Cost Curves and Capacity Utilization in the U.S. Manufacturing, 1958-1996

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Abstract

This study investigates the cost components of twenty industries of the US manufacturing sector in the 1958-1996 period. We analize, at both sectoral and two-digit levels of aggregation, the behavior of unit variable costs for different levels of output, as represented by a proxy for capacity utilization. In addition, we decompose the cost structure into payroll, wages and material costs. Finally, we investigate the patterns of technical change during the business cycle. Our results show that unit costs in general present a negative slope, with an intermediate range that reaches quasi-constancy and this may help explain the pro-ciclicality of mark-ups at the sectoral level. In addition, cost decomposition in material and labor costs shows that labor hoarding is a generalized phenomenon is the manufacturing sector, shown by steeper slopes of the LOESS fit for payroll and wage costs in relation to material costs. On the other hand, the constancy in a relevant range of our cost curves is confirmed by the observation of the isoquants for the same industries, that show evidence of a fixed-coefficient technology of the Leontieff type. Finally, the same tools show that Hick-neutrality is the most common form of technical change over the business cycle in most of industries and sector.

Keywords: Mark-ups, Business Cycles, Post-Keynesian Price Theory

JEL Classification: D40, E12, E32, L11

Introduction

While evidence that margins of profit in the U.S. manufacturing sector are pro-cyclical and quite flexible at more disaggregated levels has been presented, a more detailed account of the determinants of this phenomenon is yet to be provided in the recent literature.

One of the possible - and more conventional - interpretations of such findings asserts that the patterns of cyclical behavior are created mainly through demand side shocks that crowd in downward sloping demand curves and consequently impact margins of profit through relative price adjustments in each industry's product market. Although we certainly do not rule out the possibility of these direct income effects on the realization of markups, the acknowledgement of the existence of a certain demand relation that happens to be negatively related to prices and impacted by the movements in the income level does not necessarily imply, as we know, a fully-determined demand function, with all the respective linkages with neoclassical value theory.

Another (non excludent, indeed) source of explanation for the movements in the mark-up can be found in the cost structure faced by each industry. Firms and industries constitute the demand of multiple factor markets, and the relative movement of these input values during the cycle may provide a more complex set of elements that would help us understand what happens to the margins of profit when short-run changes in output levels take place.

For this reason, our work will concentrate on the analysis of the production side, especially its labor and material components, and will attempt to identify aggregate and industry level patterns that could help us understand what happens to this cost base when sudden variations in capacity utilization occur.

The focus on the study on the lower boundary of the margin of profit will help us also investigate associated controversial questions. The first group of related issues has to do with the very shape of cost curves and the functional form that best represents the usage of inputs at each level of output. We are interested in knowing if there is any support for the idea of u-shaped variable cost curves and the corresponding flexible-coefficient production functions typically found in the mainstream literature. A second group of questions relates to the process of cost decomposition and patterns of input utilization when capacity utilization is disturbed. In other words, we want to look at a representative group of isoquants and verify whether they correspond to the functional forms suggested in the first part of our study. In addition, we will also look at the forms of technical change in the short-run. We want to use the changes in the distributive parameters that eventually take place when capacity utilization occurs and observe if it corresponds to shifts in the set of techniques represented by a given technology.

The aforementioned questions help us answer many issues of undisputed relevance. At the microeconomic level, the possibility of instantaneous substitution of inputs, as represented by the flexible production function plays a fundamental role in the between price and distribution theories in neoclassical stories. In addition, the shape of cost curve is of direct interest to post-keynesians, who have long tried to establish a price theory through the crucial assumption that firms face constant direct cost curves until the point of full capacity utilization and are always able to set their typical production levels in that linear range of production. This perception of the normal level of production will have consequences, at the macroeconomic level, for effective demand (and, of course, economic policy) concerns that are also typical of this strand of heterodox economic theory.

Great part of our study will be based on what we call a virtual cost-capacity curve - an attempt to reproduce the standard microeconomic curves that plots (de-trended) unit costs against capacity utilization. This method, we believe, has the great advantage of allowing the use of time series to build a schedule that otherwise could only be represented with cross-sectional data. Another advantage in relation to the standard econometric studies of costs in industry is that it also allows direct visualization of the variable of interest in all ranges of output. Finally, because it is composed of (Hodrik-Prescott) filtered variables, only correlations of short-run movements are accounted, therefore correcting for medium-term effects of price and structural change[1].

This paper will initially present a brief survey of the debate on the shape of cost curves, especially in its more recent version - in the works of the post Keynesian economists. Section two will focus on the methodology of our study, discussing the traditional technical difficulties related to the estimation of cost curves, our answer to some of these problems through the establishment of a cost-capacity curve and non-parametric regression methods. Section three will present will present our findings. Conclusion summarizes our main finding and presents possibilities for further research.

1 Shape matters: heterodox perspectives on cost curves

The discontent with the conventional view of the relation between costs and the level of output in economics is almost as old as its very formulation. Piero Sraffa, as early as in 1920's, had already pointed out that the Marshallian general classification of industries according to excluding types of returns to scale and the generalization of the principle of diminishing returns lacked empirical support and analytical soundness due to the very impossibility of a general taxonomy based on these categories (Sraffa, 1925). We know that this particular organization of concepts serves the particular needs of marginalist price theory, which is largely based on the idea that is possible to imagine well determined relations between cost and quantity produced, and that this interdependency will serve the basis for the establishment of equilibrium prices that, under competitive conditions, should equal the marginal contribution of each production factor to the total income.

For classical political economy, the principle of diminishing returns was secluded to the study of rent in agriculture and its existence and level had implications for what is traditionally called the distribution of income side of theory. In Ricardo, for example, rent is seen as a deduction of potential profits in the most productive land due to the introduction of land of less quality and therefore to decrease in its marginal product. The idea that increases in production implied a correspondent increase in costs was carried out with the goal of analyzing its distributive consequences in the context of agricultural production and did not aim at explaining rises in prices of a single product, especially because such an increase in agricultural costs probably would have had consequences for the entire economy, as every product depends, in last instance, on the agricultural sector. For the classicals, in general, it seemed rather that costs bore no direct relation to the level of production.

In fact, it was only with marginalism that the connection between costs and quantity produced at the firm and industry levels was established, however, not before the demand side relation between quantity consumed and utility had already been spelled out. In this context, the principle of diminishing returns was generalized to become the basis for a general price theory, whose fundamental assumption depends on the idea that costs bear a fully determined relation to output.

A different, more empirical, strand of criticism to the neoclassical cost theory came from the advocates of the L-shaped cost curve. R.F. Kahn, after studying the effects of the Great Depression on English firms noticed that those firms preferred to shut down their plants for some days and work full time the remaining days of production whenever they needed to cut costs due to reduced demand . He concluded that the reason for this behavior was that firms, by having to deal with some form of fixed costs (or quasi fixed costs in his terminology) and uniform equipment, naturally avoided working every day for fewer hours. This, in practice meant that firms tried to adjust their levels of output to some range of production, where variable costs were not increasing with output until a point of full capacity utilization, suggesting a cost curve in the form of an inverted L.

