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Structural Decomposition Analysis (SDA) for the Mexican Economy: 2003-2012

Ana Belén Ríos, Rafael Bouchain, Zeus Guevara, Mariana Velázquez and César Altamirano¹.

Abstract

The purpose of this paper is to conduct a comparative statics analysis concerning the change in sectoral structure of production in the Mexican economy. The authors use a methodology set forth by Structural Decomposition Analysis (SDA), which is an analytical tool that allows the detailed analysis of the fundamental sources of change in the sectoral structure of production using a wide range of variables. This paper uses Mexican input output tables from 2003, 2008 and 2012, converted to 2008 prices. The results show that the Mexican economy as a whole had a growth in total production due to an augmenting effect of final demand and a reduction effect of technical change.

1. Introduction

The production of the Mexican economy has derived into a pattern of specialization dominated by the dynamics of the maquiladora export industries (such as electronic, electrical and automotive), this phenomenon has diminished private consumption, government spending and investment as components of final demand.

In contrast, these export maquiladora industries (EMI) maintain high import shares, low employment requirements and low levels of domestic investment. This situation has led to a process of disintegration of the national component of production and higher import content in the provision of inputs, two elements that offset the positive effects of dynamic exports in economic growth.

Particularly, there is a set of strategic industries that are becoming important in the current phase of development of the world economy. First, sectors linked to the EMI, most notably the automotive and electronics industries. Second, sectors

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linked to the knowledge economy ICT and media. And in third place the energy sector, specially the oil industry since its output account for 40% of government budget.

In response to the great challenges facing by the Mexican economy in the international context, a set of structural reforms were published in 2014. These reforms include regulations for the areas of Energy, Telecommunications and Broadcasting, Fiscal and Financial, among others. The reforms are aimed to strengthen the guidance of the State in the functioning of markets, promote competition, reduce the monopoly power, and contribute to development and economic growth.

The implementation of these reforms involves changes in the formal rules of the functioning of the economy. To analyze these changes is essential to understand the conditions of the pre-reform economy. Therefore, the main objective of this analysis is to break down and identify the sources of change in the structure of production of the Mexican economy during the period 2003-2012 and sub-periods 2003-2008 and 2008-2012. Input-output tables of the Mexican economy in 2003, 2008 and 2012, deflated to constant prices of 2008 are used.

In this paper, Structural Decomposition Analysis (SDA) is used to have a diagnosis prior to the implementation of structural reforms. The results of this work will enable the future analysis of the impact of these reforms. We based our work in the proposed methodology by Miller and Blair (2009), adding consideration of the methodologies by Casler Rose (1996) and The Dietzembacher (1997,1998) and Guilhoto, Hewings, Sonis and Guo (1997).

This article is organized as follows. In the second section, the SDA method to be applied is explained. Then test results are shown in section 4 and finally section 5 presents the general conclusions of the work.

2. The SDA approach applied

After 45 years of existence, the SDA has proven to be one of the best tools of input-output analysis in explaining the sources of change in the structure of production in a multi-sector economy. Today the literature of SDA is broad, targeting applications in areas such as structural change, energy, regional analysis and so on.

The history goes back to Leontief (1941; 1953). The article by Anne Carter (1970), represents a fundamental work where the application of the SDA is proposed to study technological change and sectoral specialization. Another important work SDA is the Rose and Casler (1996). These authors state that the SDA went from

being used in less than 10 articles between 1975 and 1985, to more than 50 since up to the mid-nineties. Since then, the literature on the subject has grown exponentially.

The SDA can measure the sources of change in the production structure through a comparative static analysis of key parameters in input-output tables. Therefore it requires at least two input-output tables of different year (initial year and final year).

The SDA allows separate changes in total production given by technical changes (intermediate demand represented by the technical coefficients) and changes given by the specialization of final demand. Moreover, it is possible to separate the effects of each of the components of final demand even further.

The methodology starts from the proposed input-output model by Leontief:

$$x = Z\iota + f \quad (1)$$

where x = Vector of total production, Z = the matrix of interindustry transactions, f = Vector of final demand and ι = Unit vector

We obtain the matrix of technical input coefficients:

$$A = Z(x)^{-1} \quad (2)$$

where: $a_{ij} = \frac{z_{ij}}{x_j}$, so $Ax = Z$

Substituting (2) into (1)

$$x = Ax + f = (I - A)^{-1} f = Lf \quad (3)$$

Where L = Leontief inverse matrix contains the direct and indirect production requirements per unit of final demand.

