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Patterns of Total Factor Productivity Growth in Mexico: 1991-2011.*

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Abstract: We review some patterns of Total Factor Productivity (TFP) growth in the Mexican economy during the period 1991-2011 using the KLEMS data set published by INEGI in 2013. The data shows a strong positive correlation between TFP and output growth. As a result, tests were performed in order to determine a possible causality between these two variables, with the results not rejecting the hypothesis of causality running in both directions. Another pattern that also emerges from the data set is that TFP growth in Mexico tends to be fairly concentrated and highly irregular, as just a reduced share of the subsectors in any given time period tends to account for most of the TFP growth, and also because the distribution of their performance is far from being the same across time. These patterns are similar to those found in other data sets of the Mexican economy, as well as in data from the United States and the United Kingdom at different levels of aggregation.
Keywords: Growth accounting, economic growth, TFP growth
JEL Classification: N16, O10, O40, O43, 047

Resumen: En este trabajo revisamos algunos patrones de comportamiento de la Productividad Total de los Factores (TFP) en la economía mexicana durante el periodo 1991-2011 empleando el panel de datos KLEMS publicado por INEGI en 2013. Los datos muestran una correlación positiva entre el crecimiento de la TFP y el de la producción. Como resultado de este patrón, llevamos a cabo pruebas de causalidad para datos panel a fin de determinar una posible causalidad entre estas dos variables, encontrando que no puede rechazarse la hipótesis de causalidad en ambas direcciones a niveles de significancia convencionales. Otro patrón que también arrojan los datos del INEGI es que el crecimiento de la TFP, además de irregular, tiende a concentrarse en unos cuantos sectores. Los patrones aquí identificados son similares a los observados en otras bases de datos de la economía mexicana, así como de las economías de Estados Unidos y del Reino Unido para niveles de agregación.
Palabras Clave: Contabilidad del crecimiento, crecimiento económico, crecimiento de la Productividad Total de los Factores

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1. Introduction

In a recent paper, Jorgenson and Vu (2012) sustain that the world economy will experience a massive reconfiguration that will translate into a New Economic Order by 2020. In this new order, the authors claim, "China will displace the U.S. as the world's leading economy and India will overtake Japan. This will shift the balance of the G20 from the leading industrialized economies of the G7 to the emerging economies, especially China and India (Jorgenson and Vu, 2012)." Interestingly, in that description of the future international configuration, Mexico receives very little attention, something that perhaps may be understood in terms of the low growth that the authors estimate for the Mexican economy for the current decade in their baseline scenario, and which results in Mexico being excluded out of the eight biggest economies of the world in 2020.

Such forecast invites one to ponder about what has been happening with the Mexican economy's growth fundamentals. However, attempting to answer these questions is without a doubt a difficult task, since the study of the economic growth process continues to be as complex and controversial as ever, both from a theoretical as well as from an empirical point of view (Hulten, 2000).

Considering the above, the current paper is modest in its scope as it only seeks to identify patterns in the Mexican growth process which may help us to better understand its nature and provide lines for further research. In this task, we take advantage of a new growth accounting data set at the subsector level for the period 1991-2001 recently published by INEGI (the Spanish acronym for the National Institute of Statistics and Geography), where the relevance of these estimates arises from the fact that they come from the most recent and comprehensive

effort in terms of data sources used so far in our country, and also because they are obtained through the KLEMS framework, a methodology that nowadays is being adopted by renowned institutions to study the growth process in both developed and developing economies.

The paper is organized as follows. Section 2 reviews the KLEMS data for the Mexican economy generated by INEGI. Section 3 reviews the behavior of output and total factor productivity (TFP) growth in the Mexican economy at the branch level during the period covered by this new data set (1991-2011), where it is shown that despite the fact that TFP has had a negative contribution to output growth, the traditional positive link between the two variables still holds. Section 4 analyzes how concentrated or dispersed productivity growth has been in Mexico, and whether productivity growth tends to stem or not from a similar set of industrial branches across time. Our review of the data shows that just a moderate number of industrial branches at any given period tend to account for most of the productivity growth, and that the contribution of individual branches to productivity growth is highly irregular over time. The patterns identified here –concentration, and unsteadiness of TFP- are in accordance with what has been found using data sets for other economies at different levels of aggregation. Final comments are presented in section 5.

2. The KLEMS Project for Mexico

Today it is well established that economic growth stems from the increase in the use of inputs, as well as from increases in total factor productivity. Such statement has been traditionally summarized in the following growth equation:

$$(1)\ \Delta Y = w\Delta L + \rho\Delta K + R,$$

with "*Y*" representing real gross output[1], "*L*" the employed labor force, "*K*" the real net capital stock, "w" the average real wage, and "ρ" the average real gross rate of return to capital.[2] This equation imputes to incremental labor the average real wage of existing labor, and to incremental capital the average real return of the existing capital stock. The last component, "*R*", was initially thought of as a coefficient of technical advance, but it was soon recognized to be a composite of many different elements, such as economies of scale, unused capacity, improved ways of combining resources to produce goods and services, not just at the level of new machines or processes, but also by minor adjustments at the level of the factory, among others.

Early growth accounting studies showed that about half of output growth was unaccounted for by the growth of inputs, an observation that led many economists to "attempt" to reduce the size of the residual. This research agenda quickly produced important advances by emphasizing the need to subtract from the residual the contribution stemming from increases

[1] There is disagreement about whether to use gross or net value added in these calculations. Growth theorists, for example, sustain that it is more adequate to exclude depreciation of fixed capital because "this is an intermediate cost that, like the consumption of raw materials and semi-finished goods, is excluded from the measure of final output. However, others, particularly those looking at the issue from the standpoint of production theory, prefer the gross measure because for them depreciation is part of the measure of the services of the primary factor -capital." (In Baumol and McLennan, 1985, p. 30). Following the KLEMS methodology, INEGI uses gross output, and this is why we employ this concept in this paper.

[2] If Y is net real output, "r" should be the net-of-depreciation rate of return to capital.

in the quality of the inputs (labor, physical and human capital, intermediate inputs) as well as the contribution from research and development (R&D) (Griliches, 1979; Jorgenson and Kuroda, 1986; Maddison, 1993; Hulten, 2000). These efforts, in turn, were conducive to the development of a more microeconomic oriented view of the growth process in which the growth equation was rewritten as:

$$(2) \qquad \Delta Y = \Sigma_j w_j \Delta L_j + \Sigma_i \rho_i \Delta K_i + R,$$

with "Y" representing once again real gross output, "w_j" the unit cost of labor of type "j", "ρ_i" the gross rate of return to capital of type "i", "L_j" the labor of type "j", and "K_i" the net capital stock of type "i" (Harberger, 1992).

More recently, and thanks to the availability of new data, this more disaggregated growth accounting approach was extended, once again, to include additional inputs besides capital and labor in the accounting of growth. The KLEMS approach goes along these lines, in the sense that in addition to capital (K) and labor (L), explicitly considers the contribution of three additional inputs: energy (E), raw materials (M), and services (S). Hence, the growth accounting equation now becomes:

$$\Delta Y = \Sigma_j \rho_j \Delta K_j + \Sigma_i w_i \Delta L_i + \Sigma_m \gamma_m \Delta E_m + \Sigma_n \varepsilon_n \Delta M_n + \Sigma_p \tau_p \Delta S_p + R.$$

The KLEMS methodology, expressed in this fashion, follows the old-fashioned growth accounting framework, with the extra feature that inputs go beyond traditional capital (K) and labor (L), to include also energy (E), raw materials (M) and services (S), which in turn explains why value added is replaced by gross output. Additionally, a lot of refinement is involved in measuring each of these five inputs within each sub-branch, and this is why the KLEMS project provides a lot of value to researchers.

In October 2013, INEGI released the results of its growth accounting KLEMS Project for the Mexican economy which, according to the Institute, represents the most complete information generating effort on the subject which has so far been performed in Latin America. According to INEGI (2013), this effort –which was sponsored by the OECD and CEPAL- seeks to integrate a statistical and analytical platform based on the North American Industrial Classification Code 2007 (NAICS2007) that allows regional and international comparisons of the contributions of capital (K), labor (L), energy (E), raw materials (M), and services (S), and Total Factor Productivity (TFP) to output growth in the Mexican economy. The KLEMS Project for Mexico considered a vast processing of micro data stemming from different sources of information, such as economic censuses, statistical surveys applied at the establishment and household levels, and administrative registers, in order to construct the basic data set, and in which INEGI processed the data under OECD standards to obtain the estimates of output, inputs, and TFP. [3] The project provides growth accounting decompositions for 17 industrial branches and 67 sub-branches from three sectors (primary, secondary and tertiary) at an annual frequency for the period 1991-2011, information that constitutes the basis of our study.

It is worth mentioning that INEGI's estimates were performed within the wider Latin American KLEMS (LA KLEMS) Project, in which the same methodology was employed to produce estimates of inputs, output and TFP for other seven countries of the region, namely, Argentina, Brazil, Chile, Colombia, Costa Rica, Peru, and Venezuela. This methodology, in turn, has as a background the EU KLEMS (European Union KLEMS) Project, which was

[3] For an exhaustive listing of the sources employed by INEGI to produce the information required to estimate output, inputs and TFP growth, see INEGI (2013), p.1.

financed by the European Commission and which delivered data sets for members of the European Union from 1970 up to 2008. Hence, since the methodologies employed to process the information are uniform, the KLEMS data for all these countries provide an opportunity to make international comparisons.

3. TFP and Output Growth in the Mexican Economy

Given the refinements in the estimation of the sources of growth for Mexico provided by INEGI's KLEMS data set, we proceed here to investigate whether some postulates of the empirical literature on growth accounting still hold. In particular, we review whether two traditional findings of the growth accounting literature hold, namely, (i) that TFP growth represents a significant component of output growth; and (ii) that changes in TFP growth are associated to changes in output growth. The relevance of looking into these patterns resides in that a variety of studies at different levels of aggregation show that higher rates of TFP growth are closely and positively related to output growth. After this, in section 4 we will move to investigate two other issues that are frequently overlooked in the traditional literature, but which are also relevant for a better understanding of the growth process. The first has to do with the concentration of TFP growth, while the second has to do with its resilience.

