
Munich Personal RePEc Archive

Research Note: Economic Structural Change Over Time: Brazil and the United States Compared

Joaquim J.M. Guilhoto and Geoffrey J.D. Hewings and Michael Sonis and Guo Jiemin

University of São Paulo, University of Illinois, University of Illinois, Regional Economics Applications Laboratory

2001

Online at https://mpra.ub.uni-muenchen.de/42539/
MPRA Paper No. 42539, posted 11. November 2012 07:44 UTC

Research Note: Economic Structural Change Over Time: Brazil and the United States Compared[1]

Joaquim J.M. Guilhoto,[2] Geoffrey J.D. Hewings,[3] Michael Sonis,[4] and Jiemin Guo[5]

Abstract

Using input-output tables for the economies of Brazil and the United States, this comparative study focuses on changes in the economic structure of two large countries with different levels of development over time (1958-77 for the United States and 1959-80 for Brazil). The change in the economic structure is decomposed into three initial components (final demand, technology, and their synergistic interaction) and thereafter these components are further divided into change initiated within the sector and outside the sector. The results indicate a rather remarkable degree of commonality in the patterns of growth processes in both countries, with more significant differences between sectors than between countries. The analysis confirmed earlier findings about the role of demand changes but was able to capture important differences in internal-to-sector versus external-to-sector sources of demand change.

1. Introduction

The analysis draws on some recent work by Feldman, McClain and Palmer (FMP) (1987) and subsequent modifications by Sonis, Hewings and Guo (SHG) (1996). FMP examined the degree to which changes in final demand and changes in input coefficients contributed to changes in output in the United States economy over the period 1963 to 1978. SHG proposed modifications that separate the pure effects of changes in technology and in final demand from those caused by the synergistic interaction between these two components and further decomposed changes into *self-generated* and *non-self-generated changes*; in the former case, the change in output can be traced to changes in the sector itself (i.e. changes in final demand, technology or synergy) while in the latter case, the change occurs in another sectors.

[1] We wish to acknowledge the helpful comments of an anonymous referee on an earlier version.

[2] ESALQ - Universidade de São Paulo, and Regional Economics Applications Laboratory, University of Illinois

[3] Regional Economics Applications Laboratory, University of Illinois

[4] Regional Economics Applications Laboratory, University of Illinois and Bar Ilan University, Israel

[5] Regional Economics Applications Laboratory

In this research note, the FMP methodology and SHG extensions are presented in section 2. In section 3, a brief overview of the Brazilian (1959-1980) and US (1958-1977) economies is provided prior to the presentation of the results in section 4. Section 5 offers some summary perspectives.

2. The FMP Approach and SHG Extensions

In their paper, FMP proposed the following decomposition for the analysis of the influence on output levels of changes in the input coefficients and in the components of final demand. Let X_0 and X_t be the gross output vectors for the two time periods ***0*** and ***t***. Similarly, let B_0 and B_t be the Leontief inverses and f_0 and f_t the vectors of final demand. Define:

$$\begin{aligned} \Delta X &= X_t - X_0 \\ \Delta B &= B_t - B_0 \\ \Delta f &= f_t - f_0 \end{aligned} \tag{1}$$

SHG modified the FMP approach and its decomposition of output change into only two components as follows:

$$\begin{aligned} \Delta X &= \left(B_0 + \Delta B\right)\left(f_0 + \Delta f\right) - B_0 f_0 = \\ &= B_0 \Delta f + \Delta B f_0 + \Delta B \Delta f \end{aligned} \tag{2}$$

In this way the change in output is divided into changes in final demand, technology, and the synergistic interaction between final demand and technology.[6] The entries in (2) can be transformed to percentage, positive or negative, contributions. A further transformation would separate the effects into s*elf-generated* and *non-self-generated changes* respectively. *Self-generated* changes are those resulting from changes in the sector itself; *non-self-generated* changes explore the impacts of change created elsewhere in the economy.

With more than two time periods, it is possible to see how the importance of the three components (final demand, technology, and synergistic interaction) have evolved in the determination of output change.:

[6]Previous studies of the sources of structural change in interpreting sectoral output or price variations can be found in Chenery and Watanabe (1958), Richardson, (1971), Syrquin (1976), Bezdek and Wendling (1976), Chenery and Syrquin (1979), Kubo and Robinson (1984), Fossell (1989), and Skolka (1989).

$$\Delta T_i = abs\left(\Delta X_i^f\right) + abs\left(\Delta X_i^B\right) + abs\left(\Delta X_i^{Bf}\right) \quad (3)$$

where ΔT_i is the total impact in sector *i*, and $abs\left(\Delta X_i^f\right)$, $abs\left(\Delta X_i^B\right)$, and $abs\left(\Delta X_i^{Bf}\right)$ are the absolute values of the final demand, technology, and synergistic components.