Although Kahn always saw his discovery as a particular case of the conventional U-shaped curves when severe depression took place, the flat until capacity average variable cost curve became a very popular styled fact during the post-war year of the Keynesian consensus, either in theoretical or

[1] We will see later how long run technical change and price movements are still captured by this method.

policiy making circles, leading Marcuzzo (1996), to say that [the microeconomic L-shaped variable cost curve] is 'one of the least controversial empirical facts' in economics(cf., p.7).

However established as an empirical finding it may be, the theoretical consequences of this stylized fact are deeply controversial until today. Marcuzzo (ibid.) mentions that the crystallization of two opposite positions happened in the late 1940's.

One side of the debate asserted that the linear variable cost curves were in fact a rough approximation of theoretical U-shaped curves and that the empirical finding had no further consequences for the well established belief on the marginal principle (Machlup, 1946; Bishop, 1948) . For those authors, the point behind a conventional cost curve was the idea that costs should eventually rise and that, even if some discontinuity in cost curves (as in the case of L-shaped curves), this did not rule out the marginal principle as an instrument to determine the point of profit maximization. As in a trial and error process, they argued that it was only necessary to find a point where marginal revenue was greater than marginal costs and, after that, to find the point where the opposite occurred - and in that interval was located the point of maximum rate of profit.

One of the versions of the alternative position, on its side, asserted that what the L-shaped cost curve suggested was not the inconsistency problem of neoclassical price theory on its own grounds, but rather that two of its crucial assumptions had no empirical support: the idea of a decreasing marginal productivity of labor and of the perfect substitutability of factors.

From the 1960's until today the debate on the shape of cost curves is mostly connected with the post keynesians. Their incursions in price theory is marked by the attempt to get rid of remnants of marginalism in their models, as part of what seems to be a broader intellectual project to rebuild microeconomics in alternative grounds. This initiative is best represented in formal terms by the assumption of a flat average variable costs curve 'in the relevant range of production' and thus ruling out the possibility of increasing marginal costs in the short-run.

For this reason, the distinction between practical capacity utilization and theoretical capacity is crucial in Post-Keynesian models. Post Keynesian authors strongly argue that firms normally operate in a range of production where excess capacity - and constant marginal costs - is the norm. For Kaldor (1970) and Kalecki (1971) the idea of firms having the necessity to keep reserves of capacity in order to account for unexpected movements in demand is absolutely unambiguous and it is linked to these notion that, in a world of imperfect competition it is a central necessity for firms to keep the ability to explore any chance of increasing its selling power.

In effect, the Post-Keynesian oligopolist firm, taking advantage of their large share of the market, manages to mobilize and coordinate a network of material suppliers and to have enough physical and financial capacity to absorb shocks originated from the sudden movements of demand through adjustments in the volume of inventories - in the quantity side of the price determination schedule (Eichner, 1976; Blair, 1972; Eckstein, 1964; Weintraub, 1959). As a result, for these authors, a totally different price setting mechanism was established - one no longer reliant on the interactions of independent determined supply and demand schedules, but on the *will* of the oligopolist firm to keep price stability and therefore generate a steady flow of resources necessary to finance its growth. Prices are determined fundamentally by a process where a *desired* profit margin is set and presented to the market. We then have what this tradition calls a *growth maximizing* rather than a conventional *profit maximizing* firm.

This exogenous mark-up theory (as opposed to endogenous competition-based theories) has many incarnations, but could be classified in general terms according to the *cost basis* on which the mark up is set. Here one finds either the *mark up on unit prime (or average variable) costs* - simply called *mark up pricing* - or the *mark up on unit costs*, called the *full cost pricing* method. Strict Mark-up pricing seems to be by far the most common price model used in post Keynesian models (Kalecki, 1971, p.51); or the *time frame* considered when calculating the cost base. Here we would have cost plus pricing based on *actual* costs or on *normal capacity* costs - sometimes also called the *normal cost pricing* doctrine. (Coutts, Godley, and Nordhaus, 1978; Godley and Nordhaus, 1972). In this particular case the actual shape of cost curves seems to be immaterial for the firm, as it bases its decisions on some averaged or desired level of costs.

In figure 1.1 (*vide* also Eichner and Kregel, 1975, p. 1306), we observe the two most conventional price models found in the post Keynesian literature. The mark up pricing method basically establishes that prices are set based on a procedure whereby firms, by facing a constant average cost curve below capacity, simply set prices at the level that yielded a desired gross profit margin. The Full Cost pricing variant of the model states that prices setting is based on a markup on total costs, which means accounting for the decreasing average fixed costs.

Summing up, the majority of Post-Keynesian views concerning prices assume that: 1)price is cost based, established by a mark up on some measure of costs. Depending on which particular approach, mark-ups could be set either on unit (normal or actual) variable or total costs; 2) firms face constant average variable costs up to full capacity utilization. Therefore, the mark up (on average variable costs) will be set *ex-ante* and be kept *constant* in the short-run. Of course, if the mark-up in question is set on normal costs, we may have flexible realized mark-ups; 3) as a result of imperfect competition, firms have enough power to *administer* its prices to the market, keeping its stability face demand pressures and over the trade cycle and finally, 4) the goal of price stability implies not only a definite pattern of firm's relation with the demand side, but also a characteristic set of *institutional* arrangements with potential competitors and material suppliers in order to avoid price wars and disruptions in the production process.

Diagram 1. Price, costs and mark-ups in different versions of post-Keynesian price theory

Prices
- *Cost-based*
- *Fixed*
- Insensitive to short-run demand

⇓

Costs
- *Normal* or *Realized*
  - *Constant Average Variable Costs (AVC)*
  - *Unit Costs (UC)*

⇓

Mark-ups
- *Normal*
  - **fixed mark-up on normal AVC, variable mark-up on actual AVC**
  - **variable mark-up on normal UC**
- *Realized*
  - **fixed mark-up on actual AVC**
  - **variable mark-up on actual UC**

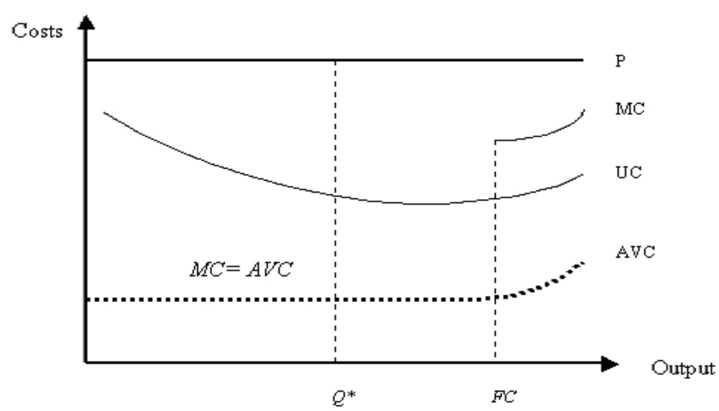

Fig. 1.1 - In the post Keynesian model, the markup on direct costs pricing mechanism can be described as a margin over average variable costs (prime costs) - the distance (P-AVC), which corresponds to a constant gross profit margin before full capacity utilization level of output (FC). In the full cost pricing version, the markup is set over unit costs (UC) and yields a profit margin that increases with output.