To set the SDA model we require at least two input-output matrices, that is, for the initial year ($t = 0$) and for the final year ($t = 1$). Then there are two models for each period:

$$\Delta x = x^1 - x^0 \quad (6)$$

Substituting (3) instead of x^1 y x^0 :

$$\Delta x = (L^1 f^1) - (L^0 f^0) \quad (7)$$

Where: $\Delta L = L^1 - L^0$ y $\Delta f = f^1 - f^0$

If it replaced and rearranged equation (7) in terms of L^1 and f^0 .

$$\Delta x = L^1 \Delta f + \Delta L f^0 \quad (8)$$

And if replaced and rearranged (7) in terms of L^0 and f^1 , we get:

$$\Delta x = \Delta L f^1 + L^0 \Delta f \quad (9)$$

Now we add (8) and (9) to obtain:

$$\Delta x = \frac{\Delta L(f^0 + f^1)}{2} + \frac{\Delta f(L^1 + L^0)}{2} \quad (10)$$

3. Results

In this section, the results obtained from the SDA are analyzed. A decomposition of the change in total production with respect to two factors: technological change and final demand, was performed. Furthermore, the latter factor was broke into their different components: private consumption, government consumption, fixed capital formation and exports.

The chart 1 shows the decomposition coefficients for the whole Mexican economy in the period 2003- 2012 and the sub-periods 2003- 2008 and 2008- 2012. Furthermore, in the following charts the results are shown for five key sectors of the economy (energy industry, electronics industry, automotive industry, mass media and ICT).

3.1. Decomposition of the Mexican economy

The total production of the economy grew at an average annual rate (AAGR) of 2.7% in the period under study. The growth was driven by the growth during 2003-2008, which had an AAGR of 3.7% while in the sub-period 2008-2012 the AAGR was relatively slower at 1.8%. The slowing down of total production growth in the second sub-period is related to the world crisis in 2008-2010. The change in total production is explained by a 67% of the first sub-period and only by a 13% by the second.

The SDA allows understanding that the change in the structure of total production is driven by changes in final demand that led to an increase and by technical changes that led to a reduction in total production. The effect of the latter technical changes is related to an improvement in the efficiency in the use of inputs by most industries, which offset the effect of final demand expansion.

Chart 1: SDA coefficients for the Mexican economy

TOTAL GROSS PRODUCTION, (Billions of pesos)				
		2003-2008	2008-2012	2003-2012
TOTAL GROSS PRODUCTION	OUTPUT CHANGE	3,192.8	1,553.3	4,746.1
	TECHNICAL CHANGE	- 886.8	- 273.8	- 1,215.9
	FINAL DEMAND CHANGE	4,079.6	1,827.0	5,962.0
PRIVATE CONSUMPTION	OUTPUT CHANGE	1,376.1	1,028.9	2,405.0
	TECHNICAL CHANGE	- 458.8	- 126.0	- 623.6
	FINAL DEMAND CHANGE	1,834.9	1,154.9	3,028.6
GOVERNMENT CONSUMPTION	OUTPUT CHANGE	271.0	183.6	481.5
	TECHNICAL CHANGE	57.1	0.0	87.1
	FINAL DEMAND CHANGE	213.8	183.6	394.4
FIXED CAPITAL FORMATION	OUTPUT CHANGE	1,237.2	- 367.4	869.8
	TECHNICAL CHANGE	- 304.3	- 158.1	- 436.5
	FINAL DEMAND CHANGE	1,541.5	- 209.2	1,306.3
EXPORTS	OUTPUT CHANGE	855.8	1,060.6	1,916.5
	TECHNICAL CHANGE	- 159.9	- 35.4	- 247.7
	FINAL DEMAND CHANGE	1,015.8	1,096.0	2,164.1

The final demand components that most contributed to rise the total production in 2003-2012 were private consumption by a 42%, exports by a 34% and to a lower extent capital formation and government demand by 15% and 8.4% respectively.

Furthermore, technical change over 2003-2012 accounted for a rise in final demand. This means that technical change had the effect of reducing total production, which derived from a better use of intermediate inputs per unit of final demand.