Note that total impact is defined in a different way from output change, since output change takes the signs of its components into consideration, whereas the total impact does not. The difference is mainly due to the fact that when output changes are measured, attention focuses on the *net effect*, while with total impact the interest focuses on the magnitude of the components, regardless of their negative or positive influence on sectoral output change.

3. The Brazilian (1959-1980) and United States Economies (1958-1977) Compared

This section gives a brief overview of the key developments in the Brazilian economy from the 1950s to the 1980s. In the 1950s the Brazilian economy experienced an intense import substitution industrialization (ISI) program accompanied by relatively high rates of growth. This period of expansion ended in the first half of the 1960s and was followed by several years of economic stagnation. The crisis of the latter period coincided with the end of the earlier ISI experience that had been characterized by import substitution of durable and nondurable consumer goods for the most part. In the period 1968 to 1973, the Brazilian economy again experienced fast economic growth with yearly real rates of growth above 10%; from 1974 to 1981, growth continued but at more modest rates. In the period from 1968 to 1981 the focus of attention was on ISI in the sectors producing capital goods (Baer, Fonseca, and Guilhoto, 1987), and at the same time there was an increase in exports of industrialized goods (Guilhoto, 1992). The 1980s were marked by high rates of inflation, excessive participation of the state in the economy, and restrictions on the balance of payments. All of these factors contributed to low rates of annual economic growth (average of 2.22% in the 1980-90 period). From the 1950s through the 1980s there was also an increase in income concentration.

The US economy was not immune from the vicissitudes of economic fortune; however, the period from the 1950s through the early 1970s was an era in which manufacturing reached its zenith both in value

added terms and in the dominating position that it exercised in employment generation. Beginning in the late 1960s, the US economy began to experience the effects of penetration from the world economy. Manufacturing employment growth was flat but, more importantly, it began to be redistributed spatially, with significant declines in the Midwest and growth in the south and western parts of the country. By the end of the period covered by this analysis, nonmanufacturing growth, especially in employment terms, was ascendant but would not be revealed in a dramatic fashion until about a decade later (late 1980s). Carter (1970) and FMP both comment on the important role that demand growth had on the economy; however, there were some important technological changes taking place, such that by the end of the 1970s, there was increasing evidence of significant capital-for-labor substitution in the manufacturing sectors of the economy.

<<Figures 1-4 here>>

4. Analysis of the Results

In this section, interpretation will be made of the application of the techniques introduced in section 2 above to the input-output data for the economies of Brazil and the United States. The period of the analysis for Brazil is from 1959 to 1980 while the data for the United States is from 1958 to 1977. To isolate the components of output change from price changes in these economies, the input-output tables are expressed in constant values,[7] millions of 1982 Cruzeiros for Brazil and millions of 1982 Dollars for the United States. Furthermore, both sets of input-output tables were aggregated to comparable sector classifications; there are of course important differences in the compositions of these aggregate sectors but it is felt that the analysis at this level still provides an important foundation for comparative analysis.

The results are represented in a schematic way in figures 1 through 4. These figures show the signs of the growth rates of sectoral output and of all of its components; the cells marked in dark gray represent the component that is the key determinant of output growth, either for total growth or for self-generated and non-self generated growth. In figures 1 and 3, cells marked in light gray are cells that by themselves are not the main component of growth, but when combined represent the majority of the growth. For

example, in figure 1, if one refers to sector 3 (Construction) for the period 1959-70, the sign of non-self generated growth is minus (-) as a result of the combination of changes in technology and synergistic components; however, the most important component in this case is final demand (dark gray cell).