3.1. The Association between Output and TFP Growth

The relevance of TFP to account for output growth is one of the main tenets of the growth accounting literature. Indeed, in this literature it is common to find claims indicating, for instance, that "roughly half of cross-country differences in per capita income and growth are driven by differences in total factor productivity (TFP)… Furthermore, much of the widening

gap between rich and poor countries results not from differences in capital investment, but from differences in technological progress (Lederman, Maloney and Serven 2005)." [4]

However, as more refinements have been gradually added to the growth accounting methodology, more studies have claimed that the connection between TFP and output growth is not really as strong as it has been usually claimed. One example would be Jorgenson and Vu (2010), who assert that "[p]roductivity growth accounted for less than 1/8 of world growth during 1989-1995; less than 1/5 in 1995-2000 and less than 3/8 in 2000-2004 and 2004-2008." Due to these contrasting views, in what follows we review the new KLEMS Mexican data to determine how strong is the connection between TFP and output growth.

We start our review of productivity growth patterns by looking first at the breakdown of output growth for the whole economy provided by INEGI's KLEMS data set. Table 1a shows the average annual rates of TFP and output growth, while Table 1b shows the average annual contribution of inputs (K, L, E, M, S) to output growth.[5] In both tables, the data are presented for the whole period, as well as for the sub-periods 1991-1995, 1996-2000, 2001-2005, and 2006-2011. [6] The first feature to observe from this data is the negative average contribution of TFP to output growth (-0.39 percent) for the period 1991-2011 (Table 1a), a figure that implies that output growth, which averaged 3.58 percent, came entirely from the growth of inputs. In fact, the last line of Table 1b shows that, for the whole period, around 44 percent

[4] See also Kendrick (1982), Baumol and Mc Lennan (1985), Elías (1992), Harberger (1992, 1998a, 1998b), Jorgenson (1990, 1995), Beyer (1996), World Bank (1998).

[5] The data in Table 1a are taken directly from INEGI, which estimates average TFP growth for the whole economy as an average of the annual growth rates. In Appendix A, we compared these estimates with weighted average measures, finding that the results were essentially the same.

[6] Our sub-periods can be initially thought as being arbitrarily defined. However, they were to a large extent defined based on relevant events. Thus, the 1991-1995 sub-period can be identified as the "pre-NAFTA period"; the 1996-2000 as the "post-crisis period"; the 2001-2005 as "post-China's accession to the World Trade Organization"; and the 2006-2011 as the "Great Recession period".

of output growth came from "K" (0.44=1.58/3.58), followed by the contribution of "M" (32 percent), "S" (20 percent), "L" (12 percent) and "E" (3 percent). When looking at the data by sub-periods, it can be seen that the average contribution of all inputs (K, L, E, M, and S) to output growth was always positive, while that of TFP growth was positive only during the sub-period 1996-2000, when it posted an average annual rate of 1.11 percent, implying that it accounted for only 15 percent of output growth.

Table 1a: Growth Accounting for the Mexican Economy 1991-2011
Absolute Contribution of Inputs and TFP to Output Growth
Annual Arithmetic Averages (%)

Period	Output value	Capital services	Labour services	Energy	Materials	Services	Contribution of inputs	Total Factor Productivity
	Y	*K*	*L*	*E*	*M*	*S*	K+L+E+M+S	*TFP*
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
1991-1995	2.09	1.28	0.47	0.06	0.83	0.38	3.03	-0.93
1996-2000	7.10	1.47	0.72	0.20	2.54	1.05	5.99	1.11
2001-2005	2.39	1.61	0.29	0.08	0.55	0.61	3.15	-0.76
2006-2011	2.88	1.90	0.26	0.04	0.79	0.76	3.76	-0.87
1991-2011	3.58	1.58	0.43	0.09	1.16	0.7	3.97	-0.39

Table 1b: Relative Contribution of Inputs and TFP to Output Growth
Annual Arithmetic Averages (%)

Period	Output value	Capital services	Labour services	Energy	Materials	Services	Contribution of inputs	Total Factor Productivity
	Y	*K*	*L*	*E*	*M*	*S*	K+L+E+M+S	*TFP*
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
1991-1995	100	61.2	22.5	2.9	39.7	18.2	144.5	-44.5
1996-2000	100	20.7	10.1	2.8	35.8	14.8	84.2	15.6
2001-2005	100	67.4	12.1	3.3	23.0	25.5	131.4	-31.8
2006-2011	100	66.0	9.0	1.4	27.4	26.4	130.2	-30.2
1991-2011	100	44.1	12.0	2.5	32.4	19.6	110.6	-10.9

Source: Own estimates based on INEGI's KLEMS (2013) data.

It is interesting to note, however, that in the sub-period in which average TFP growth was the highest (1.11 percent in 1996-2000), average output growth also registered its highest rate (7.1 percent); and when average TFP growth was the lowest (-0.93 percent, in 1991-

1995), the average rate of output growth was also the lowest (2.09 percent), suggesting that the widely known positive association between TFP and output growth might also be present in this new Mexican economy's data set.

We also reviewed the association between TFP and output growth by sectors of economic activity (primary, secondary and tertiary[7]). Results are shown in Table 2, where we present the average data for the entire period, as well as for the aforementioned four sub-periods.

Table 2: Growth Accounting for the Mexican Economy by Sub-sectors 1991-2011

Average Annual Growth Rates (%)

Period	Output Value Growth			Total Factor Productivity Growth		
	Primary (I)	Secondary (II)	Tertiary (III)	Primary (IV)	Secondary (V)	Tertiary (VI)
1991-1995	1.08	2.17	2.14	-0.89	-0.61	-1.33
1996-2000	1.73	9.20	5.35	-0.80	1.08	0.78
2001-2005	2.12	1.92	2.99	0.32	-0.86	-0.82
2006-2011	1.47	2.45	3.52	-0.24	-0.89	-0.99
1991-2011	1.60	3.87	3.50	-0.39	-0.35	-0.61

Source: Own estimates based on INEGI's KLEMS (2013) data.

A feature of the data presented here is that over the whole 1991-2011 period, the secondary sector was the one which grew the most on average (3.87 percent); however, its average TFP growth rate was still negative (-0.35 percent). In the primary and tertiary sectors average output growth was 1.6 and 3.5 percent, respectively; while TFP growth was -0.39 and -0.61 percent, respectively. Hence, the picture that emerges from Table 2 is that average TFP growth tends to be less negative when average output growth is higher, and more negative as average output growth is lower, an attribute that is in accordance with the growth accounting literature.

[7] See Appendix B for a description of the branches within each sector.

In an attempt to report a measure of the degree of association between output and TFP growth, we decided also to estimate simple correlation coefficients between these two variables for the whole period, as well as for each of the four sub-periods. The correlation using the data of all branches for the entire period reached 0.57; and by sub-periods the correlations spanned from 0.55 up to 0.71 (see column I, Table 3). When looking within each sector separately (columns II, III, and IV), all correlation coefficients remain positive and are higher on average than the ones reported in column I (take into consideration that the primary sector has only five sub-sectors).

Table 3: TFP and Output Growth 1991-2011

Correlation Coefficients

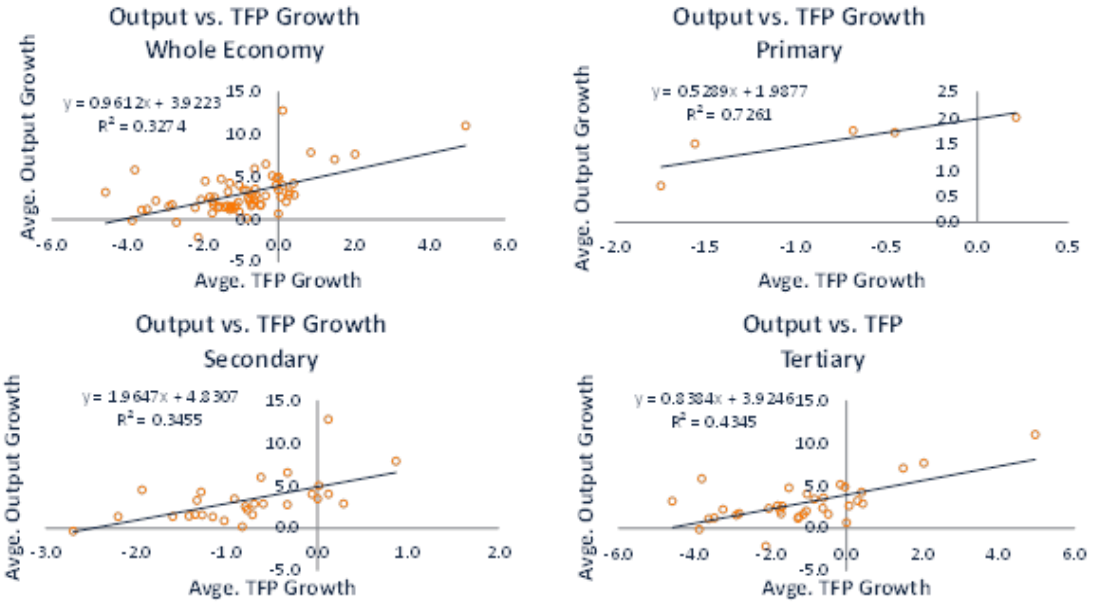
Period	All (I)	Primary (II)	Secondary (III)	Tertiary (IV)
1991-1995	0.55	0.81	0.27	0.69
1996-2000	0.56	0.90	0.61	0.59
2001-2005	0.71	0.97	0.68	0.81
2006-2011	0.59	0.80	0.68	0.59
1991-2011	**0.57**	**0.85**	**0.59**	**0.66**
n=	**67**	**5**	**28**	**34**

Source: Own estimates based on INEGI's KLEMS (2013) data.

The positive association between average TFP and output growth can also be seen in Graphs 1-4. Graph 1 shows the association between average TFP and average output growth for all branches together, as well as by sector, for the whole period 1991-2011; while Graphs 2-5 present the same associations by sub-periods (1991-1995, 1996-2000, 2001-2005, and 2006-2011) for the whole economy, as well as for each sector.

