 0.002 in the short term and 0.02 in the long term.

Looking at our results on the variables for the selected industry groups, and in a similar fashion to the results of Silva and Teixeira for the 21 countries, we find that the influence over productivity growth stems mostly from the share variables and not from the 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.

Table 4

Results of the econometric model for the 62 sectors of the economy

Variable	Base	Supp-dependent	Scale-intensive	Specialized-supp	Inf-intensive	ICT-using	ICT-producing	Elasticities	
								Short run	Long run
LP_{t-1}	0.886	0.882	0.877	0.872	0.886	0.883	0.867		
s.e.	0.028	0.028	0.027	0.030	0.028	0.028	0.026		
High Ed	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
s.e,	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
High Ed_{t-1}	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
s.e.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
$HighEd_{t-2}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.04	0.34
s.e.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Low Ed	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
s.e.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Low Ed$_{t-1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
s.e.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Low Ed$_{t-2}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.02	-0.14
s.e.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
KL	0.178	0.180	0.191	0.160	0.177	0.179	0.190	0.014	0.02
s.e.	0.094	0.093	0.095	0.080	0.094	0.093	0.091		
KL$_{t-1}$	-0.144	-0.142	-0.136	-0.130	-0.146	-0.143	-0.138	-0.011	
s.e.	0.046	0.046	0.045	0.046	0.046	0.046	0.046		
yr1995	-0.044	-0.044	-0.044	-0.044	-0.044	-0.044	-0.043	-0.04	-0.36
s.e.	0.015	0.015	0.015	0.015	0.015	0.015	0.015		
yr2009	-0.033	-0.032	-0.031	-0.030	-0.033	-0.032	-0.030	-0.03	-0.26
s.e.	0.011	0.011	0.011	0.011	0.011	0.011	0.012		
Supp-dependent$_{t-1}$		1.245							
s.e.		1.362							
ΔSupp-dependent$_{t-1}$		-0.540							
s.e.		1.293							
Scale-intensive$_{t-1}$			8.936					0.01	0.04
s.e.			4.099						
ΔScale-intensive$_{t-1}$			-17.696					-0.0001	
s.e.			4.343						
Specialized-supplier$_{t-1}$				3.839				0.01	0.11
s.e.				1.891					
ΔSpecialized-supplier$_{t-1}$				-0.609					
s.e.				1.631					
InfInt$_{t-1}$					-0.849				
s.e.					0.866				
ΔInfInt$_{t-1}$					1.220				
s.e.					1.181				
ICTusing$_{t-1}$						0.747			
s.e.						1.077			
ΔICTusing$_{t-1}$						-1.575			
s.e.						2.709			
ICTproducing$_{t-1}$							6.853	0.002	0.02
s.e.							2.998		
ΔICTproducing$_{t-1}$							19.801		
s.e.							13.701		
N	1218	1218	1218	1218	1218	1218	1218		
Arellano-Bond test AR(2)	0.86	0.94	0.84	0.80	0.85	0.78	0.87		
Sargan test of overid. restrictions	0.75	0.78	0.73	0.76	0.78	0.75	0.78		

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 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 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 of consolidation for the trade opening and the new policy scheme.

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-dependent 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 the information and communication technologies in which knowledge of and interaction of science with industry are essential.

Our results from our dynamic panel estimation demonstrate the importance of employing skilled personnel in companies, as established in other analyses of productivity determinants. However, as expected, we found important differences in Mexico's structural characteristics when compared to those of advanced and emerging countries in which labor productivity is associated with high-skill, science-based, specialized supplier and ICT-producing sectors in both services and manufacturing.

Labor productivity is positively associated with lagging participation by specialized suppliers and sectors with scale-intensive technology—consistent with the specialization pattern characterizing Mexico's economy in the international market—and with much lower elasticities with ICT-producing sectors and sectors requiring high-level skills. However, there are important differences between the industry and the overall economy. In industry, productivity is negatively associated with very low and low-skill sectors, with supplier-dependent sectors (that contribute a third of aggregate value and two-thirds of hours worked) and ICT users. An important aspect to point out is that the coefficient of negative structural change in scale-intensive industries specifies a loss of dynamism in this relationship. In contrast, in the difference in the case of specialized suppliers, it is positive—which can be considered to be an interesting index of change.

One focus of this work was to conduct an analysis of supply and demand. To this end we utilized the urban unemployment rate as an approximation of the decline in the demand. This variable did not turn out to be significant. A possible explanation 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. Nevertheless, among the variables for each year, they were significant with a negative sign for 1995, corresponding to the Tequila Crisis, and for 2009, the year of the global financial crisis that wielded a severe blow to our primary trade partner, in the case of the overall economy. This evidence demonstrates the effect of demand shocks and illustrates the importance of the macroeconomic environment on productivity growth but it is necessary to continue studying this phenomenon.

In summary, 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 the 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.

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