Examining Figures 1 and 3, one can see general patterns of growth that apply both to Brazil and to the United States. For instance, in both countries, the self-generated component dominates growth in sectors 3 (Construction), 4 (Manufacturing), 5 (Trade and Transportation) and 6 (Services), while in sectors 1 (Agriculture) and 2 (Mining) non-self generated growth is the dominant factor for Brazil and a very strong one for the United States. This can be explained by the fact that sectors 1 (Agriculture) and 2 (Mining) are mainly suppliers of raw material, and hence their level of production depends much more on the other sectors in the economy than it would if they were mainly producers of final goods. As a result, the other sectors play a major role in these sectors' growth, while the reverse is not necessarily the case. In both countries, final demand contributes to positive growth rates in almost all sectors with few exceptions, and at the same time it is in general the dominant component of total, self-generated and non-self generated change. In both Brazil and the United States the sign of the technology component tends to be negative in the earlier periods and positive in the later periods. This suggests that in the 1960s, the impact of technological changes led to productivity gains in these economies, while in the 1970s, owing in part to laws setting higher standards of quality and to changes in consumer preferences, firms were required to introduce more sophisticated methods of production, thus increasing complexity in the economy. For both countries, an exception to the above explanation is the agricultural sector, where the technological component of total growth and of non-self-generated growth is always negative, showing better utilization of agricultural products in the production process through more efficient use of material inputs.

Figures 2 and 4 show the evolution of change, i.e., the importance of the components of change over time. In this case, there does not appear to be a fully discernible pattern for either country, implying that

[7] See Bulmer-Thomas (1982), especially Chapter 10, for the idea behind the methodology used to express the input-output tables in constant values.

changes have occurred in a non-systematic fashion. Thus components become more or less important over time, depending partly on complex adjustment processes within the economic systems.

For Brazil, figure 1 shows that in sector 1 (Agriculture) the dominant factor in output growth in the 1959-70 period and again in the 1975-80 period is the demand component of non-self generated change, while for the 1970-75 period it is the demand component of self-generated change. This can be explained by the fact that in 1970-75, a period associated with a high rate of growth in the Brazilian economy, the source of change in the agricultural sector was internal, while in the other periods it was more dependent on the other sectors, in keeping with its role as a major supplier of raw materials.

For sector 2 (Mining) in Brazil, growth is mainly dependent on non-self generated growth of demand in 1959-70 and 1970-75, and on non-self-generated technology change for the 1975-80 period. In essence, with some subtle differences, Mining and Agriculture share common patterns of change.

It is interesting to note that for sector 3 (Construction) in Brazil, non-self generated changes show a predominance of the technology and synergistic components; a similar pattern is found in sector 6 (Services) in the same country. This suggests that the way in which non-self generated growth occurs in these sectors is linked to technology change in the other sectors.

Turning to the United States, for sectors 1 (Agriculture) and 2 (Mining) the dominant factor in output growth from 1958 to 1967 is the demand component of non-self generated change, while for the period 1967 to 1977, it is the demand component of self-generated change. Hence, these sectors at first experienced an externally generated growth process, while in the later periods there was an increase in the importance of growth inside the sector. Sector 3 (Construction) in the United States in the last period (1972-77) shows a predominance of non-self generated growth as well as a predominance of the technological component. Similarly, for sector 4 (Manufacturing) in the United States in 1967-1972, there is also a predominance of non-self generated change, but the dominant component is still growth in demand. It should also be noted that technology becomes the dominant component for non-self-generated change in the United States in the later periods analyzed.

5. Conclusion

The methodology presented here is offered as a complementary tool in the analysis of structural changes in economies and, further, as a methodology that could be employed in comparative analysis. It will not replace the kind of detailed evaluations conducted over many years by Syrquin (1976) and Chenery and Syrquin (1979); however, it offers the possibility of presenting, graphically as well as analytically, some of the major characteristics associated with change. The tripartite decomposition and the evolutionary patterns that can be derived from time series of input-output tables offer the possibility of developing a taxonomy of change, particularly if applied to a large sample of countries.

Confirming the findings of FMP for the United States and of Hewings et al. (1989) and Guilhoto et al. (1994) for the Brazilian economy, the final demand component plays a key role in determining the growth rate of sectoral output, no matter whether sectoral output growth is dominated by self-generated or non-self generated changes. The evolution of changes in components over time shows that there is no pattern either for Brazil or for the United States, implying that changes in both countries occur in a dynamic way, such that the importance of components increases or decreases over time depending on how the economic system is adjusting.

REFERENCES

Baer, W., M.A.R. Fonseca, and J.J.M. Guilhoto (1987). “Structural Changes in Brazil’s Industrial Economy, 1960-80,” *World Development*. 14:275-286.

Bezdek, R.H. and R.M. Wendling (1976) "Disaggregation of structural change in the American economy: 1947-1966," *Review of Income and Wealth* 22, 167-185.

Bulmer-Thomas, V. (1982). *Input-Output Analysis in Developing Countries: Sources, Methods and Applications*, New-York: John Wiley & Sons Ltd.

