From boom to gloom: Brazilian Labor Productivity in Manufacturing from International Viewpoints, 1907–2010

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Very preliminary draft. Please do not quote.

1. Introduction

Like other Latin American countries, Brazil has failed to close the gap to the leading countries in GDP per capita. Whatever catching up there were across the twentieth century, it appears meager. In 2000, you would have to multiply the Brazilian GDP per capita by a factor of 10 to land at the American level. No wonder hence Brazil has earned the often-quoted epithet of the land of unfulfilled promises.

Among the Latin American countries many of which share the frustratingly low overall productivity level in relation to the countries at the frontier Brazil distinguishes herself by having developed the greater dependence on manufacturing industries since early twentieth century, and conspicuously so in the era of state-led development between 1945 and 1970 (Bertola and Occampo; Haber 2006). The reliance on manufacturing and the failure to contract the income gap to the developed countries is a challenge to our understanding of the forces that boost convergence. Most of the literature on convergence in GDP per capita identifies the manufacturing industry as the most important engine propelling lagging countries' productivity rates forward and relative levels upwards and promoting convergence across developing and developed countries (REF). The industrial sector is a major receiver of new technology, whether trade or direct investments serve to channel the new technology into manufacturing processes (REF). The dynamic properties and forward and backwards linkages of manufacturing furthermore foster growth also in other sectors of the economy (Hirschman; Kaldor).

Did the manufacturing industry in Brazil completely fail to gain from all the potential advantages open economy forces conferred to it since its foundation in the last quarter of the nineteenth century hence reads like a pertinent question. The paper seeks respond to that question through a systematic treatment of the available if scarce and fragmentary evidence of Brazilian labor productivity since the late nineteenth century.

To answer the question requires a comparative framework that gauges the productivity achievement of the developing country that makes strides towards accelerating growth rates against that of the developed country at the productivity frontline that may be subject to decelerating growth rates owing to diminishing returns to capital deepening (Solow). In this case I put the US as the landmark, which follows a tradition among students of Latin America, thereby

making it convenient to tap from and make sense of previous studies. The use of a reference country brings the paper into affinity with the literature on comparative productivity benchmarks and time series extrapolation. The whole exercise departs from the pioneering effort of van Ark and Maddison (1989) who show that the American level of labor productivity was about double that of Brazilian in 1975. For readers unfamiliar with the historiography of international productivity comparisons, the gap may seem astounding. We must remember though that the US' manufacturing output per person engaged was more than double that of most other developed countries in the 1970s (Broadberry). The Brazilian level of labor productivity stood in fact on equal footing with many developed countries at the time of the benchmark, which van Ark (1988) exemplifies by a study showing Brazil as on pair with the UK in 1975.

If Brazil had attained such impressive levels of labor productivity in manufacturing by the mid-1970s what would this achievement imply for the record of the first three quarters of the twentieth century: the modest wave of early industrialization pre-1940 and the conspicuous era of state-led growth and massive industrialization from 1950 to 1970? Few Brazilian economic historians would probably put their faith in the potential of the early twentieth century manufacturing in its infancy, directed almost exclusively to the production of consumer nondurables, to have elevated significantly relative productivity levels. Unless comparative levels of labor productivity have remained unaltered before 1975, which seems entirely unlikely, the advances of labor productivity during the era of state-led development in 1950 to 1970 must have been responsible for bringing Brazilian productivity levels closer the frontiers (Colistete 2014).

The quite palpable relative productivity level that Brazil had achieved by the mid-1970s stands however in sharp relief against the gloomy image of productivity performance since the debt crises in the early 1980s (Arrighi and Colistete 2014).

The sequence of boom first and bust then at the whole economy level, which is a perennial theme in the literature on Latin American economic history, applies it seems also quite well to Brazilian labor productivity in manufacturing. The paper foremost contribution is to explore these contrasting images of productivity, before and after the debt crises, (i) by establishing two additional benchmarks of 1949 and 1920, coinciding with the publication of the Brazilian

industrial censuses, and (ii) by prolonging the existing time series of labor productivity that begins in 1945 (Colistete 2007) backwards to 1890.[1] Although it must be conceded that the quality of the evidence at our disposal is low, and for the earlier half of the twentieth century the paper can offer no more than a conjecture, the long-term image that emerges fits very well with most previous conceptions and manages to offer a succinct spapshot of a century of Brazilian comparative labor productivity in manufacturing.

