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STATISTICAL SPLICING OF ECONOMIC SERIES BY SMOOTHING QUADRATIC SPLINES

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Abstract. In this work we present a new method to solve the statistical difficult when economic series are spliced. Therefore, we discuss the scope of some splicing tools in the literature, namely the splicing by variation and linear interpolation methods. These methods carry on some problems of non-linearity. In this way, certain internal inconsistency or structural incongruity can appear when the economic series are spliced. This is a serious problem for the System of National Accounts. We introduce an approximation method for statistical splicing of economic series by smoothing quadratic splines. The proposed technique is linear and thus structurally congruent. Finally, we show the effectiveness of our method by the results of the splicing of the GDP (Gross Domestic Product) of Venezuela between 1950 and 2012, and the corresponding economics activities.

1. Introduction

Estimations of national accounts using constant prices are used for diverse purposes, the most common of which is the study of long-term economic growth and development. In general, we have found that much research has attempted to summarize the growth rates of economies in terms of the expansion or contraction of the real magnitude of the gross domestic product. However, if all other data allowing the compilation of the System of National Accounts were used, it would be possible to have a more precise idea of the complexity of the economic growth process. The justification for this claim is that the relative expansion or reduction of the different economic sectors that compose the GDP can have the same or greater importance than the average growth rate of the total GDP, and these important structural variations cannot be properly analyzed without having adequate information at constant prices. Therefore, the main goal of this investigation is to present a complete series of the GDP from 1950 to 2005, expressed at 1997 prices, disaggregated into the greatest number of economic activities.

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To ensure the highest quality of the spliced series, information was obtained from official sources, specifically from databases published by the Central Bank of Venezuela, because this information is prepared according to the different versions of the System of National Accounts proposed by the United Nations.

The manuscript is structured as follows: section 2 briefly describes some of the used splicing methods as variation and linear interpolation methods [?]. The next section presents the splicing methodology by smoothing quadratic splines of the economic series [?]. The fourth section shows the correlations of the different economic activities according to changes in the base year and presents the results of the splicing of the GDP series for Venezuela between 1950 and 2005 [?, ?], comparing the results of the smoothing quadratic spline splicing with the linear interpolation method.

2. Some statistical splicing methods

It is commonly noted that any change in the base year of an economic series yields results that are not entirely comparable. To solve this problem, statistics has developed a procedure to make both series comparable, known as chaining or splicing. Currently, two widely used methods are acknowledged in the literature: the variation method and the linear interpolation method. This work proposes to incorporate the smoothing quadratic spline method, which, as will be described below, not only the nominal fits but also the structural ones are considered, since this method is linear.

2.1. Splicing by variation.

The variation method represents the most used method. It consists of rescaling at constant prices the previous series on the basis of repeating the relative variations (percentages) observed in the series expressed in terms of the previous base. That is,

$$R_t^{Basis\ t^1} = R_{t-1}^{Basis\ t^1} dR_t^{Basis\ t^0},$$

where $R_t^{Basis\ t^1}$ is the value in real terms of the new base t^1 and $dR_t^{basis\ t^0}$ is the first relative difference or percentage variation of the series in terms of the previous base t^0.

The characteristic worth mentioning regarding this method is its simplicity, as the ease of its interpretation by those who use these results and the ease of its calculation are by no means negligible. In addition, the only data required to execute this methodology are the series at the constant prices of the different bases. However, in the face of changes in the relative prices or structural changes, this method is incapable of collecting such data over the long term, especially when relatively long series are built.

2.2. Splicing by linear interpolation.

This method consists of, first, defining the measurement error detected in the change of base year,

$$\eta = \frac{N_t^{Basis\ t^1}}{N_t^{Basis\ t^0}},$$

where $N_t^{Basis\ t^0}$ corresponds to the nominal value in the period t estimated by the established estimation method in the base year t^0; likewise, $N_t^{Basis\ t^1}$ corresponds to the same nominal value in the period t estimated during the new base year t^1 .

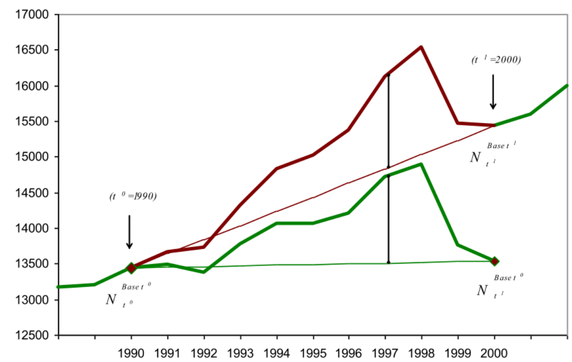

Figure 1. Splicing by Linear Interpolation.