Carter, A.P. (1970) *Structural Changes in the American Economy*, Cambridge: Harvard University Press.

Chenery, H.B. and T. Watanabe (1958) "International comparisons of the structure of production," *Econometrica* 26, 487-521

Chenery, H.B. and M. Syrquin (1979) "A comparative analysis of industrial growth," in *Measurement, History and Factors of Economic Growth*, edited by R.C.O. Matthews. New York, Macmillan

Feldman, S.J., D. McClain, and K. Palmer, (1987) "Sources of structural change in the United States 1963-1978: an input-output perspective," *Review of Economics and Statistics* 69:503-510

Fossell, O. (1989) "The input-output framework for analyzing the transmission of industrial progress between industries," *Economic Systems Research* 1, 429-445.

Guilhoto, J.J.M. (1992). "Mudanças Estruturais e Setores Chave na Economia Brasileira, 1960 - 1990," *Anais do XIV Encontro Brasileiro de Econometria*. 1:293-310.

Guilhoto, J.J.M., P.H.Z. Conceição, and F.C. Crocomo (1994). "Estrutura de Produção, Consumo, e Distribuição de Renda na Economia Brasileira: 1975 e 1980 Comparados," Mimeo. Departamento de Economia e Sociologia Rural, ESALQ-USP.

Hewings, G.J.D., M.A.R. da Fonseca, J.J.M. Guilhoto e M. Sonis (1989). "Key Sectors and Structural Change in the Brazilian Economy: A Comparison of Alternative Approaches and Their Policy Implications," *Journal of Policy Modeling* 11(1):67-90.

Kubo, Y. and S. Robinson (1984) "Sources of industrial growth and structural change: a comparative analysis of eight economies," in *Proceedings of the Seventh International Conference on Input-Output Techniques*, UNIDO, New York, United Nations.

Richardson, J.D. (1971) "Constant-market-shares analysis of export growth," *Journal of International Economics*, 1: 227-239

Skolka, J. (1989) "Input-output structural decomposition analysis for Austria," *Journal of Policy Modeling* 11, 45-66

Sonis, M., G.J.D. Hewings and J. Guo (1996) "Sources of Structural Change in Input-Output Systems: a Filed of Influence Approach," *Economic Systems Research* 8: 15-32.

Syrquin, M. (1976) "Sources of industrial growth and change: an alternative measure." Paper presented to the European Meeting of the Econometric Society, Helsinki, Finland.

Figure 1
Signs of the Growth Rates of Output and of Its Components - Brazil

Sector	Period	Total	Total		Total			Self			Non-Self		
			Self	Non	Dem	Tech	Syn	Dem	Tech	Syn	Dem	Tech	Syn
	59-70	+	-	+	+	-	-	-	+	-	+	-	-
1. Agriculture	70-75	+	+	+	+	-	-	+	-	-	+	-	-
	75-80	+	-	+	+	-	-	-	+	-	+	-	-
	59-70	+	+	+	+	-	-	+	-	-	+	-	-
2. Mining	70-75	+	+	+	+	-	-	+	+	+	+	-	-
	75-80	+	+	+	+	+	+	+	-	-	+	+	+
	59-70	+	+	-	+	-	-	+	-	-	+	-	-
3. Construction	70-75	+	+	-	+	-	-	+	-	-	+	-	-
	75-80	+	+	+	+	+	+	+	+	+	+	+	+
	59-70	+	+	+	+	-	-	+	-	-	+	-	-
4. Manufacturing	70-75	+	+	+	+	+	+	+	+	+	+	+	+
	75-80	+	+	+	+	+	+	+	+	+	+	+	+
	59-70	+	+	+	+	-	-	+	-	-	+	+	-
5. Trade and Transp.	70-75	+	+	+	+	+	+	+	+	+	+	+	+
	75-80	+	+	+	+	-	+	+	+	+	+	-	+
	59-70	+	+	-	+	-	-	+	-	-	+	-	-
6. Services	70-75	+	+	+	+	+	+	+	+	+	+	+	+
	75-80	+	+	+	+	+	+	+	+	+	+	+	+