The final image that comes into view is reminiscent of a roller-coaster ride. The productivity lag before the 1930s was abysmal; on average the level of Brazilian labor productivity in manufacturing was 10 percent of the American. Brazilian economic historians concur in the view that Brazilian technology was poorly developed in the first decade of the twentieth century; and consumer goods industries and raw-material based industries dominated. The evidence presented here bolsters their judgments. But in the era of state led development that commended in the aftermath of World War II the Brazilian manufacturing industry began to make great progress in diminishing the productivity gap to the productivity frontiers. The gap contracted to about 50 percent in the end of the 1970s. A palpable achievement also in view of what for instance South Korea mustered (REF). The boom then turned to bust in the debt crises of the early 1980s and the record since then is very discouraging.

2. Brazilian manufacturing: historiographical views

The overview of voices on the development of Brazilian manufacturing serves to put the coming new long-term evidence of productivity into historical context. By necessity, it is limited to broad strokes. An older line of research centers on the epochal studies of Furtado (1959) and Prebisch () and stresses the deliberate import substitution strategies the Brazilian state pursued by the establishment of Estado Novo in 1937. What happened in the manufacturing sector before the 1930s receives little or no attention? For them, the Great Depression of the early 1930s marks the end of the old era of reliance on coffee exports and the beginning of the new, which entailed great efforts to develop domestic industry behind tariff walls. Even though the adverse effects of the volatile world market

[1] There are various studies that draws on the van Ark and Maddison (1988) to gauge the comparative record of Brazilian labor productivity, and some also uses time-series extrapolation to extrapolate the record backwards: van Ark (1993); Timmer and Szirmai; Colistete (X, XX); Hofman and Mulder (1998); Naudé et al. (2013).

prices of coffee had been felt since long, the great loss of world demand for Brazilian coffee in the wake of the Great Depression became the catalyst for change. What furthermore has fuelled this interpretation, sometimes coined "a teoria dos choques adversos", is that the available evidence of industrial production pointed to a marked acceleration in the 1930s, which contrasted with the sluggish performance of the 1920s (Versiani).

In the wake of the early interpretations and impressive list of works dealing with the developments of Brazilian industrialization pre-1930 appeared in the 1960s and 1970s.[2] What units many of these followers is an objection to dig deeper into the origins and consequences of industrialization from at least as early as the 1890s. Even though there are differences of interpretation and emphasis among those voices, the general judgment is that Brazilian pre-WWII industrialization was slow in coming and relied largely on foreign technologically. It is very likely that the coffee boom fuelled the rise of domestic manufacturing plants when industrialization was still at its infancy (Dean; Arrighi and Collistete). Most authors point to the preponderance of consumer goods industries, above all textiles and food, and the deficiency of capital goods industry, like iron and steel industry and mechanical engineering.[3] In Fishlow's (1975, p. 322) synoptic words: "as a whole, industrial production was limited and unsophisticated". The textile industry dominated with a quarter of total output in 1920, rivaled only by the sum of all food processing industries, which accounted for 33 percent of output (Ibid. p. 323). Furthermore, the use of electricity lagged behind. In 1907, only 4.2 percent of the power used by industry was based on electricity. In sum, there appears to have been great scope for enjoying the benefits of backwardness, to use the jargon of the convergence literature.

Until 1930s, when domestic production of many capital goods began to substitute imports, Brazil was dependent on imports of a wide range of machines and sophisticated equipment. As a corollary to the lack of experience in the production of capital goods, foreign entrepreneurs played a decisive role in the development of more sophisticated manufacturing processes, as well as in the

[2] Baer (1965), Dean (1969), Simonsen (1973) Villela and Suzigan (1973), Peláez (1972) Suzigan ()

[3] Villela and Suzigan (1973 p. 50); Topik (1987 p. 155–7); Fishlow (1975 p. 322–3) (more…). The patent record recently unearthed by Colistete (2014) shows however that most patent were allotted to the mechanical engineering industry, the majority of these patent concerned special-purpose machinery for coffee processing.

establishment of heavy industry like steel and cement. Whatever sign of sophistication you would come by, bet it was foreign. Postwar industrialization, at least in Sao Paulo, became very much different than prewar because foreign entrepreneurs took part more actively in it (Dean 1969; Colistete 2001).