Graph 1: TFP and Output Growth 1991-2011: Whole Economy and Sub-sectors

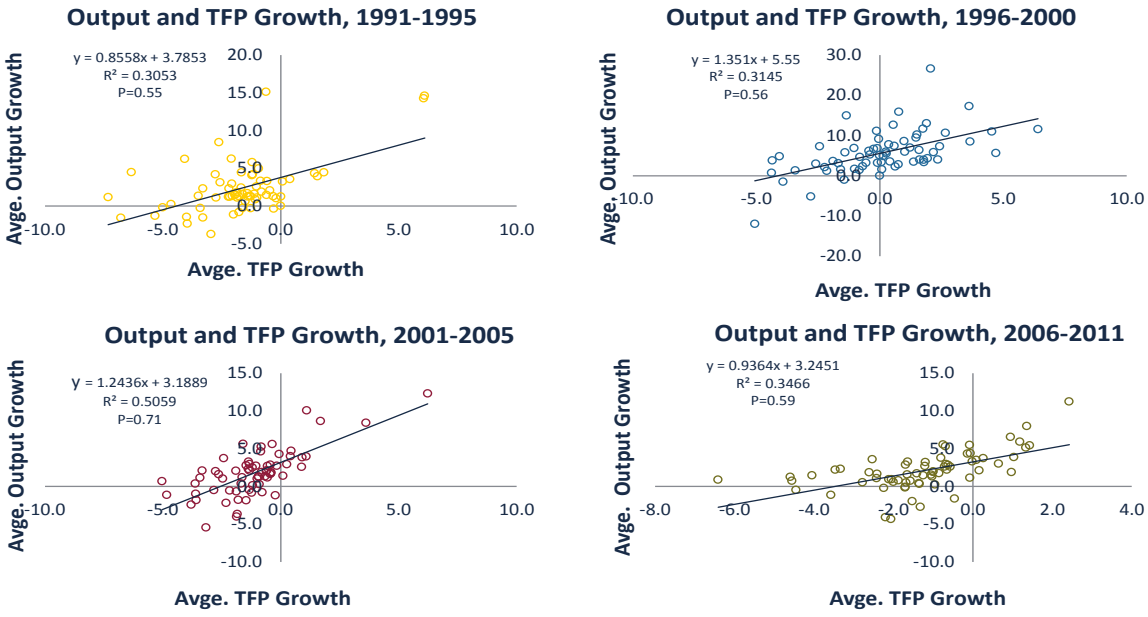
Average Annual Rates (%)



Source: Own estimates based on INEGI's KLEMS (2013) data.

Graph 2: TFP and Output Growth by Sub-periods: Whole Economy

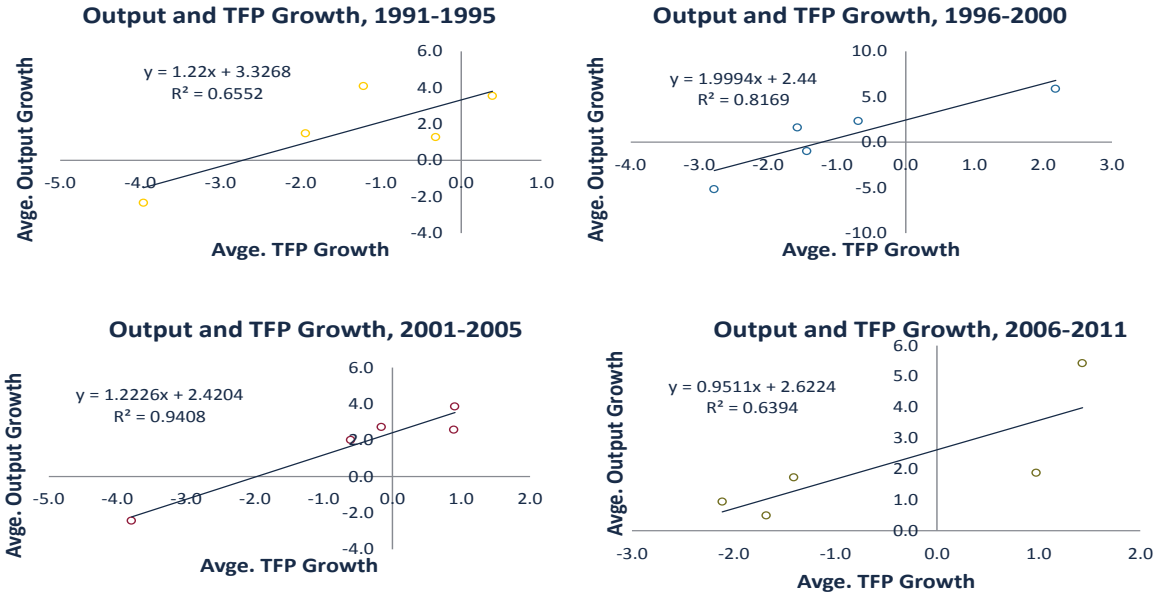
Average Annual Rates (%)



Source: Own estimates based on INEGI's KLEMS (2013) data.

Graph 3: TFP and Output Growth by Sub-periods: Primary Sector

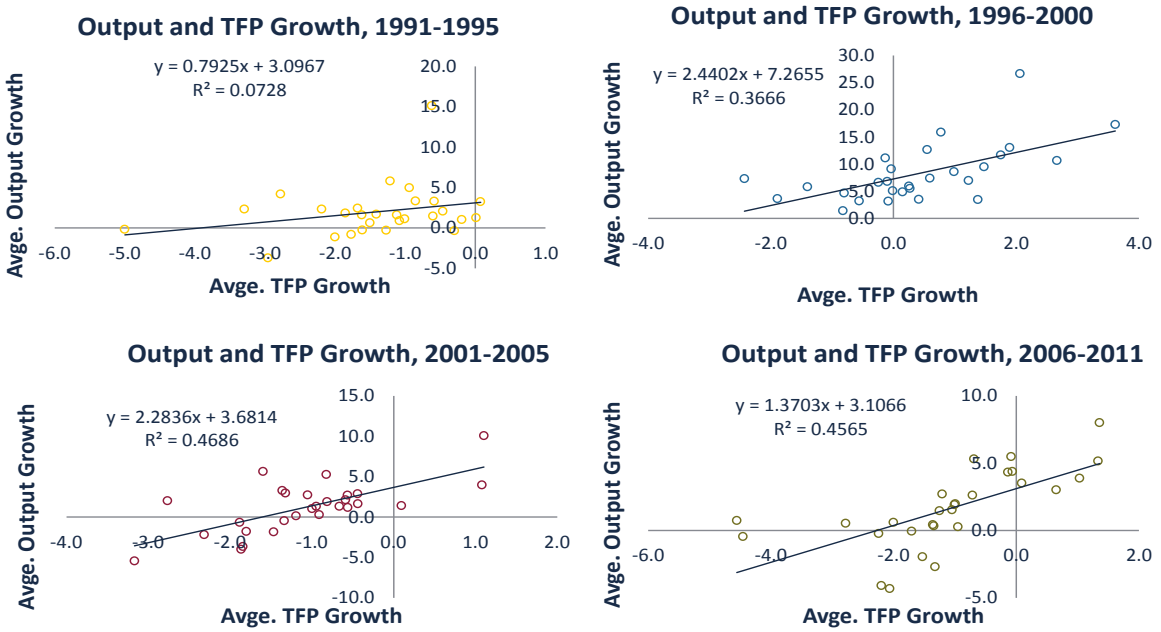
Average Annual Rates (%)



Source: Own estimates based on INEGI's KLEMS (2013) data.

Graph 4: TFP and Output Growth by Sub-periods: Secondary Sector

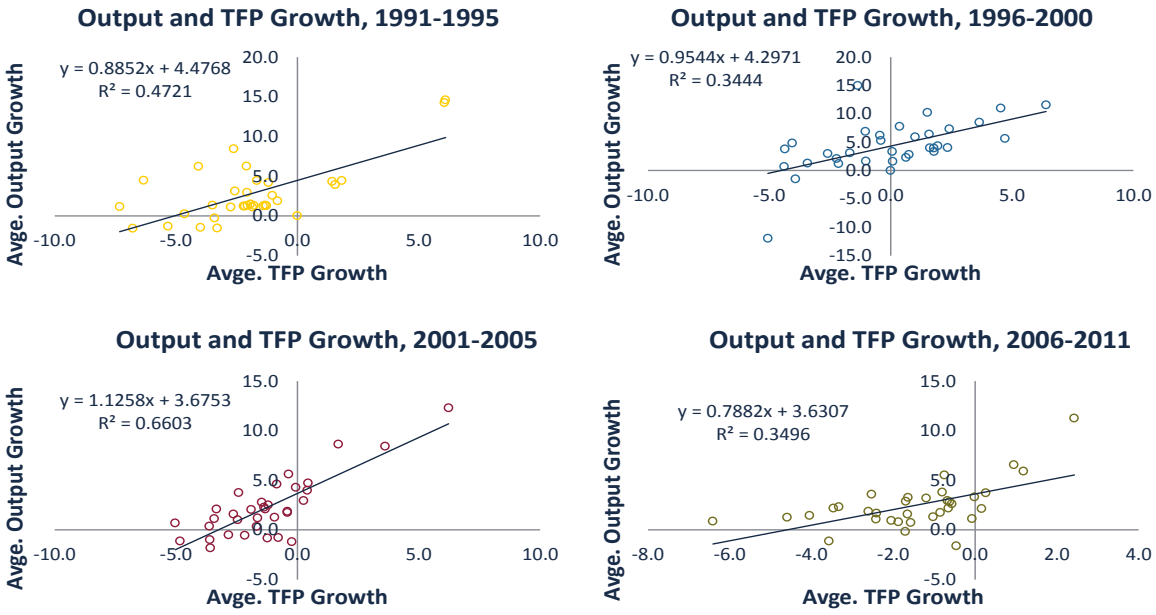
Average Annual Rates (%)



Source: Own estimates based on INEGI's KLEMS (2013) data.