It can be observed that there was a relatively increase in the effect of technical change in the second sub-period 2008-2012 compared to the first 2003-2008. Over the whole period the effect of private consumption and exports (main driving components of final demand) had the effect of increasing total production. However these effects were relatively smaller during the second sub-period.

The change in government consumption had a small contribution to the change in total production. The change in magnitude of this component of final demand had the effect of reducing total production while technical effect had the opposite effect.

The results of the capital formation component of final demand stand out because the associated change in total production is positive in 2003-2008 yet negative in 2008-2012 with an overall positive change over the whole period 2003-2012. Nonetheless, there are contrasting values in the effect of final demand between the two sub-periods (augmenting vs reducing). On the other hand, the technical change had the effect of reducing associated total production in both sub-periods.

3.2. Decomposition of the energy industry

Chart 2: SDA coefficients for the energy industry

		ENERGY INDUSTRY (Billions of pesos)		
		2003-2008	2008-2012	2003-2012
TOTAL GROSS PRODUCTION	OUTPUT CHANGE	- 70.6	- 116.0	- 186.6
	TECHNICAL CHANGE	- 293.0	- 85.5	- 386.9
	FINAL DEMAND CHANGE	222.3	30.5	200.3
PRIVATE CONSUMPTION	OUTPUT CHANGE	89.2	200.0	110.8
	TECHNICAL CHANGE	- 171.7	- 53.0	- 216.8
	FINAL DEMAND CHANGE	260.8	147.0	105.9
GOVERNMENT CONSUMPTION	OUTPUT CHANGE	22.5	10.1	43.6
	TECHNICAL CHANGE	8.5	0.0	19.1
	FINAL DEMAND CHANGE	14.1	10.1	24.5
FIXED CAPITAL FORMATION	OUTPUT CHANGE	77.9	40.0	37.9
	TECHNICAL CHANGE	- 60.4	- 25.5	- 86.5
	FINAL DEMAND CHANGE	138.3	14.6	124.4
EXPORTS	OUTPUT CHANGE	- 41.2	13.9	- 27.2
	TECHNICAL CHANGE	- 52.2	- 21.2	- 84.2
	FINAL DEMAND CHANGE	11.0	35.1	56.9

The energy sector is key to the Mexican economy. It includes the branch refers to the extraction of oil and gas. The chart 2 shows the efficiency that this sector has had during the entire period. While final demand had an effect to reduce in the period 2008- 2012; in the period 2003- 2012 final demand had a positive effect. Another point to note is that the production had a contraction in this sector with regard to the production of the entire economy. Therefore, the effect of technical change that this sector had benefited the optimization of resources, despite the economic downturn shown in the chart.

The effect of private consumption change is to decrease total energy production in the first period, in the second is the opposite, but if we consider both periods, the effect of technical change is to reduce energy consumption. This occurs also in

capital formation, there is a negative effect (decreasing) of final demand in the first period and positive (augmenting) in the second, but the effect of technical change is negative in both sub-periods, which was good for the economy.

3.3. Decomposition of the electronics industry

Chart 3: SDA coefficients for the electronics industry

ELECTRONICS INDUSTRY (Billions of pesos)					
		2003-2008	2008-2012	2003-2012	
TOTAL GROSS PRODUCTION	OUTPUT CHANGE	307.7	- 84.5	223.2	
	TECHNICAL CHANGE	- 17.9	11.0	- 8.1	
	FINAL DEMAND CHANGE	325.5	- 95.4	231.2	
PRIVATE CONSUMPTION	OUTPUT CHANGE	- 28.9	8.3	- 20.6	
	TECHNICAL CHANGE	- 5.5	3.6	- 3.2	
	FINAL DEMAND CHANGE	- 23.4	4.7	- 17.5	
GOVERNMENT CONSUMPTION	OUTPUT CHANGE	- 1.1	0.1	- 0.0	
	TECHNICAL CHANGE	- 1.3	0.0	- 0.4	
	FINAL DEMAND CHANGE	0.2	0.1	0.4	
FIXED CAPITAL FORMATION	OUTPUT CHANGE	1.1	0.7	1.8	
	TECHNICAL CHANGE	- 1.4	2.7	1.1	
	FINAL DEMAND CHANGE	2.5	- 2.0	0.7	
EXPORTS	OUTPUT CHANGE	63.2	- 163.2	344.7	
	TECHNICAL CHANGE	3.5	2.8	- 9.6	
	FINAL DEMAND CHANGE	59.7	- 166.0	354.4	

In the electronics industry we see an effect of increasing the total production for the nine years covered by the study, but this change was not constant for the two periods. For the first period (2003- 2008) it influenced the total production more than in the subsequent period. From 2008, the required technical inputs had a magnifying effect, in the second quarter had an unfavorable exchange rate for the economy was stagnated.