Leff (1982) does not consider the lack of capital industry an impediment for subsequent growth prospects. The establishment of a consumer goods industry was the natural first step as the intermediate consumption in the form of mostly agricultural products used to produce final goods was readily available domestically. The presence of it did not hamper the formation of a capital goods sector, to which the later development in the 1930s testifies. In addition, Versiani (1987) paints a brighter picture of Brazilian industry in the 1920s. He questions the claimed bifurcation as to the pace by which industrialization advanced in the 1920s relative to the 1930s. He has shown that the quantity index based on the *Imposto de Consumo* used by most authors is in error in 1919–1923. The error biases the level of the index in 1924 upwards causing the impression that there was no subsequent growth of output until 1929. This bias has above all affected our perception of the production of cotton textiles, which weighs heavily in the combined index for manufacturing as a whole. A correct index shows a more steady growth trajectory throughout the 1920s. In addition, several new industries were established in the 1920s, some of which were based on new science and technology developed in late nineteenth and early twentieth century, commonly associated with the Second Industrial Revolution. The first steps in the electrification of manufacturing processes were also taken. The impact newer industries would exercise on the manufacturing sector at large took time to realize though; even though the traditional industries grew by inches their large weight dwarfed the dynamic industries' contribution.

The question whether Brazil de facto realized the potential gains of backwardness through technology import and accelerated productivity in manufacturing the previous literature does not answer. Even though Brazilian intellectuals have so explicitly related the development of domestic industry to the external conditions set by the most important trading partners, no attempts have been made to establish comparative levels of productivity. But the dearth of useful sources about productivity performance for manufacturing at large implies that we all fumble about in the dark. It is a preliminary contention that the pre-World War II primordial characteristics the literature ascribes to the

Brazilian manufacturing industry prevented it from growing faster than the international productivity frontiers.

The external crises that hit Brazil and other Latin American countries between 1930 and 1945, the Great Depression with the breakdown of international trade, and the Second World War, prompted the state to take on a greater responsibility for economic development in general and industrialization in particular. The broad contour of this development regime is by now quite well known and the Brazilian features of it fit with the overall Latin American outline, whether we prefer to call it Import substitution, state led development or developmentalism (Bulmer-Tomas; Collistete; Bertola and Occampo).

Barring perhaps Mexico, we may recognize two distinctive properties of the Brazilian experience that separates her from other Latin American countries'. First, the manufacturing industry played the more important part in Brazil. The share manufacturing grew slowly but steadily until it peaked as a sectorial share of employment at 21 percent in the mid-1970s (REF; Arrighi and Collistete). The peak share may seem unimpressive relative to those countries that embarked on massive industrialization in the nineteenth century some of which reached shares of employment between 40 and 50 percent; generally though countries that experienced delayed industrialization did not come close to similar amplitudes (Feinstein 1999; Rodrick). Second, the GDP per capita growth rates were higher in Brazil than elsewhere on the continent, at least if we restrict ourselves to comparing Brazil with the other larger countries in the Southern Cone. Mexican record was similar.

Even more impressive than progress in aggregate is the growth acceleration of labor productivity between 1950 and 1980, hence before the debt crises. The annual rate of progress for manufacturing at large was 5.8 percent. This arithmetic masks large varieties over time and across industries. The more rampant growth rates were accomplished in 1945 to 1960 (8.7 percent) and in 1970 to 1980 (6.9 percent). Progress was way slower in the 1960s (2.7 percent). A shift share analysis that decomposes the aggregate into its constituent components testifies to the importance of within industry advances and downplays the importance of the changing industry-specific shares of employment. The overwhelming share of the aggregate growth rate resulted from within industry productivity advances, which is an important observation because the large literature on shift share analysis attributes productivity

advances within industries to actual efficiency gains from technological changes.[4]

Whereas previous studies of the pre-World War II era did not bring an explicitly comparative framework to bear on the Brazilian productivity record, owing mostly to a paucity of evidence, some of the post-World War II studies on Brazilian productivity have used comparisons with the US, above all, but also other countries' productivity records. The general view is that Brazil grew faster than the US and other developed countries in the era of state led development in 1950 to the mid-1970s. From these previous authors preliminary judgments the comparative record we would be inclined to believe that the quite palpable level of labor productivity the Brazilian manufacturing had attained by the mid-1970s was the outcome of the determinants conducive to catching up that the Brazilian government, whether ruled by a democratic government, established in 1945 to at least the mid-1970s. Though long since the verdict on this era's achievement has largely been colored by the debt crises of the early 1980s that turned the boom into bust; and the decade that followed was doomed; "lost" as X put it (REF).