Graph 5: TFP and Output Growth by Sub-periods: Tertiary Sector

Average Annual Rates (%)



Source: Own estimates based on INEGI's KLEMS (2013) data.

But having a positive association between TFP and output growth is not an indication of causation. Hence, we decided to perform Granger causality tests to investigate whether a line of causation between TFP and output growth could be identified. After having confirmed the stationarity in practically all series[8], in a first attempt we performed Granger causality tests using the annual growth rates provided by INEGI. These tests were performed with 1, 2 and 3 lags for each of the 67 sub-sectors, with their results presented in Table 4. The table presents cases in which output growth causes TFP growth, cases in which TFP growth causes output growth, cases in which causality runs in both directions; and cases in which there is no causality at all. The top panel of Table 4 shows that, considering one lag, there are more cases in which output growth causes TFP growth than the other way around; but when considering

[8] This should not be surprising as we are working with growth rates. Results of the stationarity tests are presented in Appendix C.

2 and 3 lags, the results are more balanced. For instance, with one lag there are only 4 cases in which causality runs from TFP to output growth, and 13 in which causality runs from output to TFP growth. The number of cases in which causality runs in both directions is 8, while the number of cases in which there is no causation at all is 42. Using 2 lags, however, we find 6 cases in which Granger causality goes from TFP to output growth, and only 5 cases in which output growth Granger-causes TFP growth. The number in which Granger causality is seen in both directions is identified in 8 cases, while the number of cases in which there is no causality goes up to 48.

Table 4: TPG Growth vs. Output Growth 1991-2011

Granger Causality Tests

Lags included	Output causes TFP	TFP causes output	Granger causality in both directions	No Granger causality in either direction
1 lag	13	4	8	42
2 lags	5	6	8	48
3 lags	6	4	7	50

Granger causality test by subsector (2 lags included), 1991-2011

Sector	Output causes TFP	TFP causes output	Granger causality in both directions	No Granger causality in either direction
1.- Primary	0	1	1	3
2.- Secondary	1	3	1	23
2.1.- Manfacturing	0	2	1	18
3.-Tertiary	4	2	6	22
Total	5	6	8	48

Source: Own estimates based on INEGI's KLEMS (2013) data.

The bottom panel of Table 4 presents the Granger causality tests by sector when using 2 lags. The interesting feature of presenting the data this way is that reveals that most cases in which TFP growth Granger-causes output growth are found in the secondary sector, while causality in the other direction is seen in a higher number in the tertiary sector.

We tried other specifications in an attempt to uncover a stronger connection between TFP and output growth. Hence, we considered using moving averages for the series of TFP and output growth under the argument that probably more stable relationships could be identified if we looked at data smoothed this way. The top panel of Table 5 presents the results of Granger causality tests for the 2, 3, and 4 year moving averages of TFP and output growth.[9] We present the results of the tests using only 2 lags since it was under this specification that we obtained the best results. Notice, however, that even under this specification, the cases in which we were not able to identify causation in either direction was still quite large: 5 cases out 67 cases under moving averages of 2 years, 33 out of 67 under moving averages of 3 years, and 41 out of 67 moving averages of 4 years. The evidence, hence, suggests the difficulty of concluding about a relation of causality among the variables.

Table 5: TFP Growth vs. Output Growth 1991-2011

Granger Causality Tests

2 lags included	Output causes TFP	TFP causes output	Granger causality in both directions	No Granger causality in either direction
Moving average MA(3)	12	9	13	33
Moving average MA(4)	5	12	9	41

Granger causality test by subsector (2 lags included-MA(3)), 1991-2011				
Sector	**Output causes TFP**	**TFP causes output**	**Granger causality in both directions**	**No Granger causality in either direction**
1.- Primary	0	0	1	4
2.- Secondary	4	5	3	16
2.1.- Manfacturing	2	3	3	13
3.-Tertiary	8	4	9	13
Total	12	9	13	33

Source: Own estimates based on INEGI's KLEMS (2013) data.

[9] We did not try more lags as we only have 21 observations for each sub-sector.

The previous analysis, however, is subject to criticism as it applies the Granger causality tests to a very short data set. Because of this, we also decided to use panel data techniques to our data in order to determine, within this context, whether causality was or not present.[10] In this pursuit, we run first the Im-Pesaran-Shin (2003) panel unit root test to our data (21 years, 67 sectors, 2 variables) considering two lags, which were chosen based on the Akaike and Quinn Information Criteria. In this test, the null is that *all* panels contain unit roots, while the alternative is that *some* panels do not contain unit roots (see Table 6).

Table 6: Im-Pesaran-Shin Unit-root Tests*
Number of Panels=67, Number of Periods=21.

Ho: All panels contain unit roots.
Ha: Some panels are stationary.

Variable	Statistic (Z-t-tilde-bar)	p-value
TFP Growth	-18.585	0.000
Output Growth	-17.211	0.000

*Own estimates using STATA. Time trend not included.

Results in Table 6 show that the null of all panels containing unit roots can be rejected at the 99 percent confidence level for both output and TFP growth, result that should not be surprising as we are working with growth rates. Given these results, panel cointegration tests were not required. Instead, we proceeded directly to perform panel Granger causality tests.

The tests were applied –with two lags- using both "forward orthogonalized deviations" and "first differences", since there is not a strict formal procedure to choose one method over the other. The estimates are presented in Table 7, with the first panel showing the results using "forward orthogonalized deviations", and the second the results using "first differences".

[10] We thank an anonymous referee for this suggestion.

Table 7: Panel VAR-Granger Causality Wald Test*

Fixed-effects removed using forward-orthogonal deviation method

Ho: Excluded variable does not Granger-cause Equation variable.
Ha: Excluded variable Granger-causes Equation variable.

Equation Variable	Excluded Variable	chi2	Df	Prob > chi2
TFP Growth	Output Growth	8.45	2	0.02
Output Growth	TFP Growth	0.10	2	0.95

Fixed-effects removed using first difference method

Ho: Excluded variable does not Granger-cause Equation variable.
Ha: Excluded variable Granger-causes Equation variable.

Equation Variable	Excluded Variable	chi2	df	Prob > chi2
TFP Growth	Output Growth	18.57	2	0.00
Output Growth	TFP Growth	16.44	2	0.00

*Own estimates using STATA with the package of programs of Panel Vector Autoregression by Abrigo and Love (2015). VAR previously estimated with maximum lag order=2.

Results of the test using "forward-orthogonalized deviations" indicate that the hypothesis that output growth does not Granger-cause TFP growth can be rejected at a 95 percent confidence level, while the hypothesis that TFP growth does not Granger-cause output growth can not be rejected at the traditional confidence levels. In other words, based on this test, causality goes only from output to TFP growth.

However, when using "first differences", the test reveals that we can reject the null that output growth does not Granger-cause TFP growth, and also reject the null that the TFP growth does not Granger-cause output growth. In other words, under this specification, causality goes in both directions.

Thus, these tests suggest that it is not possible to conclude that causality goes only from output to TFP growth, and therefore future studies about the sources of growth in Mexico should take this into account.

In summary, in this section we have seen that in the Mexican economy output and TFP growth are positively correlated, but the evidence that TFP growth causes output growth, or the other way around, is not very strong.

4. Concentration and Irregularity of TFP Growth in Mexico

> *"The grand design that emerges … is that: (i) a small-to-modest fraction of industries can account for 100 percent of aggregate real cost reduction in a period; (ii) the complementary fraction of industries contains winners and losers, the TFP contributions of which cancel each other; and (iii) the losers are a very important part of the picture most of the time."*
>
> *Harberger (1998), p.10*

Other dimensions of the Mexican productivity growth process that we revise with the new data set relate to its concentration and irregularity.[11] These two features are interesting to look at since they may be compared with the view implied by aggregate models of economic growth. For instance, aggregate neoclassical and endogenous growth models convey the view of economic growth as being smooth, uniform and steady, and more importantly, stemming from a few general forces [Solow 1956, Cass 1965, Koopmans 1965, Romer (1986,1987,1988), Lucas 1988]. Some practitioners, however, assert that is not the case and propose instead that productivity growth tends to be a quite uneven and unsteady process at all levels of aggregation, and emphasize that this feature stems from the fact that productivity and output growth derive from a vast array of forces that makes no sense to try to model them (Ehrlich 1990, Nelson 1996, Harberger 1998a).

[11] We will explain below what we mean precisely by concentration and persistence.

Using the Mexican data, we look first at the concentration patterns of TFP growth for the Mexican economy by constructing "sunset-sunrise" diagrams as proposed by Harberger (1998a); next, we review the persistence of the growth process by looking at the distribution of leader and laggard sectors across different time periods. As we will see, the Mexican data suggests, not surprisingly, that productivity growth is highly concentrated and highly irregular.

4.1 Concentration of TFP Growth in the Mexican Economy 1991-2011

We start this subsection by reviewing first the construction and interpretation of a "sunset-sunrise" diagram, for this is the tool we will employ here to look at the concentration patterns of productivity growth. A "sunset-sunrise" diagram simply contrast how much of the productivity growth for an aggregate (i.e, the total economy, an economic sector, or sub-sector, etc.) during any given period is accounted for a given fraction of the economic units for which we have information to construct the corresponding aggregate, and that is why it provides a measure of concentration. In terms of their design, a "sunset-sunrise" diagram is similar in spirit to a Lorenz curve.[12] It is important to emphasize here that "sunset-sunrise" diagrams are just descriptive tools, and therefore one can not perform econometric hypotheses on them.

The construction of a "sunset-sunrise" diagram follows the next steps:

1. Arrange economic units in descending order according to their average TFP growth rates for the period.

[12] The methodology to construct a "sunset-sunrise" diagram is taken from Harberger 1998a.