2 Unit costs and capacity utilization

Considering the seemingly conflicting positions on the relation between cost and price theory surveyed in the previous section, one could think that the test of empirical claims of contrasting theories could be a straighforward process.

However, things are a little bit more complicated than our posititivist goodwill may suggest. More than often empirical findings bear only a partial relation to the theory that made us actually think about those statistical relations and, as we have seen in the profession, the interpretation of how the findings relate to the general structure of theory seems to be the most important step in the intellectual reconstruction of the world through theory.

For example, if we were to test the behavior of mark-ups as a test of the post-keynesian price theory, a natural way to proceed, after observing figure 1, would be to simply check how mark-ups actually behave and see if they are constant in any meaningful way. However, a closer inspection of the hypothesis of the theory shows that this procedure is insufficient due to some particular characteristics of the post-Keynesian literature on prices. The source of confusion seems to regard the cost base of the mark-up. The plurality of approaches to pricing has allowed post-Keynesians to shift between various mark-up procedures according to their particular goals and modelling convenience, while keeping what we believe to be the core of their price theory: an ex-ante behavioral pricing doctrine. And this fact brings considerable difficulties for the design of definite empirical tests of the post-Keynesian hypothesis as the behavioral pricing idea is simply non-testable, at least in any objective form. In addition, another problem regards the very concept of 'normal costs, which in practical terms is calculated on a smoothed series of actual costs (vide Godley and Nordhaus, 1972), and therefore relatively constant by construction. In spite of these methodological shortcomings and the intense controversy among post-Keynesians[2], a great part of heterodox macro models are built around the idea of a fixed mark-up on constant (or decreasing) unit variable costs, and hence the data they will use will obviously refer to realized, ex-post mark-ups.

The marginalist reaction to the initial findings regarding the L-shaped cost curves is somewhat similar. We have seen that the acceptance of the findings by member of this school did not lead them to a corresponding refusal of the tenets of the marginal principle. Sraffa (1925) mentions that one of the usual answers of Marshallian economics to the critics of their view of short-run cost was that the eventual mismatch between theory and the empirical facts was mainly due to the lack of good quality databases. Sraffa suggests a quite different diagnosis, pointing to the very structure of the marginalist system as the source of the problem.

Notwithstanding the limits of empirical studies, they are of course still crucial for the proper grounding of any theory. In our specific case, it would be interesting to check if we can build stylized facts and observe if there is any sense in thinking about cost relations to output level than can be summarized by the shape of the average variable cost curve that could give us information on the effects of competition in a cross section of industries and help inform the process of macromodeling in economics. To our benefit we have (the long waited!) improvement in data[3] and the power of negative results that can be used to suggest that theories may need more than cosmetic reorganization.

2.1 Historical Cost-capacity schedules

The analysis of mark-ups with principal components in the previous chapter allowed us to identify few regularities in a relatively large data set constituted by only one variable. It would be interesting, however, to look at how the generalized movements in the mark-up fit in a picture where costs are

[2] Lee (1998, 1995, 1994, 1986) provides an extensive survey of studies suggesting the empirical irrelevance of the idea of constant average direct cost curves.

[3] We will use data for the manufacturing secotr provided by the NBER and Census Bureau's Center for Economic Studies. The most recent version of the NBER-CES database was released in June 2000 (vide NBER, 2000).

explicitly included, so that we are able to better understand the causes of cyclical movements in profit margins and directly observe if the diverse claims about the shape of unit direct cost curves have any empirical support.

A possible way to plot our data is by building an unit (historical) cost-capacity schedule inspired by the conventional short-run cost schedules, where instead of having output level in the horizontal axis we directly include a proxy for capacity utilization, i.e., variations of product from its trend. In this manner, besides having an explicit idea of how prices and short run unit direct costs interacted in the event of business cycles, we can also have a notion of the proportion of mark-up movements in relation to cost (and therefore price) variations.

We have seen that the conventional theory asserts that cost curves have the form of an U, being its right portion the representation of the increases in costs caused by the diminishing returns that occur when the more intense use of a single variable input is used with the same combination of other fixed inputs. The increase is costs is depicted as a gradual, smooth process due to the form of flexible technology that is often assumed as the general case. In contrast with this view, the L-shaped cost curve tradition, stresses the linearity of technology and the sudden (due to the fixed coefficients of their production function) capacity limits.

Before presenting the results we want to clarify some questions related to our calculations.

Mark ups are calculated as a ratio between total profits and total direct costs (material costs plus payroll expenditures) , both in current values. Therefore its movements, for time series data, can be influenced by the eventual relative price adjustments that may occur *from one period to another*. In order to keep the consistency among results produced by different methods of research, our cost-capacity curves are therefore written as ratios of unit costs in level terms to its hp-filtered series (see fig. 1) against the same ratio for output (our measure of capacity utilization). They are therefore different from the idea of the conventional cost curves, where constant input prices are assumed. This is why we are calling them historical cost curves. Notwithstanding this fact, the use of deviations from trends corrects for a considerable amount of secular influence of prices without unnecessary loss of variance in the series We believe then that our results can provide considerable insight on what happens to mark-ups and cost when capacity utilization changes.

Our variables were built as follows:

Price: Price index for value of shipments, 1987=1

Unit variable cost: (wages+material) in current dollars/value of shipments (in 1987 dollars).

Capacity: value of shipments/HP-filtered value of shipments (both in 1987 dollars).

On the other hand, we know that the construction of cost curves in microeconomics is a representation in logical time and, as we mention above, is able to assume that inputs prices are constant so that a function of output alone can be written. Because of that, we will also present results for deflated cost-capacity curves (which we will call the virtual cost-capacity curve) and observe if they somehow relate to the conventional cost schedules.

Another problem is to define the correspondence between levels of capacity utilization, given by our proxy and the variations of output in a typical business cycle. We identified the troughs of business cycles as references and mapped them into our capacity utilization curve to identify to what level of utilization these references points correspond. Figure 2 shows our proxy for capacity utilization, and we can observe that, besides the strong coincidence of its troughs with NBER's official dates, peaks and troughs normally corresponded to a maximum of $\pm 8\%$ deviation from the (HP) trend - here represented by a horizontal dashed line[4].