The most important effect of the components of final demand is the change in exports, which is higher in the first period 2003-2008 than in the second 2008-2012. We observe a negative effect on technical change, it reveals less efficient use of inputs per unit of final demand. It is worth mentioning that the effect of private consumption is very low.

3.4. Decomposition of the automotive industry

Chart 4: SDA coefficients for the automotive industry

AUTOMOTIVE INDUSTRY (Billions of pesos)				
		2003-2008	2008-2012	2003-2012
TOTAL GROSS PRODUCTION	OUTPUT CHANGE	234.7	249.3	484.0
	TECHNICAL CHANGE	- 23.3	- 17.5	- 45.0
	FINAL DEMAND CHANGE	258.0	266.8	529.1
PRIVATE CONSUMPTION	OUTPUT CHANGE	- 16.8	213.6	196.8
	TECHNICAL CHANGE	- 0.5	3.2	- 2.9
	FINAL DEMAND CHANGE	- 16.4	210.4	199.7
GOVERNMENT CONSUMPTION	OUTPUT CHANGE	- 0.7	0.1	- 0.6
	TECHNICAL CHANGE	- 1.0	0.0	- 1.1
	FINAL DEMAND CHANGE	0.3	0.1	0.4
FIXED CAPITAL FORMATION	OUTPUT CHANGE	91.1	- 93.0	- 2.0
	TECHNICAL CHANGE	- 7.0	- 7.0	- 10.1
	FINAL DEMAND CHANGE	98.1	- 86.0	8.1
EXPORTS	OUTPUT CHANGE	163.2	239.1	402.3
	TECHNICAL CHANGE	- 14.5	- 14.6	- 32.8
	FINAL DEMAND CHANGE	177.7	253.6	435.1

The automotive industry is one of the most important industries for the growth of the Mexican economy. Within this sector there is a large domestic and foreign investment can be seen reflected in the effect of final demand growth in exports and the technical change that remained fairly constant over the period 2003- 2008 and 2008- 2012. Which means that the requirements for the production of goods in this industry have remained efficient inputs in exports over the entire economy. The peculiarity of this sector is that despite the crisis faced in the period 2008-2012 was not affected, but rather the final demand in the gross value of production had the effect of increasing production of these goods. However, technical change in the total value of production had the effect of decrease in the period of the crisis which means that the sector suffered a structural change in the amount of inputs required per unit produced.

3.5. Decomposition of the mass media industry

Chart 5: SDA coefficients for the mass media industry

MASS MEDIA (Billions of pesos)		2003-2008	2008-2012	2003-2012
TOTAL GROSS PRODUCTION	OUTPUT CHANGE	- 40.8	- 6.4	- 47.1
	TECHNICAL CHANGE	- 29.3	- 10.5	- 40.7
	FINAL DEMAND CHANGE	- 11.4	4.1	- 6.4
PRIVATE CONSUMPTION	OUTPUT CHANGE	- 34.3	- 0.3	- 34.6
	TECHNICAL CHANGE	- 18.1	- 6.6	- 25.4
	FINAL DEMAND CHANGE	- 16.2	6.3	- 9.2
GOVERNMENT CONSUMPTION	OUTPUT CHANGE	- 0.1	0.6	- 0.8
	TECHNICAL CHANGE	- 1.4	- 0.0	- 2.6
	FINAL DEMAND CHANGE	1.2	0.6	1.7
FIXED CAPITAL FORMATION	OUTPUT CHANGE	- 2.3	- 1.1	- 3.4
	TECHNICAL CHANGE	- 4.8	- 0.9	- 5.3
	FINAL DEMAND CHANGE	2.5	- 0.2	1.9
EXPORTS	OUTPUT CHANGE	- 5.8	- 1.1	- 6.9
	TECHNICAL CHANGE	- 4.5	- 1.7	- 6.8
	FINAL DEMAND CHANGE	- 1.3	0.6	- 0.0

Analyzing the sector of mass media, final demand from 2003 to 2008 had a negative effect, but if you look at the branches that make up this sector can see that the Publishing of newspapers, magazines, books is a fundamental branch to study it behaves an atypical way to other branches and the weight of the changes that take place is a big part of the total change in this industry. For example the effect of total technical change for the period 2003-2012 was - 40.707 billion while in the same period in the field of publishing of newspapers, magazines, etc. was - 41.327 billion. The same case is for government consumption, for the total economy was -91 billion and the industry was 92 edition surpassed only by the film industry relevance with a change of -96 billion.