The debt crises probably contributed to decelerate the growth of labor productivity in the 1980s, still it grew by 2.1 percent a year until the 1990. Although this record marks a slow down relative to the boom in the 1970s it may not be as detrimental as the expression lost decade implies. Some domestic consumer goods industries like textile and rubber grew vigorously and also electrical engineering. On the downside the productivity growth of the mechanical engineering industry that accounted for the majority of the overall performance of manufacturing in the 1960s and 1970s ceased almost altogether.

What happens with the growth of productivity in the first half 1990s is difficult to conjecture because the IBGE revised their national accounts. We have all the reasons to believe that the Brazilian record was sluggish given the macro-economic conditions of soaring inflation until 1994 when the Plano Real managed to bring inflation down. The rest of the 1990s did not bring any further advances worth mentioning, neither did the following decade, surprising as that may seen provided that growth rate at the whole economy level gathered impressive speed from at least 2004 (Baer). Growth rate of labor productivity in manufacturing did not even surpass one percent a year.

[4] Kendrick m.fl.

3. Benchmarks of comparative labor productivity

The exercise to trace the movement of Brazilian comparative levels of labor productivity in manufacturing throughout the twentieth century requires two things: first, one or several benchmarks of Brazilian labor productivity levels in relation to a suitable reference country, and secondly, time series of labor productivity to extrapolate from one of the benchmarks to cover the entire century.

The use of the US as a reference mark for the Brazilian level of labor productivity conforms to the propensity among Latin American scholars to relate the performance of the Latin American countries to that of the US.[5] One may argue that in fact the US is not the most indicative measure of the relative development of Latin American countries because of what the literature refers to American exceptionalism, the supreme productivity performance the US achieved since at least the late nineteenth century.[6] We therefore cast the Brazilian productivity lag into sharper relief by relating it to the US.[7] From a pragmatic viewpoint though few countries offer census of manufacture comparable to the American, which has made the US the subject of several studies of comparative productivity. If we venture to assert that the available set of country comparisons using the US as a reference country are transitive, we would greatly expand the potential to relate the Brazilian record to a global context. If not know so at least in the future as more benchmarks becomes available.

The recognized methodology for productivity benchmark is the industry of origin approach that aims at comparing output by industry. The two most commonly used industry of origin methodologies, Rostas' (1948) by comparing directly physical output per worker, and Paige and Bombach' (1959) by constructing unit value ratios to convert nominal to real value added per worker, require Census information on output in physical terms. Whereas physical output information usually accompany industrial censuses, as in the case of the US, the UK and the Swedish' over the course the entire twentieth century, the *Censos Industrial do Brasil* did not provide it until 1975. The pre-1975 omission of

[5] See for instance the contributions in Fokuyama (2008) or Sokoloff and Engerman (1998). Mera här.

[6] See Allen (2014) for a recent discussion.

[7] Prados de la Escosura (2007) argues that the average of OECD countries is a better yardstick than the US.

physical output indicators may explain why the van Ark and Maddison (1989) benchmark of Brazil relative to the US and Mexico for the mid-1970s is the only previous attempt to provide a reference point for Brazilian comparative productivity levels in manufacturing.

Their benchmark is based on the *Censo Industrial do Brasil* that pertains to 1975, which provides a wealth of information on physical quantity and covers the entire manufacturing sector. The authors matched it to the *US Annual Survey of Manufactures*, representing 1975 to 1976. The comparison comprises 17 industries accounting for 40 percent of the Brazilian gross output and 28 percent of the American. They follow the unit value ratios route to the industry of origin approach to estimate a set of country-specific unit values on the basis of physical output indicators corresponding prices of 171 Brazilian products and 372 American products. For each industry, they established price and quantity ratios weighted by either Brazilian or American quantities. The methodology gives two sets of price and quantity ratios, expressed in either cruceiro or dollar. The final step implies taking the geometric mean of the two different "prices", or couched in statistical vocabulary, the geometric mean of Paasche and Laspeyres indices that gives Fisher. To establish the productivity ratios the comparable volume measures of value added were divided by number of persons engaged. The use of persons engaged instead of number of hours probably favours the US level because Americans oiled longer hours (Huberman).