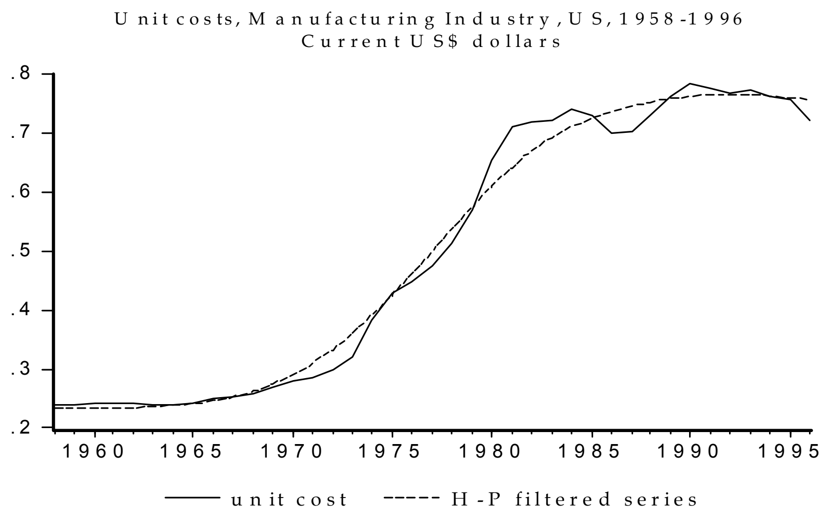

Figure 1: The unit direct cost series and its corresponding H-P filtered trend. The ratio of these series gave us the unit variable cost series used in the historical cost-capacity schedule. We also deflated the cost series and produced a constant input prices cost curve.

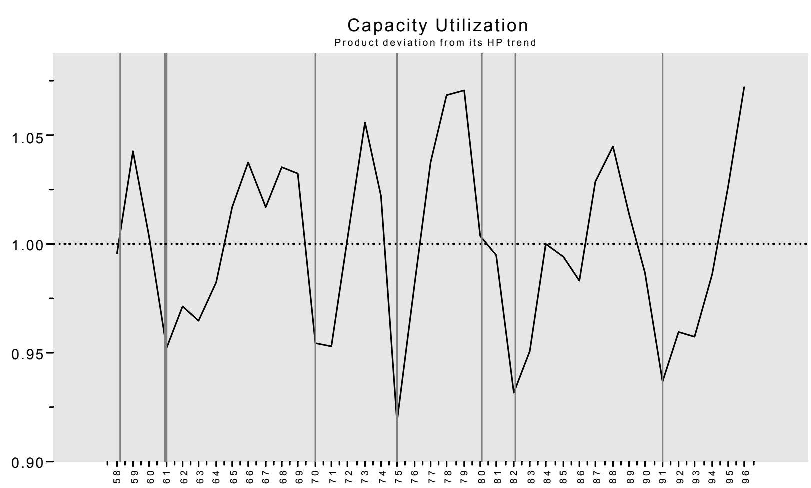

Figure 2: Capacity utilization for the manufacturing industry has troughs highly coincident with NBER's reference dates. The distance from peaks and troughs to 'normal capacity'- our horizontal reference line -is at maximum ±8%.

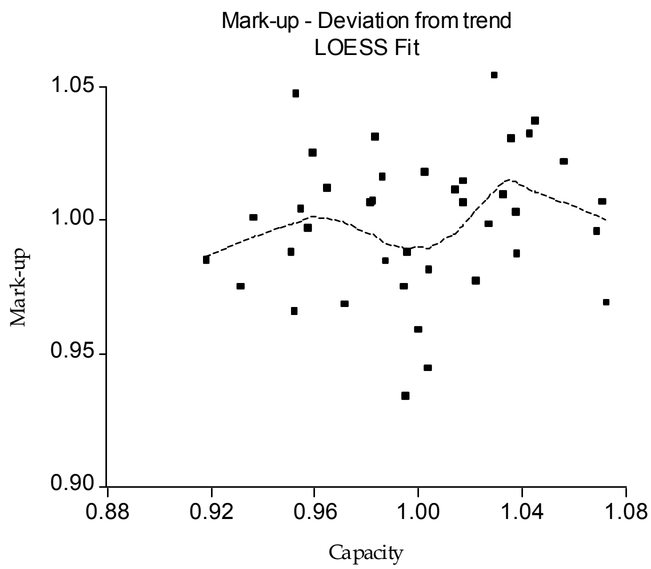

Figure 3: A pro-cyclical mark-up at the manufacturing sector level.

2.2 Aggregated historic cost-capacity relations

When we first looked at the plots of our unit cost measures against capacity, it was clear that our sample seemed to present two quite separated blocks of observations, where the 1970's represented a considerable shift in the cost-capacity relations. After successfully fitting two (local) regression lines with the use of dummy variables for the period between 1970-1978, we decided to re-scale the data, so that we could keep the convenience of a single cost curve.

A initial relevant question related to the robustness of our tool. We wanted to observe if it was possible to roughly replicate results for the cyclical behavior of mark-ups that had been produced with different methodology, as in the case of the chapter 3, where a pro-cyclical mark-up is found at the aggregated level and range of quite flexible mark-ups, with pro-cyclical and anti-cyclical cases were found at the industry level[5]. In Figure 3 the loess fit for the manufacturing sector mark-up shows a curve with an overall positive slope, confirming that this variable , in general, is not 'fixed' and increases with output. As an important note, we should remark that the form of local regression chosen is extremely flexible, and even under these conditions an upward sloping curve was found.

Figure 4 finally shows the historical cost-capacity curve for the manufacturing in the 1958-1996 period, with the corresponding pointwise errors at the 5% level. We observe a tendency for a fall in the series in points located immediately to the left and to the right of the vertical capacity line, in spite of the spike in the series when we approach 'normal capacity', the HP trend, from below.

This result is consistent, at the microeconomic level, with the idea of a procyclical mark-up and suggest that a possible explanation for movements in margins of profits can be found not only in the increase in monopoly power of firms, represented among other factors by generalized output

[4] Comparison between our measure of capacity utilization and other standard measures like FRED, show that they are strongly correlated. Our measure of normal capacity (one) roughly coincided with 80-84% utlization level in those official measures. Hence it is the so-called planned capacity level and not the engineer-rated one.

[5] Results in that study show that mark-ups at the two-digit level have strong co-movements, even when they respond with lags to the general business cycle dates. Patterns of cyclicality are highly related to input-output relations, rather than to conditions in the products market.