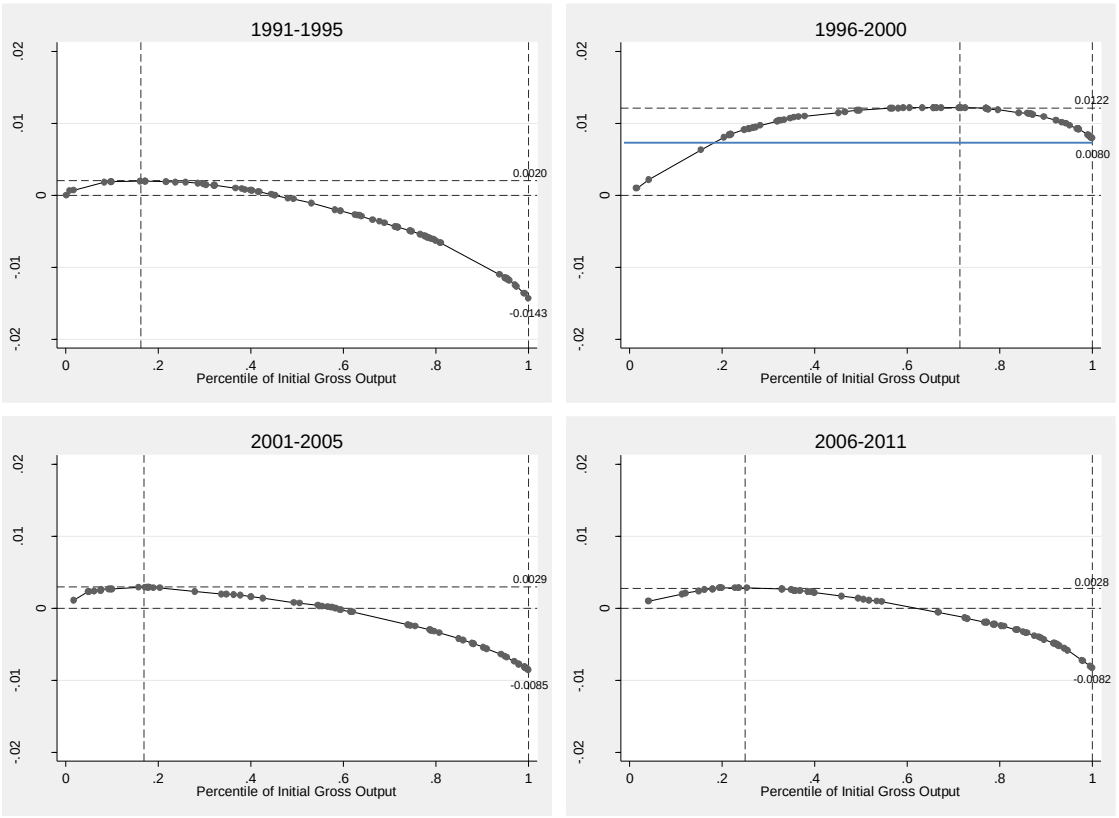
2. Obtain the constant peso value of TFP for the period for each economic unit. This value is simply the result from multiplying each unit's average TFP growth for the period, times the corresponding initial value of output of each economic unit (which is expressed in constant pesos). For instance, if we had an economic unit with an initial output of 100 constant pesos and an average rate of TFP increase of 5 percent for the period, then the value of TFP for the period in constant pesos for that economic unit would be 5 pesos.
3. Calculate the cumulative sum of real TFP values of the economic units from the previous step (and which are already arranged in descending order according to average TFP growth), and associate them with cumulative initial real value of output.
4. Next, divide the data of the cumulative sum of real TFP values by total TFP increase for the period. Notice that the last figure of this series will be the rate of TFP growth for the period.
5. Then, calculate cumulative initial real value added as a fraction of total output.
6. Finally, create a graph with the values created in step 4 shown along the vertical axis; and the values estimated in step 5 shown along the horizontal axis.

Based on the above, if all economic units of an aggregate had posted the same average rate of TFP growth, we would have obtained a 45 degree straight line, with the concentration lecture being obtained by looking at that amount that economic units were gradually accounting of the initial output for the aggregate shown along the horizontal axis.

With the Mexican data, however, we obtain non-linear patterns. This is the case since, as it will be evident below, we have sub-sectors with positive, zero and negative average TFP growth rates. Moreover, the patterns that emerge also tend to indicate the TFP growth tends to be uneven and fairly concentrated.

We computed "sunset-sunrise" diagrams for sub-periods 1991-1995, 1996-2000, 2001-2005 and 2006-2011 using all sub-sectors of the economy together (Graph 6), and then we performed the same exercise within each sector (Graphs 7, 8 and 9). The first feature to notice out of these graphs is that they are far from resembling 45 degree straight lines, implying that productivity growth in Mexico has not been uniformly distributed. To appreciate this feature, look at, for instance, period 1991-1995 in Graph 6. There we have that TFP growth was positive in only 18 percent of the sub-sectors (as measured by their accumulated gross output); while the remaining sub-sectors (82 percent) reported zero or negative TFP growth.

Graph 6: TFP Growth Profile in the Mexican Economy (67 subsectors)



Source: Own estimates using data from INEGI (2013)

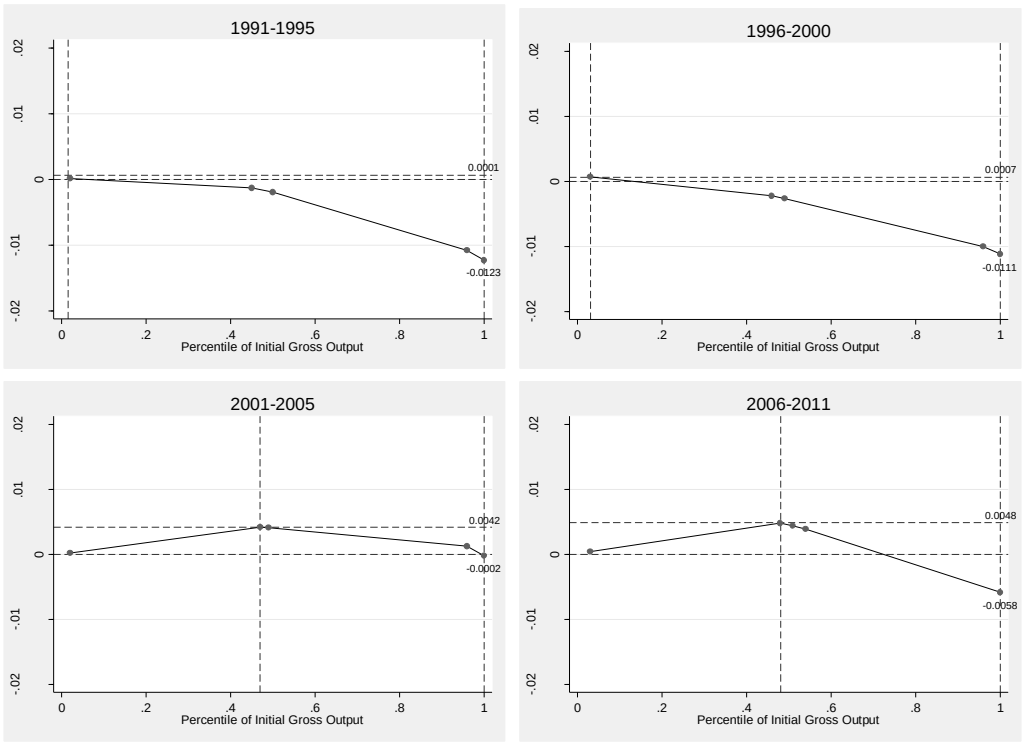
If the sub-sectors with nil or negative contributions had not been present, the average TFP growth of the Mexican economy for the 1991-1995 period would have been 0.2 percent,

instead of the -1.4 finally reported. Similar readings can be done out of the graphs for sub-periods 2001-2005 and 2006-2011, for which average TFP growth was negative. In these two cases, if those sub-sectors with zero or negative contributions had not been present, the average rate of TFP growth had been 0.29 and 0.28 percent, respectively.

The graph for 1996-2000 is interesting to look at independently, since during this sub-period, the Mexican economy registered an average positive TFP growth rate of 0.8 percent. Here, if we follow the horizontal line traced along the 0.008 (or 0.8 percent) value of the vertical axis (which measures the cumulative rate of TFP growth) we find, first, that only 20 percent of the sub-sectors accounted for the entire growth in TFP; and second, that if the sub-sectors with negative TFP growth had not been present, the average TFP growth in the Mexican economy during 1996-2000 had reached 1.22 percent. When we revise the data by sector (primary, secondary, and tertiary), similar patterns are still observed. In particular, that average TFP growth in all sub-sectors is negative during 1991-1995, 2001-2005 and 2006-2011, and that only a handful of branches register positive average TFP growth rates in those sub-periods. For 1996-2000, we find that in the secondary and tertiary sectors average TFP growth is positive, and that growth is accounted for less than 30 percent of the branches.