Because the pre-1975 *Censos Industrial do Brasil* fail to give physical output the door leading to the most accepted solution of productivity benchmark remains shut. Still they boost two merits worth considering as sources for comparative studies. First, like the *US Census of Manufactures*, they provide industry-specific information on cost shares of intermediate consumption, which permits the computation of net output. Second, the Brazilian classification scheme is similar, if not identical, to the American. Whereas the lack of physical output spoils Rostas (1948) idea of comparing physical output per worker, the net output information at least leaves open the option of comparing net output per worker converted to a single currency.

In the Paige and Bombach (1959) industry of origin approach, weighted unit value ratios are constructed for groups of industries based on unit values in each country's census. The unit value ratios are used as currency converter. The justification is that these relative prices may diverge significantly from the

trading exchange rate, which is the relative price of all traded goods. The trading exchange rate is furthermore under the sway of short-term capital movements and deliberate attempts by central banks to peg the rate different from the relative price of the traded goods. Hence, to convey the flavor of the industry of origin approach, the absence of unit values in the Brazilian census needs to be circumvented by resorting to wholesale prices.[8]

The Brazilian government published four Industrial Censuses in the first half of the nineteenth century. The first appeared in 1907 and is incomplete. In fact, it was not a governmental report because the national manufacturers' association was responsible for the survey. It feared that company owners would dismiss a survey conducted by the federal government. Large swath of industries was excluded in the first census because of the deficient coverage of São Paulo. It may therefore not be indicative of manufacturing at large. The surveying procedure used in the following censuses that appeared in 1919, 1939 and 1949 improved the coverage, which rendered them useful summaries of key aspects of Brazilian manufacturing.[9]

American wholesale prices underlying the various indices issued by the Bureau of Labor Statistics are available annually since at least the beginning of the twentieth century. Many of the goods covered appear in NBERs macrohistory database.[10] A sample about 180 products prices appears in the various issues of the Statistical Abstract of the United States.[11] Both sources supply information sufficiently detailed for accurate product matching. What limits the number of included products is instead the scarcity of Brazilian price information. Fundacão Getulio Vargas (FGV) constructed a wholesale price index beginning in 1944 but has never published the particulars of the products underlying the index. Neither did the Instituto Brasileiro de Geografia e Estatística (IBGE) despite efforts to collect wholesale prices.[12] The only price information available appears instead in de Octavio Gouveia de Bulhões' "Índices de preços" published in *Revista Brasileira de Economia* (1948), which

[8] Broadberry and Klein (2011) use whole sale prices to establish a Checkoslovak/UK benchmark of 1935.
[9] See Haber (1992) and Dean (1969) for a discussion on the Censo Industrial do Brasil in 1907.
[10] adress
[11] REF
[12] See chapter 5, Índices de preços, in IBGE (1990). Information on what appears to be consumer prices of various products appear annually in IBGEs *Annuário estatistico do Brasil* between 1935 and 1947.

contains annual price quotations for a wide range of products from 1938–1947. It lists 99 products, and if sub categories are included, no less than 133 products. The article does not abound with data description. We are told that the price quotations were collected by IBGE and that they pertain to Distrito Federal, at this time Rio de Janeiro. He also let us know that "IBGE obtém os preços em grosso por meio de informantes escolhidos", wholesale prices thus, free from retail mark-up.[13]