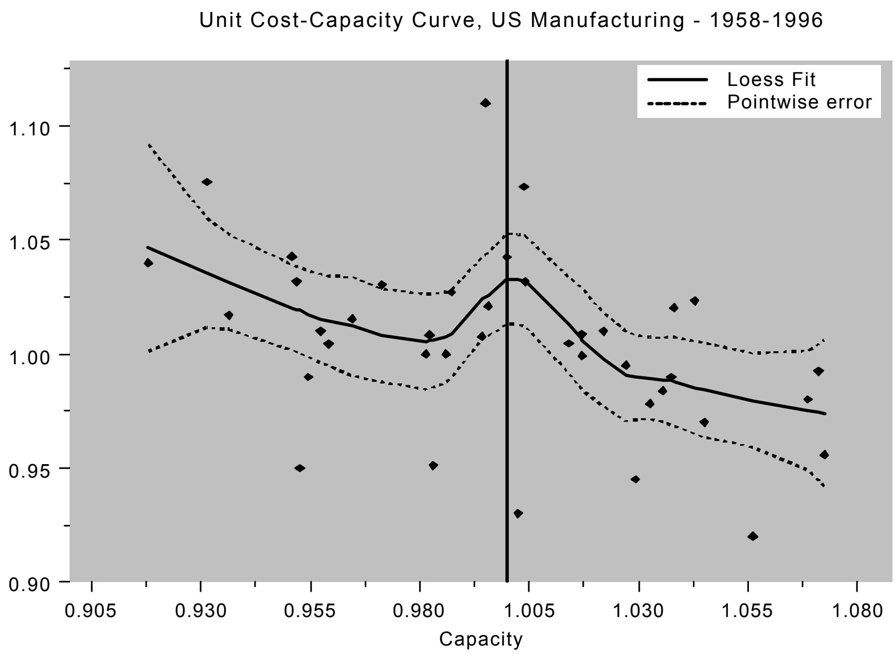

Figure 4: The loess fit above shows that unit variable cost diminishes with capacity utilization, suggesting a possible explanation for a pro-cyclical mark-up at the sectoral level.

price increases, when the economy is growing, but also to the scale effects represented by the more efficient use of quasi fixed inputs and labor before capacity constraints are reached. The question then is whether these quasi-fixed inputs really exist and if all components of cost behave equally in the event of huge changes in capacity utilization.

2.2.1 Cost components and variations in margins of profit

In the set of figures below (Figure 5) we have decomposed the trend deviation of unit direct costs in material costs (inclusive of energy consumption) and labor costs - total payroll costs and wages of production workers.

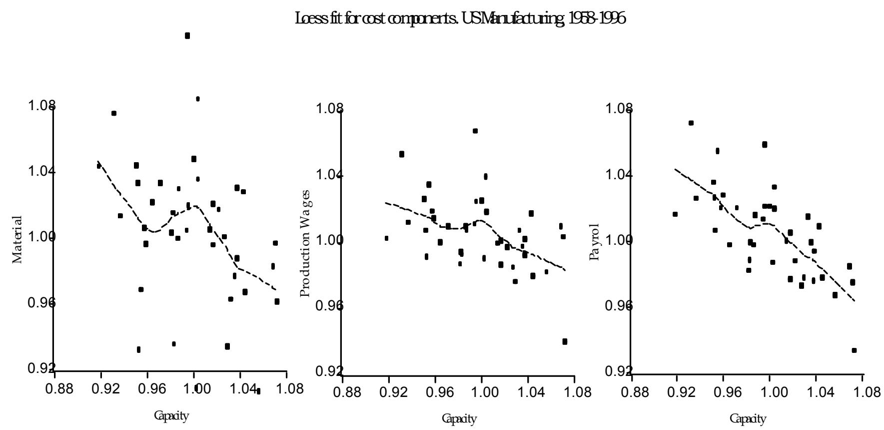

Figure 5: As capacity falls, unit variable costs rise. However, costs components do not grow at the same rate - the cost of wages of production workers increase relatively less than total wages.

The figure above show that, as capacity falls, all component of unit costs grow, providing the rationale for the aforementioned cyclical squeeze in the mark-up. However, we observe that costs do not change in the same proportion. Material costs present a range of constancy around our reference point of normal capacity utilization (capacity equal to one). We can possibly argue that material costs presented a more constant relation to output for levels below our threshold point of normal capacity. Production wage costs presented a much tighter regression fit, with almost the same slope in the entire sample, showing an increase unit of output with falls in capacity utilization. Finally, payroll costs showed the steepest curve, with a clear increase in these costs for lower levels of output and much smaller for the highest range of capacity utilization.

The main conclusion suggested by these figures is that we have a form of labor hoarding, which is specially clear for total payroll costs, as we have wage and salaries of administrative personnel included in the calculation. We can call it quasi-fixed costs for the sake of our analysis here. In addition, if we temporarily disregard the regression line and observe the dispersion of data in the three plots above, we notice that it was not only administrative workers that grew more for the lowest levels of utilization, but wages of workers in production too, although at a much less dramatic rates, while material costs, as we have seen, showed much stronger signs of constancy in its patterns of usage. An interesting consequence of these figures is that they may indicate that, for our sample, a profit squeeze created by rises in unit labor cost may not be a crucial element in the overall constraints faced by industries and firms during the process that leads to a business cycle.

Labor hoarding, as we see here, demonstrates, in our opinion, two main elements. Firstly, and more important, the crucial difference between labor and any other forms of input. Exactly because labor represents social relations that are embedded in any productive process, and wages are the quintessential element of the labor process in capitalism, their behavior as a cost present, among other things, what neoclassical economists call rigidities that cannot be erased without quite considerable social violence from the State and the bourgeoisie. Secondly, as at a more concrete level, this phenomena also reflects the institutional specificity of each industry, with its level of labor organization and characteristic production process, that may need more a more trained, and therefore more stable, workforce.

2.2.2 Aggregated cost-capacity schedules at constant prices: the virtual cost-capacity curve

So far we have analyzed cost curves with variable output prices, although the de-trending process in some form or another, adjust for secular technical change and inflation. However, we want to approximate with the highest precision the conventional cost curves with constant input prices, so that we can observe if they have any general form that resembles a L–shaped curve.

Deflation of cost curves yielded the schedules seen above. This time, as we can observe, the structural change occurred in the 1970's is reflected in our cost capacity curve not only by a upward shift in the sample, but also by a more complex change in the data distribution, that could be interpreted as changes in the slope patterns of a local regression. As simple re-scaling of data would not correct for the shocks of the period, we divided our sample in two - from 1958-81 and form 1982-1996. Figure 6 presents the loess fit for the entire sample, followed by fits of the sub-samples. The deflated curve for the entire sample shows signs of rising costs with capacity, following a range of data could arguably called constant. As the dispersion of data is quite strong, we believe that the a better idea of our proxy for cost curves is given by the fit for the 1958-1981 sample, where we have a curve that is linear until a point located around 1.03 and then suddenly rises, give support to the hypothesis of a post-Keynesian L-shaped cost curve. On the other hand, the shape of the cost-capacity curve for the later period seems to be negatively sloped, maybe due to the cost in labor cost occurred in the period or simply for the fact hat in this period we have very few representative business cycles.