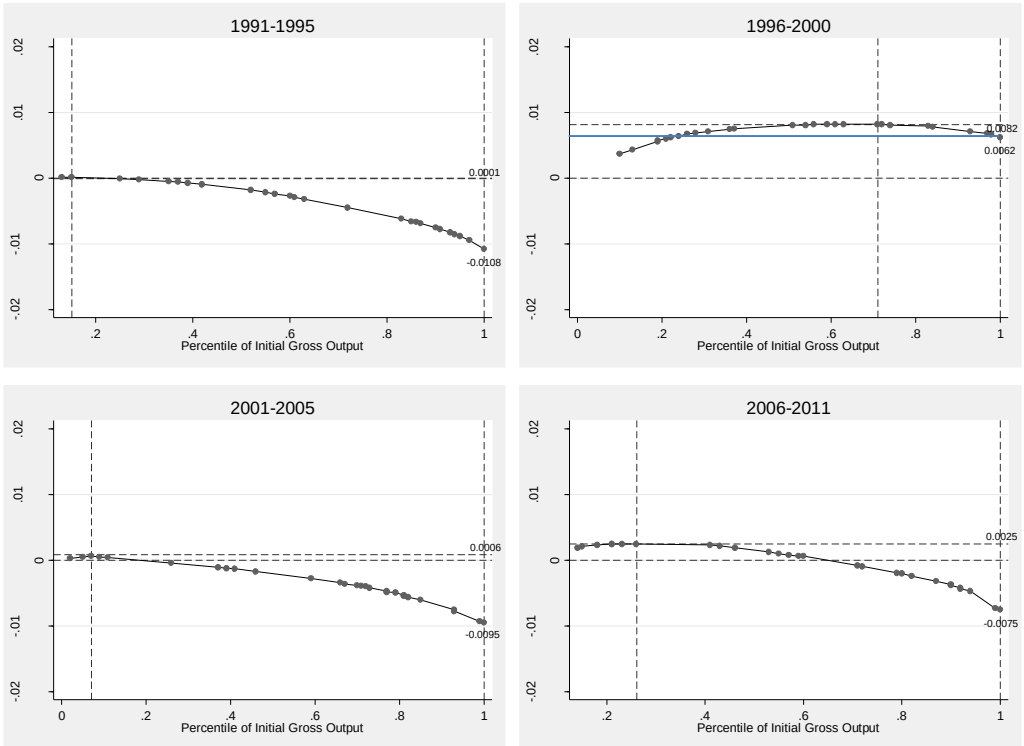
It is worth mentioning that the message here may have been anticipated from Graphs 1-5, where it was shown that just a small (large) number of sub-sectors were in the positive (negative) quadrant of TFP growth. However, Graphs 6-9 are more compelling since they tell us right away if during any given period TFP growth is being explained by a relatively small or large number of economic units, with that size being measured in terms of the initial value of output of the corresponding economic units.

Graph 7: TFP Growth Profile in the Mexican Primary Sector



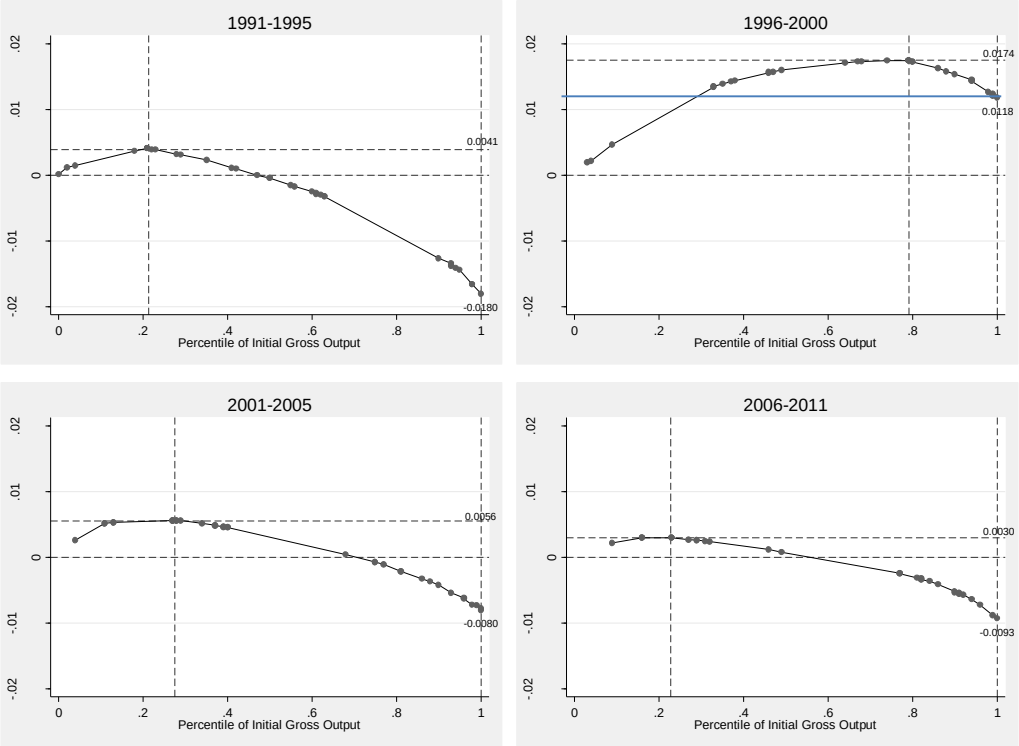
Source: Own estimates using data from INEGI (2013).

Graph 8: TFP Growth Profile in the Mexican Secondary Sector



Source: Own estimates using data from INEGI (2013).

Graph 9: TFP Growth in the Mexican Tertiary Sector



Source: Own estimates using data from INEGI (2013).

The patterns observed here, we should add, are nothing new, as they resemble closely those that have emerged when using data from other countries, time periods and levels of aggregation. For instance, data for 32 sectors of the U.S. economy in sub-periods 1948-1953, 1953-1957, 1957-1960, 1960-1966, 1969-1973, and 1979-1985 taken from Jorgenson (1995) imply that TFP growth was accounted for only the top 17, 4, 22, 31, 3, and 54 percent of the industries, respectively. Also, data from Oulton and O'Mahony (1994) for 130 branches of the U.K. manufacturing sector indicate that in 1954-1963, and 1963-1973, industry's average TFP growth was explained by only the 18 and 4 percent, respectively, of the branches. In a third sub-period (1973-1979) their estimates revealed an average TFP growth for the industry of -1.75 percent, with only 21 percent of the sub-branches registering positive TFP growth rates; while in a fourth sub-period (1979-1986), industry's average TFP growth was also

negative (-0.18 percent), although in this case the branches with positive and negative average TFP growth were very similar in terms of their initial output.[13]

In summary, the recent data from the Mexican economy are consistent with the view of a process of productivity growth that tends to be fairly concentrated, similar to what has been observed in other economies and for different levels of aggregation.

4.2 How Irregular is Sectorial TFP Growth in the Mexican Economy?

The previous section showed evidence that productivity growth in the Mexican economy tends to show signs of concentration, a feature that is in accordance with existing empirical literature on the matter.[14] A question remains, however, about how regular or irregular this process is, with "regularity" referring here to the possibility of some sectors tending to report the highest rates of productivity growth and others tending to report the lowest. Although one may anticipate that the answer is "no", actually there is no evidence on this feature simply because a long data series was not available for the entire economy.[15] Thanks to INEGI's KLEMS data set, it is now possible to look into this issue. We will see next that in Mexico, productivity growth tends to be an irregular process as high and low performers usually differ across time.

To tackle this issue, we ordered sub-sectors from high to low based on their average productivity growth during four sub-periods of five years and two sub-periods of ten years: (I) 1991-1995, (II) 1996-2000, (II) 2001-2005, (IV) 2006-2011, (V) 1991-2000, and (VI) 2001-2011. Then, we chose for each sub-period the 8 sub-sectors with the highest average TFP growth, the 8 with the middle, and the 8 with the lowest average TFP growth (these sub-

[13] The calculations for the U.S. economy and the U.K. manufacturing sector can be found in Torre (2000).
[14] Oulton and O'Mahony (1994), Jorgenson (1995), Beyer (1996), Harberger (1998), Torre (2000).
[15] Torre (2000) uses a data set covering 1984-1994, but is only data of the manufacturing sector.

sectors are shown in Table 6, with their names shown in Appendix 2). Finally, we compared how many sub-sectors remained within each group from one sub-period to the next. Here, we will mean that the growth process tends to be "regular" if a significant fraction of the same sub-sectors tend to remain within each sub-group across time; and "irregular" if sub-sectors do not tend to remain within each sub-group.

Considering first the five-year sub-periods, Table 8 shows that among the top 8, only 2 sub-sectors repeat between sub-periods I and II (491&492, and 517&518), 2 between sub-periods II and III (517&518 and 237) and 3 between sub-periods III and IV (52, 112 and 517&518). Also notice that just one sector remains within the top 8 in all sub-periods (517&518).

Now, if we compare across ten-year sub-periods, we find that two sub-sectors repeat in the top 8 (517&518 and 336); just one in the middle 8 (326); and three in the bottom 8 (515&519, 541, and 713).

Table 9 presents the same exercise as in Table 8, but now across sectors (primary, secondary and tertiary). In this case, since the number of sub-sectors varies within each sector we chose the top performer, the middle performer and the worst performer in the primary sector; the top 5, the middle 5, and the bottom 5 performers in the secondary sector; and the top 6, the middle 6, and the bottom 6 performers in the tertiary sector. Considering again the five-year sub-periods we have been working with, the picture is again one in which there are constant changes within each group across sectors, except perhaps in the bottom 6 in the tertiary sector, where the number of sub-sectors that remain there between sub-periods I-II, II-III, and III-IV are 4, 1, and 4, respectively. When comparing ten-year sub-periods, it can be seen

that in none of the cases there are more than 33 percent of the sub-sectors repeating from one sub-period to the next.

Table 8: Irregularity of TFP Growth in Mexico: 1991-2011

	1991-1995 (I)	1996-2000 (II)	2001-2005 (III)	2006-2011 (IV)	1991-2000 (V)	2001-2011 (VI)
Top 8	491 & 492	**517 & 518**	**517 & 518**	52	517 & 518	518 & 518
	517 & 518	482	52	115	491 & 492	52
	721	484	493	336	721	112
	531	434	237	212	482	312
	722	336	312	**517 & 518**	484	115
	114	237	114	221	336	336
	311	491 & 492	112	112	531	237
	333	711	533 & 551	491 & 492	722	493
Middle 8	931	488	814	**326**	322	335
	322	327	212	485 & 489	493	326
	211, 213 & 486	**322**	**326**	**322**	316	323
	236	312	238	434	238	324
	326	611	337	222	313	482
	52	485 & 487	812	311	211, 213 & 486	222
	337	624	813	313	711	561 & 562
	323	316	339	236	326	327
Bottom 8	711	561 & 562	541	713	515 & 519	621
	813	115	811	532	814	713
	713	712	713	722	483	722
	237	713	722	621	813	515 & 519
	515 & 519	541	512	211, 213 & 486	713	211, 213 & 486
	541	814	113	321	622	321
	712	813	511	541	712	541
	622	483	515 & 519	511	541	511

Source: Own estimates based on INEGI's KLEMS (2013) data.