The range of years covered in "Índices de preços" almost overlaps the census of 1939 and 1949. This information therefore builds the foundation on which two new Brazilian/US productivity benchmark will rest. In relation to the sample of wholesale price quotations in Statistical Abstract of the United States, the information on Brazilian product quality is scarce, which circumscribes the usefulness of this source for international comparisons. After having cautiously considered product heterogeneity, I paired fifty products to form the final fictitious exchange rate used to convert the different currencies into a single unit of pay in 1939 and 1949. Value added from each of the two countries' industrial census provides the weights used to construct two sets of measures. As in inter-temporal comparisons of prices and quantities, we compare a country's price level with the price level of a reference point, in this case the price level of Brazil in relation to that of the US. The second term of formula (1) illustrates a Laspeyres index that compares Brazilian prices multiplied by American quantities with American prices multiplied by American quantities, and the second term of (2) a Paasche index that compares Brazilian prices multiplied by Brazilian quantities with American prices multiplied by Brazilian quantities. To establish the two indices without information on physical quantities the first terms of the formulas show the actual procedure in operation, weighting the price relatives for each commodity by the share of that commodity in total output. Output shares are value added taken from each country's Industrial Census. As has become standard in the literature on international product and price comparisons, the preferred measure is the geometric mean of the two, the so-called Fisher index.

[13] Some of these prices appear in IBGE Anuário 1941–1945 p. 312–324

$$Laspeyres\ (US\ weights) = \frac{\sum_{i=1}^{n}\left(\frac{P_{Brazil,i}}{P_{US,i}}\right)P_{US,i}Q_{US,i}}{\sum_{i=1}^{n}P_{US,i}Q_{US,i}} = \frac{\sum_{i=1}^{n}P_{Brazil,i}Q_{US,i}}{\sum_{i=1}^{n}P_{US,i}Q_{US,i}}$$

$$Paasche\ (Brazilian\ weights) = 1\Big/\frac{\sum_{i=1}^{n}\left(\frac{P_{US,i}}{P_{Brazil,i}}\right)P_{Brazil,i}Q_{Brazil,i}}{\sum_{i=1}^{n}P_{Brazil,i}Q_{Brazil,i}} = \frac{\sum_{i=1}^{n}P_{Brazil,i}Q_{Brazil,i}}{\sum_{i=1}^{n}P_{US,i}Q_{Brazil,i}}$$

The construction of the final measure of relative prices proceeds stepwise: in a first step, from commodity to groups of similar commodities; in a second from groups of similar commodities to branches; and in a third from branches to overall manufacturing. The shares of value added at the group and branch levels mirror the output structure as given in each country's Industrial Census, and do not amount to the sum of output value for the modest sample of commodities compared. This approach requires us to re-classify some industries in the two countries' Industrial Censuses to make branches look alike. The procedure implies minor corrections; remaining differences in the structure of industries owe mostly to the fact that the two countries produced different commodities. At each level of aggregation, one has to assume that the sample of commodities gives a representative picture of relative prices. The coverage ratio is low because of the small sample of commodities. I make no pretense to having established these fictitious exchange rates with high accuracy. Steve Broadberry suggests that a margin of error of 10 to 15 percent should accompany productivity benchmarks. For the ones under construction here, resting as they do on a quite weak evidential platform, we need to at least consider a margin of error in the upper end of the proposed range.

Table X shows relative wholesale prices for the sample of industries. The difference between the Laspeyres and Paasche index goes all in the same direction; the established levels of relative Brazilian wholesale prices turn out to be higher when they the weights reflects American output structure. The exception is the paper industry and the leather industry in which an insufficient number of commodities was included (paper) or no output value could be assigned to the commodities (leather). Such discrepancy between Laspeyres and Paasche indices should come as no surprise because lower relative prices

indicate higher relative productivity, and higher relative productivity often leads to higher growth of output. The geometric mean of the two yields 27.95, which is significantly higher than the trading exchange rate at 18.38. Again, this discrepancy is expected. Brazil experienced rapid inflation in the immediate post-WWII era than the US did. The exchange rate, however, remained fixed. The result was a dramatic overvaluation of the cruzeiro which brought large increase in imports while exports of manufactures were curtailed. To protect domestic producers import licenses the Brazilian state introduced import controls.[14]

Equipped with the new relative price levels the establishment of benchmarks of comparative labor productivity follows straightforwardly. Each country's Industrial census provides value added by industry. To render the Brazilian one more in harmony with the American, I have removed all the extractive industries. Differences attributable to the output structure remain unaltered. The new relative price level is used to translate dollar into cruzeiro. The new Brazilian/US productivity benchmark arrives at 23.96, thus the Brazilian productivity level was roughly one fourth of the American in 1947. The table also includes the Maddison and van Ark (1989) benchmark of 1975, which indicates that the Brazilian level was half that of the US. In sum, the post-WWII era witnessed an impressive Brazilian productivity catch-up in manufacturing. Whether the new benchmarks can be reconciled by country-specific time series of labor productivity is the subject of the coming section.