Comparing the results of the previous sections show that maybe have a negativelly sloped cost curve at current prices, which helps explain the pro-cyclicality of the mark-up, while at constant output prices we have a L-shaped curve, giving support to the idea that we have of cost curves that are constant and therefore implying that the marginal products of capital and labor are undetermined in a wide range of the production process.

2.3 Industry Level Historical Cost-capacity relations

We wanted to investigate if the relations observed at the sectoral level could be found at the two-digit industry. Cost capacity schedules for twenty industries of the manufacturing sector are seen in figure 7.

Its quite clear that the negative slope is again reproduced here, with the sole exception of the *instruments* industry, whose cost curve presented a slightly upward sloping curve.

No particular grouping of industries was found, but we can see that industries *like machinery, transportation, food and textiles* presented a steeper curves, maybe showing that those processes present strong scale effects than the average industry in the manufacturing sector. *Petroleum*, presented a pretty undetermined pattern. with a strong concentration around the point of normal

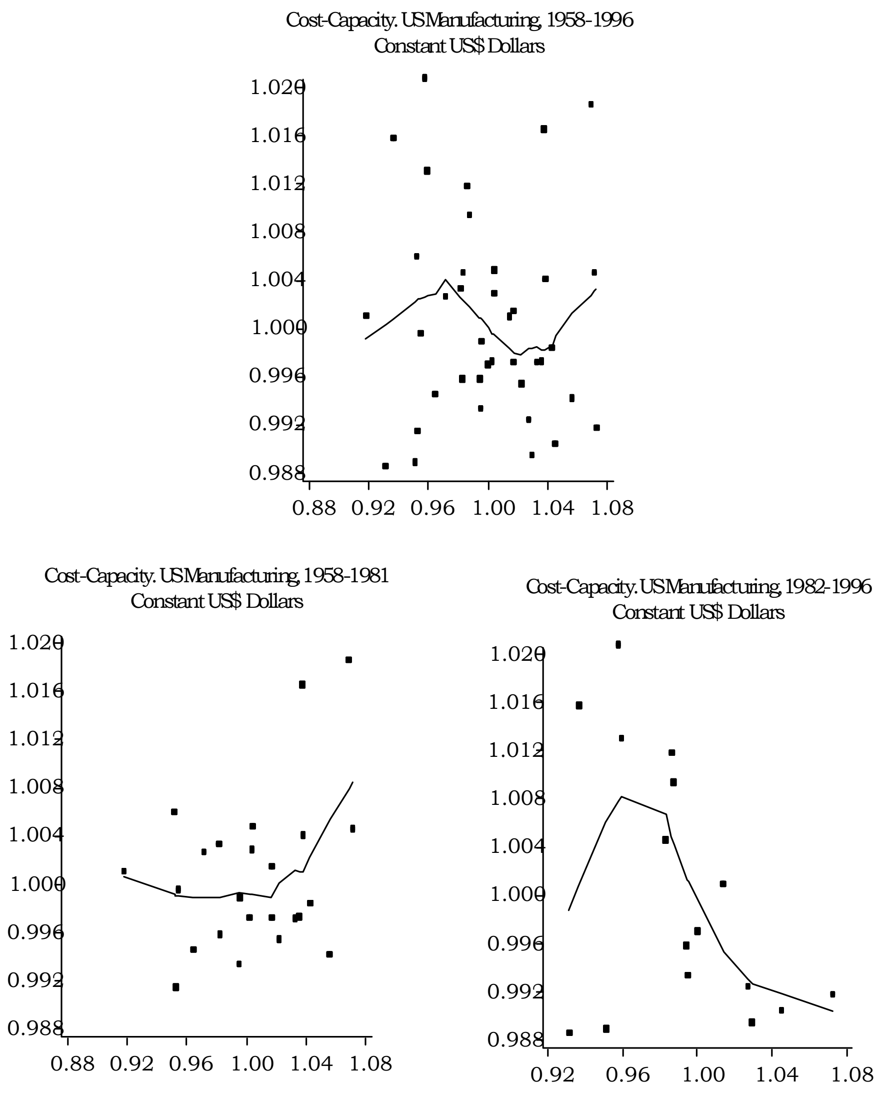

Figure 6: Here we have (virtual) cost-capacity schedules with constant dollar cost series for the entire sample and for two periods - 1958-1981 and 1982-1996. The curves in general present a range of relatively constancy in the neighborhood of the trend - our point of 'normal capacity' utilization - with some tendency for growing unit costs to the right of that point when we control for prices. The exception to the case is the period between 1982 to 1996, when a negatively sloped cost curve was found.