Table 9: Irregularity of TFP Growth in Mexico, by Sector: 1991-2011

Sector:		1991-1995 (I)	1996-2000 (II)	2001-2005 (III)	2006-2011 (IV)	1991-2000 (V)	2001-2011 (VI)
Primary	Top	114	113	114	115	112	112
	Middle	115	114	115	113	113	114
	Bottom	113	115	113	111	115	113
Secondary	Top 5	311	336	237	336	336	312
		333	237	312	212	334	336
		325	334	332	221	333	237
		324	314	333	312	314	212
		331	332	327	323	212	221
	Middle 5	332	313	325	332	325	339
		314	311	212	326	324	335
		335	327	326	322	322	326
		316	322	238	222	316	323
		322	312	337	311	238	324
	Bottom 5	315	325	315	315	237	314
		238	324	236	337	222	238
		321	323	323	238	321	315
		339	222	211, 213 & 486	211, 213 & 486	323	211, 213 & 486
		237	339	321	321	339	321
Tertiary	Top 6	491 & 492	517 & 518	517 & 518	52	517 & 518	517 & 518
		517 & 518	482	52	517 & 518	491 & 492	52
		721	484	493	491 & 492	721	493
		531	434	533 & 531	624	482	624
		722	491 & 492	482	711	484	491 & 492
		624	711	531	484	531	711
	Middle 6	481	531	814	622	811	488
		485 & 487	722	812	531	493	482
		811	488	813	485 & 487	711	561 & 562
		623	611	491 & 492	434	512	434
		611	485 & 487	481	813	485 & 487	813
		533 & 551	624	434	512	611	485 & 487
	Bottom 6	813	712	811	713	483	621
		713	713	713	532	813	713
		515 & 519	541	722	722	713	722
		541	814	512	621	622	515 & 519
		712	813	511	541	712	541
		622	483	515 & 519	511	541	511

Source: Own estimates based on INEGI's KLEMS (2013) data.

In an attempt to measure more formally the irregularity of TFP growth captured in Tables 8 and 9, we also computed rank correlation coefficients across the five and ten-year sub-periods within the three sectors, as well as for the entire economy.[16] Results are shown in Table 10. The table presents the rank correlation coefficients within each sector in columns A (primary), B (secondary), and C (tertiary); while column D presents the estimates using all sub-sectors together.

When looking at the rank correlation coefficients of the five year sub-periods (rows "b", "c", and "d") we found that in the primary sector (column A) all coefficients resulted below 0.10, and none of them was statistically different from zero. This should not be surprising as there is only five observations in this sector and not much could be said in statistic terms from such a small sample.

Table 10: Rank Correlation Coefficients for TFP 1991-2011

	Primary (A)	Prob > |t|	Secondary (B)	Prob > |t|	Tertiary (C)	Prob > |t|	Total (D)	Prob > |t|
(a) 1991-1995 vs 1991-1995	1		1		1		1	
(b) 1991-1995 vs 1996-2000	-0.2	0.75	0.18	0.36	**0.55**	0.00*	**0.31**	0.01*
(c) 1996-2000 vs 2001-2005	-0.2	0.75	**0.43**	0.022**	0.24	0.17	0.16	0.19
(d) 2001-2005 vs 2006-2011	0.1	0.87	**0.42**	0.027**	**0.54**	0.00*	**0.50**	0.00*
(e) 1991-2000 vs 2001-2011	*0.30*	*0.62*	***0.41***	*0.031***	***0.43***	*0.01**	***0.38***	*0.00**
n=	5		28		34		67	

Source: Own estimates based on INEGI's KLEMS (2013) data.
[a] Test of Ho: Period A and Period B are independent.
* Indicates significance at the one percent level.
** Indicates significance at the five percent level.

However, in the secondary sector (column B), where we have 28 observations, we found one coefficient of 0.43 and another of 0.42, both statistically different from zero at a 95 percent confidence level (see rows "c" and "d"); while in the tertiary sector (column C), where we

[16] We thank an anonymous referee for this suggestion.

have 34 observations, we found other two coefficients with values of 0.55 and 0.54 (rows "a" and "d", respectively), both statistically different from zero at the 99 percent confidence level. And if we look at all subsectors together (column D), we find two instances in which the rank correlation coefficients result statistically different from zero at a 99 percent confidence level (rows "b" and "d"), with those coefficients reaching values of 0.31 and 0.50, respectively.

Finally, when we compare the rankings that emerge from the ten year sub-periods (row "e"), we find that the rank correlation coefficients for the secondary sector, the tertiary sector, and all 67 sub-sectors reached positive values of 0.41, 0.43, and 0.38, respectively, all statistically different from zero at least at the 95 percent confidence level. The coefficient for the primary sector, on the other hand, did not result statistically different from zero.

Now, while we recognize that most of the rank correlation coefficients estimated here are positive and statistically different from zero at conventional levels, we also raise the point that such coefficients are still far from the value which would imply "a constant ordering" of winners and losers across time, since for the latter to be true, the value of the coefficient would have to be equal to 1. In consequence, the picture that productivity growth is a complex and irregular process remains valid**.**

Hence, the empirical evidence presented here about the tendency of TFP growth to be simultaneously concentrated and irregular, suggests that productivity growth in any given period most likely does not emerge from one or a reduced number of economic forces. Instead, the picture would seem to be more consistent with one in which micro and macroeconomic forces interact at the same time.

5 Final Comments

In this work we reviewed patterns of TFP growth for the Mexican economy during the period 1991-2011 based on the KLEMS data set at the sub-sector level published by INEGI in 2013. Based on this new data set our analysis showed first that, despite the negative contribution of TFP to output growth for the period in consideration, the typical positive association between the two variables is still present. A second finding, based on Granger-causality tests between TFP and output growth could not be discarded, suggesting a complex picture of the growth process in the Mexican economy.

The evidence on the complexity of the growth process is reinforced by the fact that TFP growth in Mexico, as in other experiences, has been fairly concentrated and irregular, in the sense that in any given period just a handful of sub-sectors tend to account for most of the productivity growth, but that rarely the same sectors remain at the top across time.

These findings are consistent with the view of practitioners who sustain that economic growth must be understood as a process in which a multitude of forces interact, and because of this, sometimes produces unexpected results. Or, for instance, how can one explain that the average contribution of TFP to output growth after a trade liberalization episode such as NAFTA reached just 15.6 percent (Table 1b)?[17] Or why after China's accession to the World Trade Organization in 2001, the Mexican secondary sector, which was supposed to be the one to react the most to increased Chinese competition, showed negative rates of TFP growth

[17] The claim that TFP growth in Mexico performed poorly after NAFTA is not new. There is, indeed, substantial research attempting to account for the behavior of productivity and output growth in Mexico after NAFTA. See, for instance, Gutiérrez, 2005; Montes and Santamaría, 2007; Amoroso et al, 2008; Varella and Cabral, 2009; Hanson, 2010; Kehoe and Ruhl, 2010; De León and Parra, 2011; Cabral and Mollick, 2011; López-Córdova, 2002; Salgado and Bernal, 2007; Ito, 2010; Verhoogen, 2012; López-Córdova, 2012; De Hoyos and Iacovone, 2013; Weisbrot et al, 2014).

during the periods 2001-2005 and 2006-2011 (Table 1b)? [18] The evidence that Mexico's new KLEMS data do not show the "expected" association between productivity growth and these external shocks invites one to propose that the reasons behind our poor productivity and output growth performance may rest on internal factors of different kinds. Indeed, few specialists would deny today that domestic restraints, such as concentrated markets, excessive regulations, low quality human capital, deficient public infrastructure, lack of economies of scale and scope, among others, are at the core of poor growth experiences across the world.

In the Mexican case, to the extent that these type of restraints are effectively abated, the microeconomic forces that motivate entrepreneurial activity and investment - key drivers of productivity and economic growth- are more likely to be unleashed. And in the process of learning which factors may stimulate and which may constrain sectorial performance, the KLEMS data set from INEGI will continue providing researchers great opportunities. Our effort was just one modest illustration of what this new data set offers to those interested in investigating with more detail why our growth experience from the last two decades has been quite disappointing.

[18] See, for instance, Gallagher et al (2008), Gallagher and Porzecansky (2008), López-Córdova et al (2008), and Uthar and Torres (2013).

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Appendix A

Arithmetic vs. Weighted Averages of TFP Growth: A Comparison

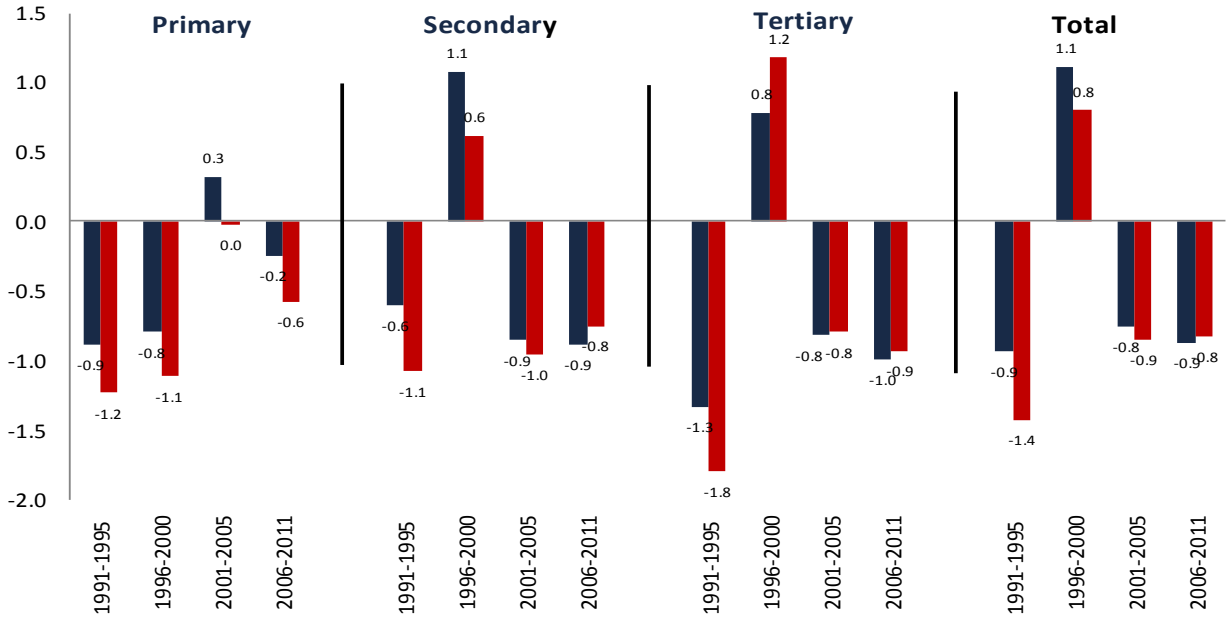
(%)

Period	Total Factor Productivity Growth (arithmetic average)				Total Factor Productivity Growth (weighted average)			
	Primary (I)	Secondary (II)	Tertiary (III)	Total (IV)	Primary (I)	Secondary (II)	Tertiary (III)	Total (IV)
1991-1995	-0.89	-0.61	-1.33	-0.93	-1.23	-1.08	-1.80	-1.43
1996-2000	-0.80	1.08	0.78	1.11	-1.11	0.62	1.18	0.80
2001-2005	0.32	-0.86	-0.82	-0.76	-0.02	-0.95	-0.80	-0.85
2006-2011	-0.24	-0.89	-0.99	-0.87	-0.58	-0.75	-0.93	-0.82

Source: Own estimates based on INEGI's KLEMS (2013) data.