Subsequently, this discrepancy is geometrically distributed as

$$\gamma_t = \sqrt[n]{\eta^{t-t^0}},$$

where n is the number of periods observed between the different base years $t^1 - t^0$; interpolation of the nominal values for each period t is performed as follows

$$N_t^{Basis\ t^1} = N_t^{Basis\ t^0}\gamma_t.$$

In this manner, we can say that the previously mentioned interpolation method is a splicing method that linearly adjusts the nominal values between different base years. That is, it assumes that structural changes are adjusted without bias between bases, as it does not take into account if the origins of the discrepancies occur with lesser or greater proximity between the bases.

3. Splicing by smoothing quadratic splines

To define the problem, suppose we have $n+1$ time bases $t^0, \ldots, t^n$ and, for $i = 0, \ldots, n-1$, let $N_t^{Basis\ t^j}$ be the nominal value in the period t estimated by the established estimation method in the base year t^j, for $j = i, i+1$ and $t^i \leq t \leq t^{i+1}$.

Denote by $d^t = N_{t+1}^{Basis\ t^i} - N_t^{Basis\ t^i}$, for any $t^i \leq t < t^{i+1}$ and $i = 0, \ldots, n-1$, and let $\triangle_n = \{t^0, t^0+1, \ldots, t^n\}$.

Let $S_2(\triangle_n)$ be the C^1 quadratic spline function space constructed from the partition T_n and $\{B_1, \ldots, B_{n+2}\}$ the B-spline basis of $S_2(\triangle_n)$.

By using the variational approach (see [**?**]), we consider an interpolation problem of the data series $N_{t^i}^{Basis\ t^i}$, for i=0,...,n, in the space $S_2(\triangle_n)$.

The solution of such interpolation problem is denoted by S that belongs to $S_2(\triangle_n)$. Hence, S is written as a linear combination of the basic functions of $S_2(\triangle_n)$, which hepls us compute the function S.

4. Splicing of the GDP series 1950 – 2005 for Venezuela at constant 1997 prices

Since the System of National Accounts was established in Venezuela, the country has witnessed four base year changes: 1957, 1968, 1984 and 1997, which, on average, have spanned intervals of approximately fifteen years. In addition to this temporal

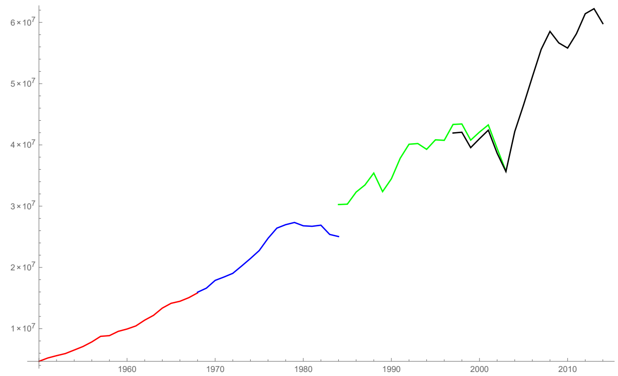

FIGURE 2. Series at constant prices, period $1950 - 2012$.

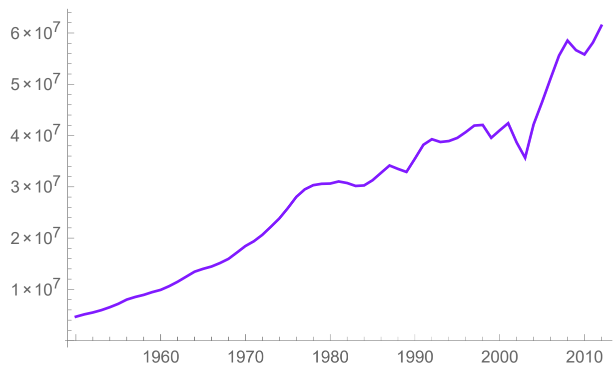

FIGURE 3. Splicing by a smoothing quadratic spline of the series at constant prices during the period $1950 - 2012$.

characteristic in the Venezuelan series, it has to be considered that for each change in the base year, methodological changes have occurred in regard to the opening and classification of the economic activities.