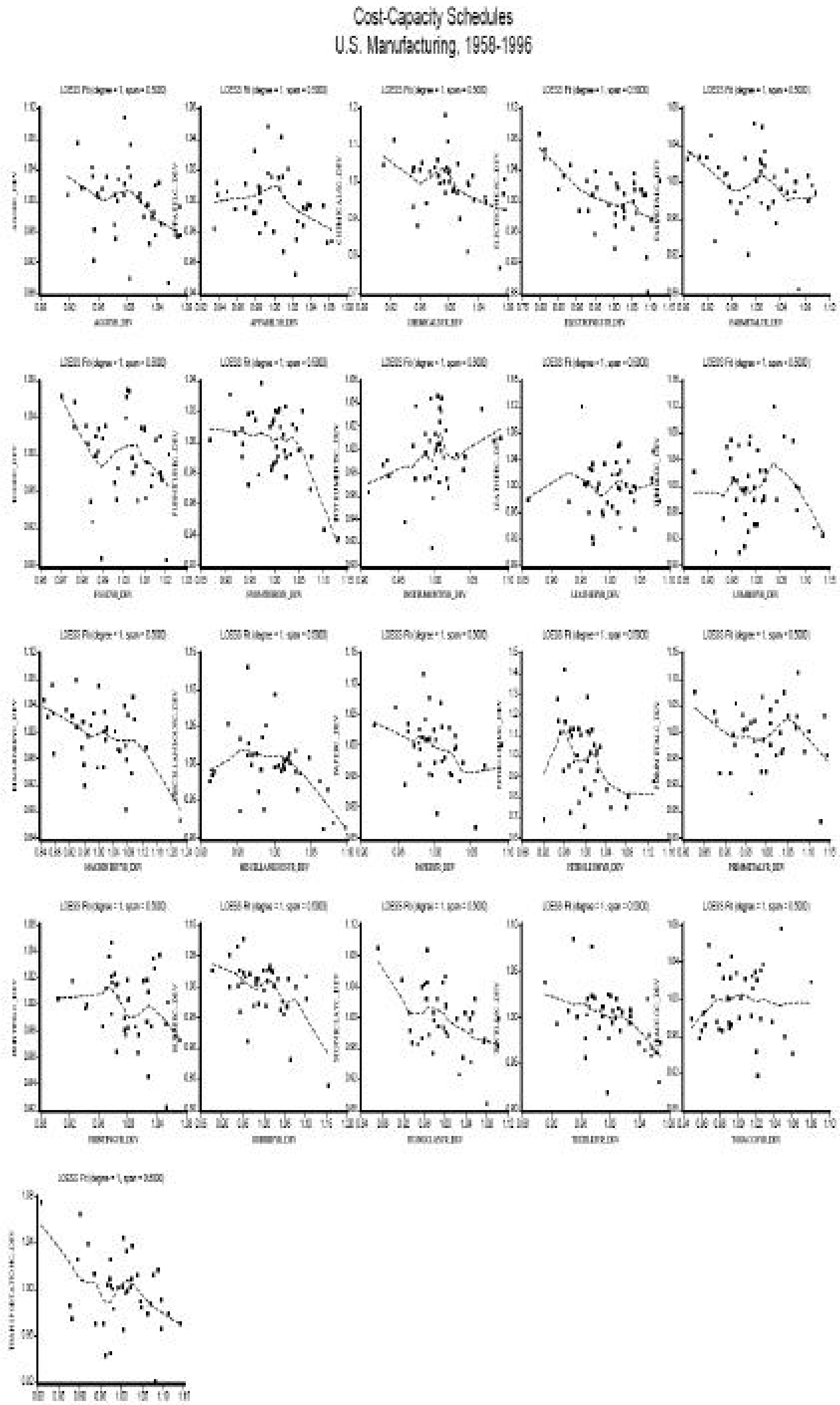

Figure 7: Industry historical cost-capacity curves, 1958-1996, current U.S. dollars

capacity. This was expected, as this industry has been presenting particular behavior in most studies of sectoral mark-ups and costs that we have encountered.

2.3.1 Industry Level Virtual Cost-capacity schedules: constant input prices

With constant prices, our cost-capacity curves for the twenty industries presented, again, results which are comparable to the patterns found at the sectoral level.

In most of the cases (14 industries) presented in figure 8, we observed a change in the average slope of their local regression cost curve after correction for input prices was performed. We could possibly argue that these industries were *apparel, chemicals, fabricated metal, food, furniture, leather, lumber, miscellaneous, primary metal, printing, rubber, stone and clay, textiles and transportation equipment*, where slopes who were negative became more like horizontal lines, especially in the middle range of the fit.

Electronics, machinery, paper and tobacco increased the negative slope of their unit variable cost curves. Finally, *instruments* and *petroleum* industries presented upward sloping curves, with the later showing a change in slope when input prices were adjusted - an expected result considering the period under examination.

As we have seen in the results for the manufacturing sector, most of the fits with adjusted prices were performed on data that seemed to be quite spread out around the graph, especially because our sample probably captures some of the effects of structural change occurred in the period. Hence, figure 9 shows cost-capacity curves for the period 1958-1981.

The main feature of the period 1958-1981 is that curves that were quasi horizontal became positive sloped at least in the extreme sections of the fit: *apparel, electronics, fabricated metal, food, lumber, printing, and transportation equipment*. These industries, plus those who had already presented curves with positive slope or L-type shapes (*instruments and stone & clay)* account for almost half of our sample of industries. The remaining industries presented either a slight negative slope or multiple changes in inclination, with *considerable constancy in large parts of the local fit*: *chemicals, furniture, leather, machinery, miscellaneous, textiles, tobacco and transportation equipment.*

Considering these results, the general partial conclusion that could be drawn is that industries at the two-digit level share with the sectoral virtual cost-capacity schedules the same general behavior when we observe the 1958-1996 sample - a tendency for constancy around our point of 'normal ' capacity utilization, with diverse cross-sectional behavior before and after this middle range of the unit cost curve. When the sample 1958-1981 that, at the sectoral level had presented a clear L-shaped fit is considered, we still observed a tendency for a constancy of the fit around the trend, with a bias toward positive slopes in the range of lowest and highest capacity utilization.

3 Technology and Technical Change in the Short Run

Along this work with been dealing with the cost structure across industries, a topic that directly refers to the relation between patterns of input utilization and the outcome of production. Concern with the actual conditions of production is broadly represented by the study of *technology,* especially in the forms in which those inputs are 1) combined in *different ranges* of output under 'normal' conditions of production - the problem of the scale in production; 2) combined to produce the same level of output - the problem of the different available techniques and the relative flexibility of the coefficients of production, and finally 3) used over time - the problem of changes the relative share of each relevant input in a unit of output as a result of the transformations in the effectively used techniques of production, the so-called technological change. In the main schools of economics, this