Arithmetic vs. Weighted Averages of TFP Growth: A Comparison

(%)



Source: Own estimates based on INEGI's KLEMS (2013) data.

Appendix B
Subsectors of the Mexican Economy: NAIC2007 Code

NAIC2007 Code	
	Primary Sector
111	Agriculture
112	Animal breeding and production
113	Forestry
114	Fishing, hunting and trapping
115	Services related to agricultural and forestry activities
	Secondary Sector
211, 213 y 486	Oil and gas extraction, Services related to mining and Pipeline transportation
212	Metallic and nonmetallic ore mining, except oil and gas
221	Electric power generation, transmission and distribution[MÉX.]
222	Water and gas supply through mains to final consumers[MÉX.]
236	Construction
237	Civil engineering construction Works
238	Specialized construction Works
311	Food industry
312	Beverage and tobacco industries
313	Textile inputs manufacturing, and textiles finishing
314	Textile products manufacturing, except apparel
315	Apparel manufacturing
316	Leather and fur tanning and finishing, and manufacturing of leather, fur and allied materials products
321	Wood industry
322	Paper industry
323	Printing and related industries
324	Manufacturing of products derived from petroleum and coal
325	Chemical industry
326	Plastic and rubber industry
327	Nonmetallic mineral products manufacturing
331	Basic metal industry
332	Metal products manufacturing
333	Machinery and equipment manufacturing
334	Manufacturing of computer, communications, and measuring equipment, and other electronic equipment, components and appliances manufacturing
335	Electric appliances, accessories and electric power generation equipment manufacturing
336	Transportation equipment manufacturing
337	Furniture, mattresses and blinds manufacturing
339	Other manufacturing industries
	Tertiary Sector
434	Wholesale trade of agricultural, forestry and industrial raw materials, and waste materials[MÉX.]
481	Air transportation
482	Rail transportation
483	Water transportation
484	Freight truck transportation
485 y 487	Passenger transportation by road, except by rail and Sightseeing transportation
488	Services related to transportation
491 y 492	Postal services and Courier and messenger services
493	Warehousing services
511	Newspaper, magazine, book, software and other materials publishing and integrated publishing/printing of these publications
512	Film and video industry, and sound recording industry
515 y 519	Radio and television and Other information services
517 y 518	Other telecommunications and Electronic data processing, hosting, and other related services
52	Financial and insurance services
531	Real estate services
532	Rental of tangible goods
533 y 551	Rental services of trademarks, patents and franchises and Head offices
541	Professional, scientific and technical services
561 y 562	Business support services Waste management and remediation services
611	Educational services
621	Outpatient medical services and related services
622	Hospitals
623	Social assistance and health care residential facilities
624	Other social assistance services
711	Artistic, cultural and sporting services, and other related services
712	Museums, historical sites, zoos and similar institutions
713	Amusement services in recreational facilities and other recreational services
721	Temporary accommodation services
722	Food and beverage preparation services
811	Repair and maintenance services
812	Personal services
813	Associations and Organizations
814	Private households employing domestic personnel
931	Legislative, governmental and justice administration activities[MÉX.]

Appendix C: Augmented Dickey Fuller Unit Root Tests using 1991-2011 Data

		Output Growth		TFP Growth	
Number	Sub-sector	Setup	Statistic	Setup	Statistic
111	Agriculture	c	-6.549*	c	-6.773*
112	Animal breeding and production	c	-3.837*	c	-3.752*
113	Forestry	c	-3.7*	c	-3.524*
114	Fishing, hunting and trapping	c	-5.682*	c	-4.811*
115	Services related to agricultural and forestry activities	c	-2.941**	c	-3.739*
211, 213 y 486	Oil and gas extraction, Services related to mining and Pipeline transportation	c	-3.86*	c	-3.783*
212	Metallic and nonmetallic ore mining, except oil and gas	c	-3.98*	c	-3.119**
221	Electric power generation, transmission and distribution	c	-3.808*	c	-4.375*
222	Water and gas supply through mains to final consumers	c	-4.636*	c	-3.983*
236	Construction	c	-4.704*	c	-5.287*
237	Civil engineering construction works	c	-5.048*	c	-4.176*
238	Specialized construction works	c	-6.654*	c	-5.81*
311	Food industry	c	-2.6***		-2.040**
312	Beverage and tobacco industries	c	-3.733*	c	-4.346*
313	Textile inputs manufacturing, and textiles finishing	c	-4.041*	c	-5.839*
314	Textile products manufacturing, except apparel	c	-3.076**	c	-4.624*
315	Apparel manufacturing		-2.339**	c	-5.194*
316	Leather and fur tanning and finishing, and manufacturing of leather, fur and allied materials products	c	-4.309*	c	-4.77*
321	Wood industry	c	-3.066**	c, t	-3.246***
322	Paper industry	c	-3.343**	c	-5.674*
323	Printing and related industries	c	-3.987*	c	-5.177*
324	Manufacturing of products derived from petroleum and coal	c	-3.884*	c	-3.53*
325	Chemical industry	c	-2.596***	c	-4.582*
326	Plastic and rubber industry	c	-4.091*	c	-5.454*
327	Nonmetallic mineral products manufacturing	c	-4.375*	c	-4.349*
331	Basic metal industry	c	-4.043*	c	-5.048*
332	Metal products manufacturing	c	-4.657*	c	-4.318*
333	Machinery and equipment manufacturing	c	-5.082*	c	-4.733*
334	Manufacturing of computer, communications, and measuring equipment, and other electronic equipment, components and appliances manufacturing		-1.634***	c	-3.944*
335	Electric appliances, accessories and electric power generation equipment manufacturing	c	-4.226*	c	-5.542*
336	Transportation equipment manufacturing	c	-5.319*	c	-4.931*
337	Furniture, mattresses and blinds manufacturing	c	-6.104*	c	-4.537*
339	Other manufacturing industries	c	-5.616*	c	-4.461*
434	Wholesale trade of agricultural, forestry and industrial raw materials, and waste materials	c	-4.811*	c	-4.7*
481	Air transportation	c	-3.136**	c	-4.978*
482	Rail transportation	c	-8.255*	c	-4.646*
483	Water transportation	c	-4.454*	c	-5.299*
484	Freight truck transportation	c	-4.732*	c	-4.019*
485 y 487	Passenger transportation by road, except by rail and Sightseeing transportation	c	-4.29*	c	-4.185*
488	Services related to transportation	c	-5.143*	c	-4.936*
491 y 492	Postal services and Courier and messenger services	c	-2.595***	c	-3.079**
493	Warehousing services	c	-4.207*	c	-4.978*
511	Newspaper, magazine, book, software and other materials publishing and integrated publishing/printing of these publications	c	-3.61*	c	-5.035*
512	Film and video industry, and sound recording industry	c	-3.015**	c	-3.112**
515 y 519	Radio and television and Other information services	c	-5.591*	c	-3.933*
517 y 518	Other telecommunications and Electronic data processing, hosting, and other related services	c, t	-3.058*	c	-3.976*
52	Financial and insurance services	c, t	-2.392*		-2.224**
531	Real estate services	c	-2.973**	c	-2.64***
532	Rental of tangible goods	c	-4.543*	c	-4.379*
533 y 551	Rental services of trademarks, patents and franchises and Head offices	c	-5.548*	c	-4.059*
541	Professional, scientific and technical services	c	-3.735*	c	-3.277**
561 y 562	Business support services Waste management and remediation services	c	-3.673*	c	-4.754*
611	Educational services	c	-3.606*	c	-10.17*
621	Outpatient medical services and related services	c	-4.263*	c	-7.102*
622	Hospitals	c	-3.541*	c	-5.427*
623	Social assistance and health care residential facilities	c	-3.888*	c	-7.111*
624	Other social assistance services	c	-10.195*	c	-9.394*
711	Artistic, cultural and sporting services, and other related services	c	-6.637*	c	-6.165*
712	Museums, historical sites, zoos and similar institutions	c	-4.538*	c	-4.1*
713	Amusement services in recreational facilities and other recreational services	c	-4.234*	c	-4.409*
721	Temporary accommodation services	c	-5.93*	c	-5.459*
722	Food and beverage preparation services	c	-3.031**	c	-3.26**
811	Repair and maintenance services	c	-4.767*	c	-4.226*
812	Personal services	c	-4.409*	c	-4.915*
813	Associations and Organizations	c	-3.896*	c	-4.253*
814	Private households employing domestic personnel	c	-5.148*	c	-4.634*
931	Legislative, governmental and justice administration activities	c	-4.801*	c	-6.041*

* Indicates significance at the one percent level
** Indicates significance at the five percent level
*** Indicates significance at the ten percent level
c: Constant, t: Trend