Additional benchmark?

4. Time series of output and employment

Our knowledge on the movement of labor productivity before 1944, when IBGE began to collect annual data for output and employment of manufacturing industries at large, is meager, mildly put. Apart from the industrial censuses the only sources at our disposal are those commodities subject to the *imposto de consume*, a tax levied on sold output. The early *Estado Velho* established it to overcome the fiscal dependence on tariffs at the turn of the century. In the beginning of the 1910s, the number of units purchased by each industry subject to the tax began to be published annually along with the corresponding value of

[14] Fishlow ()

the sold items. The number of products subject to taxation expanded gradually; in 1920, the sample of products comprised 24 items. Besides, because the sample included the most important capital goods and nondurable consumables, the value of the sold items the lion's share of the manufacturing sector. The published series end in 1938.

The various attempts to aggregate the different series of physical units are based on industry- specific value added shares from the Industrial Census of 1919 and 1939. The aggregate series so constructed suffer from three weaknesses. First, the physical units registered pertain to sold, not produced, items. Anchoring our view of manufacturing performance on a series of sales that does not take into account the size of the stock runs the risk of misjudging periods when the stock dramatically changes. Haber (1992) has for instance shown that in 1927–1930, textile firms were selling off at a discount rate in order to diminish the stocks that had been accumulated in preceding years. Production of new textiles thereby dropped significantly. The series of textile sales fails to record this decline of production. Second, series of physical quantities do not take into account any change in the quality of the services these products confer to the buyer. Changes and improvements in product qualities and varieties are inherent features of modern economic growth. The method fits homogenous products like cement and but fails when it comes to more complex goods., heterogeneity and improvements in quality remain however a minor problem for most of the products subject to *imposto de consume.* Third, twenty years elapse from the first to the second benchmark of value added shares, which implies that the weighted series does not incorporate changes in technological coefficients or changes in the price relation of intermediate consumption units and final produce, a shortage it shares with quite a few other countries' historical national accounts before WWII (Thomas and Feinstein 2005). Hence, similar objections could be raised against many countries series of manufacturing output.

Instead, the lack of employment data represents the greatest obstacle to establish a reliable picture of productivity movement in pre-1945 Brazil. No information on employment accompanies the figures on physical output. All we have is the incomplete census of 1907, and the complete censuses of 1919 and 1939. Hence, we have to recourse to a proxy, designed to provide a conjecture of the movement of labor productivity from 1890 to 1944. There are two ways to solve this problem, even though both of them are highly questionable. The first

of these takes as a prerequisite that there exists a positive relationship between the growth of output and the growth of labor productivity. What is known as Verdoorn's law poses a positive relationship between output and labor productivity. This relationship can be identified by running regressions on the two variables, like in (1),

$$ln(Q / L) = \alpha + \beta lnQ$$

where Q represents the volume of gross output and L number of workers. As both output and labor productivity are expressed in natural logarithms β shows the elasticity of labor productivity with respect to output; it indicates how much labor productivity would change in response to a percentage change in output. Since in this case there is no employment series for the period under consideration, one may choose elasticity either based on similar studies or run a regression with data from another (later) period. In his pioneering investigation, Verdoorn found that the estimated elasticity of labor productivity was about 0.5. Later investigations, cross sections as well as inter-industry studies, have also produced significant coefficients of about the same magnitude. The econometrics used to solve the apparent simple equation meets formidable problems, not the least in a time series framework. Obviously, by this method, applying the assumed size of the elasticity coefficient, we can do no more than produce a very rough guide as to how Brazilian labor productivity evolved before 1944.