3.6. Decomposition of the computers and telecommunications industry

ICTs globally do not represent a key sector in the economy as they have a very poor participation within it. There is an effect of increase in the final demand of the total production and unlike other sectors this does not present a decreasing effect of technical change on the economy. Within the breakdown of final demand the one that accounts for structural change by type of final demand is the private consumption as it grew with respect to other types of final demand.

Chart 6: SDA coefficients for the computers and telecommunications industry

COMPUTERS AND TELECOMMUNICATIONS INDUSTRY (Billions of pesos)				
		2003-2008	2008-2012	2003-2012
TOTAL GROSS	OUTPUT CHANGE	203.1	110.1	313.2
PRODUCTION	TECHNICAL CHANGE	13.4	3.0	19.0
	FINAL DEMAND CHANGE	189.6	107.1	294.2
PRIVATE CONSUMPTION	OUTPUT CHANGE	173.2	104.1	277.3
	TECHNICAL CHANGE	- 1.5	2.5	1.0
	FINAL DEMAND CHANGE	174.7	101.6	276.3
GOVERNMENT CONSUMPTION	OUTPUT CHANGE	10.0	2.3	13.2
	TECHNICAL CHANGE	7.7	0.0	9.5
	FINAL DEMAND CHANGE	2.3	2.3	3.6
FIXED CAPITAL FORMATION	OUTPUT CHANGE	15.3	- 2.2	13.1
	TECHNICAL CHANGE	3.8	- 2.0	2.2
	FINAL DEMAND CHANGE	11.5	- 0.3	10.9
EXPORTS	OUTPUT CHANGE	10.7	6.6	- 0.1
	TECHNICAL CHANGE	3.7	3.6	0.0
	FINAL DEMAND CHANGE	7.0	3.0	- 0.1

4. Conclusions

The SDA is a suitable tool in input-output analysis, it allow us decompose the causes of structural change and its contribution to economic growth.

This paper presents a decomposition of the effects of changes in final demand (and its components) and the effects of technical change. The technical change allows showing the efficiency of inputs to industries per unit of final demand.

The results show that when we consider the Mexican economy as a whole occurs a positive effect on the structural change due to the effect of final demand and the effect on technical change. This is true for the period 2003-2012, and for their two sub-periods, though in the second sub-period the effects are smaller because of the global crisis that erupted in 2008.

Although the structural change of the Mexican economy during the period 2003-2012 can be considered positive, there are differences in the groups of industries considered in this study.

First, it is shown that the energy industry, primarily composed of oil extraction, is affected by the contractive effect of final demand, because of low demand for exports. The private consumption is the main element of final demand. While

showing a slight positive effect on technical change, in the second period, the effect of demand of capital formation falls. This shows the high sensitivity of capital formation to the recession caused by the crisis.

Regarding the electronics industry, there is a positive effect generated by final demand, it is associated with the effect of increasing of export demand. In contrast, the effect of private consumption demand is negative; also, the effect on growth of capital formation is reduced. In general, the effect of technical change is positive in the first period and negative in the second period.

Structural change in the automotive industry reacts positively to positive effects of final demand and technological change, the effect of export demand and the effect of private consumption are very important. However, the effect of capital formation is not very important throughout the study period, particularly in the second sub-period, which shows a high sensitivity of capital formation to the crisis that occurs in 2008.

The media sector has a negative structural change, both the period 2003-2012 and in their two sub-periods, this is reflected in a negative effect of all the components of final demand, although there is a slight positive effect on technical change sector.

Finally, we observe a positive structural change in the ICT sector, due to a positive effect of final demand, especially in private consumption. However, there is a negative effect on technical change, reflecting a decrease in efficiency input in this sector. The capital formation declines in the period 2008-2012 reflecting high sensitivity of this variable in the global crisis that erupted in 2008.

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