The first estimation of the series at constant prices begins during the fifties and encompasses the period $1950 - 1968$. These estimations were used as the basis for calculating the recommendations of the United Nations Development Programme in their periodic reviews of the National Accounts Manual; therefore, they were based on an accounting of constant prices using the year 1957 as a baseline.

5. Conclusions

- We have presented a new method to solve the statistical difficult when economic series are spliced.
- The splicing methods existing in the literature are not linear in general; this is a great problem since certain problems of internal inconsistency or structural incongruity can appear.
- The proposed technic in this work is linear and thus structurally congruent.

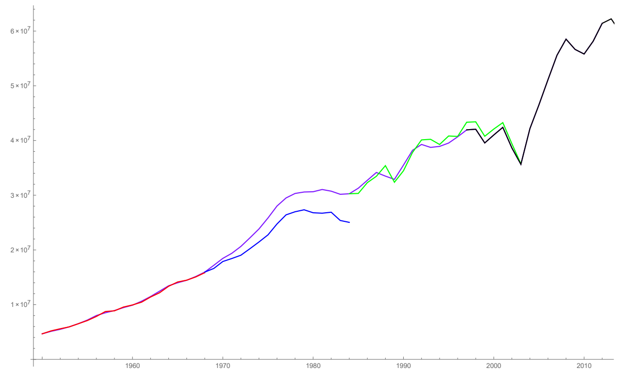

FIGURE 4. Original series and the splicing by a smoothing quadratic spline.

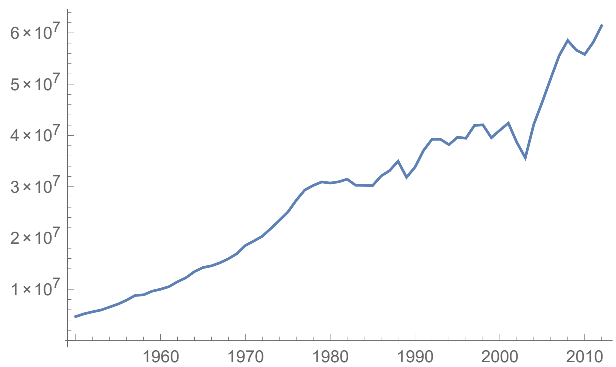

FIGURE 5. Splicing by linear interpolation of the series at constant prices during the period $1950 - 2012$.

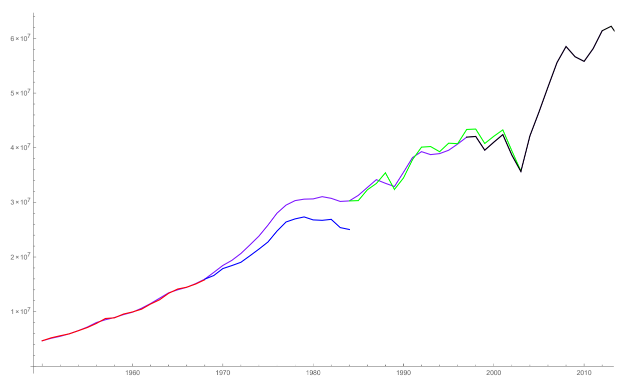

FIGURE 6. Original series and the splicing by linear interpolation.

- Finally, we have shown the effectiveness of our method by the results of the splicing of the GDP (Gross Domestic Product) of Venezuela between 1950 and 2012.

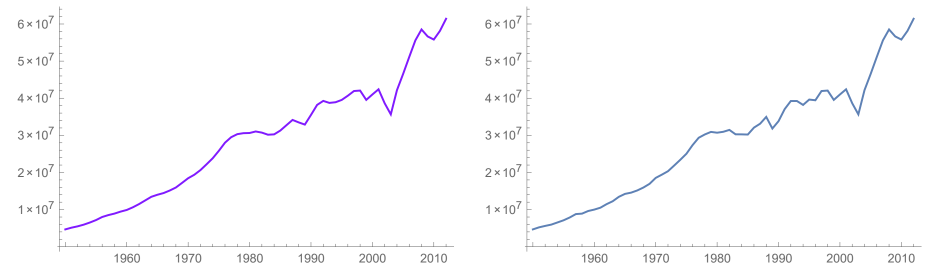

FIGURE 7. From left to right, Splicing by a smoothing quadratic spline and linear interpolation, respectively.

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