The other way forward is to use a series of product wages, a series of nominal wages for manufacturing workers deflated by a series of output prices, as a proxy for labor productivity. The idea is reminiscent of the accounting identity, or price dual, used to establish a measure of total factor productivity without measuring the volume of capital and labor inputs.[15] In addition, the great virtue of national account is that the numbers must add up in a consistent manner. Labor productivity, i.e. value added per worker-working hours, includes remuneration to labor in the form of wages and remuneration to capital in the form of profits. Unless distributional considerations play a significant part, then the growth of labor productivity goes hand in hand with the growth of product wages. The crucial assumption is that the wage share did not undergo changes

[15] McCloskey; Antras and Voth

large enough to render product wages a misleading proxy of labor productivity.[16] The growth of product wages would also, because it mimics value added, incorporate efficiency gains in the use of intermediate consumption. Provided, again, that the wage share is quite stable, and that our evidence of labor market outcomes constitutes an accurate account of wage movement for manufacturing at large.

There is no abundance though of useful wage series of manufacturing workers for the first half of the twentieth century. Two possible sources will be explored: First, Lobo (REF) presents a wage series of artisan workers from Rio de Janeiro. Despite being a questionable measure of Brazilian wages at large, this series has been extensively used in the recent literature on Latin American inequality (Williamson 1999; Bertola et al. 2010; Frankema 2010). Second, Ball (2013, pp. 61–89) presents a wage series of manual workers from textile, railway and public utility workers in São Paulo in 1890 to 1930.[17] The difference between the two wage series is surprisingly small, which conveys credibility to both of them as being indicative evidence of Brazilian wage development (Figure 1). In the following the series of São Paulo is used since it pertains more closely to manufacturing. The nominal wage series is deflated by a series of output prices; Catão's (1992) series of wholesale prices between 1890 and 1913 is spliced with Haddad's (1978) deflator of manufacturing output until 1930. Figure 2 compares the two conjectures of labor productivity growth between 1890 and 1930 in which the index series is set to 100 in 1930. The two measures follow a similar path (to be continued…).

After 1944 IBGEs official figures on employment, nominal value added and a partial number of industry-specific price series are used to establish the record of labor productivity from 1944 to 2010. It worth putting emphasis on the noteworthy differences between the three series of volume gross value added per person engaged for the post-World War II era that the previous literature offers: van Ark (1993, p. 189); de Vries and Hofman (2007) through the Groningen Growth and Development Centre's (GGDC) sectoral database for Latin America; and Arrighi and Colistete (2014). The more confounding it becomes as

[16] Renato (2007)

[17] Companhia Paulista de Estrados de Ferro railway company (Paulista), the Fiação, Tecelagem e Estamparia Ypiranga Jafet (Jafet) textile factory and the São Paulo Tramway, Light and Power Company (Light) public works firm.

all three are based on IBGEs official statistics. Graph 3 compares the three (to be continued…).

Having established the Brazilian long-term evidence let us close this digression on time series by examining (to be continued…).

Looking at the investigated era in its entirety the most striking turning point with respect to the growth of labor productivity is that of 1980. Before that year labor productivity grew steadily, after it the growth of labor productivity stagnated. Anther noteworthy feature is that growth rates accelerated after 1945. The average growth rate between 1912 and 1944 was 1.27 per cent even though it must be conceded that this figure rests on assumptions. The annual growth rate then accelerated to 2.46 per cent between 1945 and 1980. This is in line with what we would expect to find. If we instead consider alternative labor productivity proxy based on product wages the picture looks bleak before 1944; virtually no growth at all took place, which is unexpected given the significant rate of industrialization that gained ground before WWII. It may instead caution against using this wage series to represent labor market outcomes in Brazil.

The American record of labor productivity growth rates in manufacturing is well documented since at least the magisterial volume of Kendrick (1961), and so is the record of total factor productivity. The American growth of labor productivity in manufacturing was impressive in particular in the 1920s when the impact of electrification on the reconstruction of plant design became widespread (Field, David and Wright). The rate of TFP growth was unprecedented in the 1920s. Progress continued also in the 1930s, against the backdrop of the Great Depression, propelled by what Gordon (REF) has coined the One Big Wave, centered on electricity, the combustion engine, and modern housing. In fact, few countries could do better than keeping up with the growth of the US economy in the first half of the twentieth century. Probably even less so in manufacturing, where the productivity forces gathered momentum in the 1920s and the 1930s (Field 2011).

With this in mind the evidence that the Brazilian manufacturing industry kept the productivity gap between it and the US intact testifies to the (to be continued).

5. The comparative record over the long haul

to be written