Figure 2
Signs of the Evolution of Changes - Brazil

Sector	Period	Total			Self			Non-Self		
		Dem	Tech	Syn	Dem	Tech	Syn	Dem	Tech	Syn
1. Agriculture	59/70 - 70/75	+	-	-	+	-	-	+	+	-
	70/75 - 75/80	-	+	-	-	+	+	-	+	-
2. Mining	59/70 - 70/75	+	-	-	-	+	-	+	-	-
	70/75 - 75/80	-	+	+	+	-	-	-	+	+
3. Construction	59/70 - 70/75	+	-	-	+	-	-	-	+	-
	70/75 - 75/80	-	+	+	-	+	+	-	-	+
4. Manufacturing	59/70 - 70/75	-	+	+	-	+	+	-	+	+
	70/75 - 75/80	-	+	+	-	+	-	-	+	-
5. Trade and Transp.	59/70 - 70/75	-	+	+	+	-	-	-	+	+
	70/75 - 75/80	+	-	-	-	+	+	+	+	-
6. Services	59/70 - 70/75	+	-	-	+	-	+	+	-	-
	70/75 - 75/80	-	+	+	-	+	+	-	+	+

Figure 3
Signs of the Growth Rates of Output and of Its Components - United States

Sector	Period	Total	Total		Total			Self			Non-Self		
			Self	Non	Dem	Tech	Syn	Dem	Tech	Syn	Dem	Tech	Syn
	58-63	+	+	+	+	-	-	+	+	+	+	-	-
1. Agriculture	63-67	+	-	+	+	-	-	-	-	+	+	-	-
	67-72	+	+	-	+	-	-	+	+	+	+	-	-
	72-77	+	+	-	+	-	-	+	-	-	+	-	-
	58-63	+	+	+	+	-	-	+	-	+	+	-	-
2. Mining	63-67	+	+	+	+	-	-	+	-	-	+	-	-
	67-72	-	-	+	+	-	-	-	+	-	+	-	-
	72-77	-	-	+	-	+	+	-	-	-	+	+	+
	58-63	+	+	+	+	-	-	+	-	-	+	-	-
3. Construction	63-67	+	+	+	+	-	-	+	-	-	+	-	-
	67-72	+	+	+	+	-	-	+	-	-	+	-	-
	72-77	+	-	+	-	+	+	-	+	-	+	+	+
	58-63	+	+	+	+	-	+	+	+	+	+	-	-
4. Manufacturing	63-67	+	+	+	+	-	-	+	-	-	+	+	+
	67-72	+	+	+	+	-	-	+	-	-	+	-	-
	72-77	+	+	+	+	+	+	+	+	+	+	+	+
	58-63	+	+	+	+	-	-	+	+	+	+	-	-
5. Trade and Transp.	63-67	+	+	+	+	-	-	+	+	+	+	-	-
	67-72	+	+	+	+	-	-	+	-	-	+	-	-
	72-77	+	+	+	+	+	+	+	+	+	+	+	+
	58-63	+	+	+	+	-	-	+	+	+	+	-	-
6. Services	63-67	+	+	+	+	+	+	+	+	+	+	+	+
	67-72	+	+	-	+	-	-	+	-	-	+	-	-
	72-77	+	+	+	+	+	+	+	-	-	+	+	+

Figure 4
Signs of the Evolution of Changes - United States

Sector	Period	Total			Self			Non-Self		
		Dem	Tech	Syn	Dem	Tech	Syn	Dem	Tech	Syn
	58/63 - 63/67	-	+	+	+	-	-	-	+	+
1. Agriculture	63/67 - 67/72	-	-	+	-	+	+	-	+	+
	67/72 - 72/77	+	-	-	+	-	+	-	+	-
	58/63 - 63/67	+	-	-	+	-	-	+	-	-
2. Mining	63/67 - 67/72	-	+	+	+	-	-	-	+	+
	67/72 - 72/77	+	+	-	-	+	+	-	+	-
	58/63 - 63/67	-	+	+	-	+	-	-	+	+
3. Construction	63/67 - 67/72	-	-	+	+	-	+	-	-	+
	67/72 - 72/77	-	+	-	-	+	+	-	+	-
	58/63 - 63/67	+	-	+	+	-	-	+	-	-
4. Manufacturing	63/67 - 67/72	-	+	+	-	+	-	-	-	+
	67/72 - 72/77	-	+	-	+	-	+	-	+	-
	58/63 - 63/67	+	-	-	-	+	+	+	-	-
5. Trade and Transp.	63/67 - 67/72	-	+	+	-	+	-	-	+	+
	67/72 - 72/77	-	+	-	+	-	+	-	+	-
	58/63 - 63/67	+	-	-	+	-	-	+	-	-
6. Services	63/67 - 67/72	-	+	+	-	+	+	-	+	+
	67/72 - 72/77	+	+	-	+	-	-	+	-	-