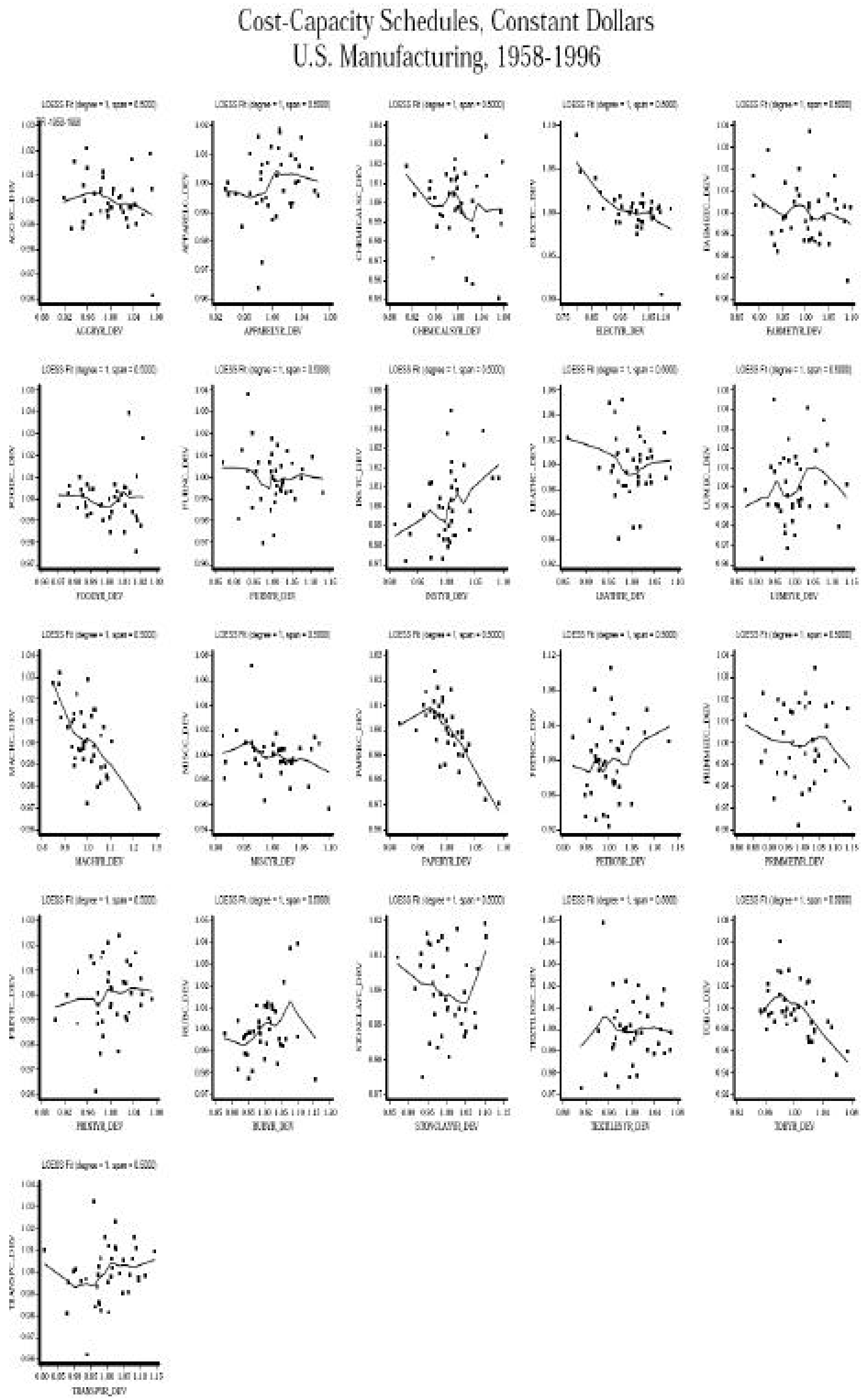

Figure 8: Industry virtual cost-capacity curves, 1958-1996, 1987 U.S dollars.

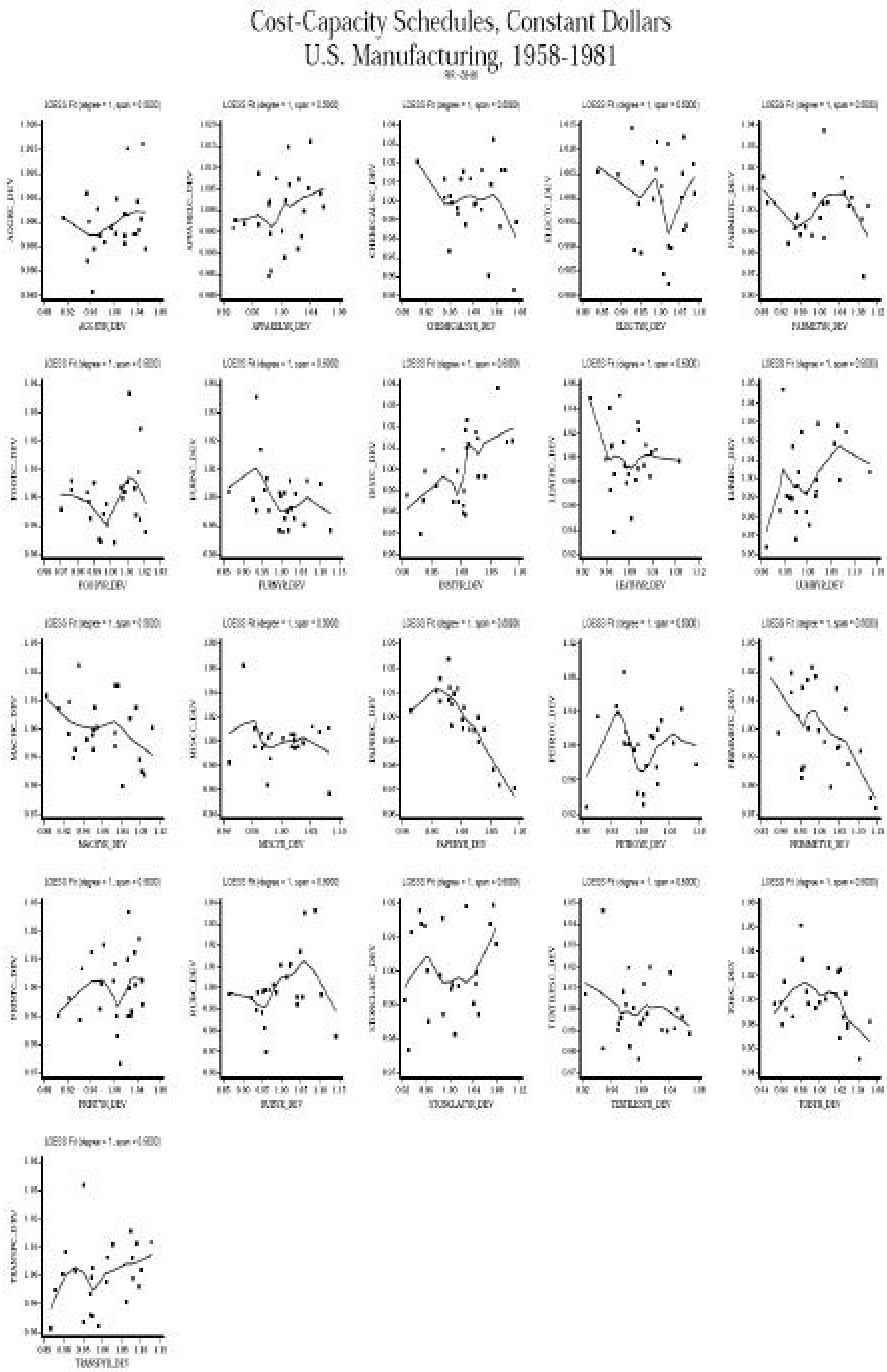

Figure 9: Industry cost-capacity curves, 1958-1981, 1987 U.S dollars.

set of problems represents the central elements for the understanding how distributive variables as margins of profit are determined and behave in the short-run.

Our results strongly suggest that at both sectoral and industry levels historical and virtual cost-capacity curves, our proxy for unit direct cost curves, are highly constant around a point of planned capacity utilization, represented by the threshold number one (corresponding, as mentioned before, to a range of 80-84% of engineer-rated capacity utilization) in our graphs. We are now interested in directly observing if this relative constancy in cost curves reflects patterns in inputs utilization that may suggest a particular technology in use in actual industry. In next sub-section we will investigate the question of scale and the related question of the substitutability of inputs in production. The following sub-section will look closely to the patterns of technological change over the business cycles spanned by our data set.

3.1 Production with fixed coefficients

Basic microeconomics teaches us the idea that production systems can be represented by firms as its basic unity. This representative firm will produce its output from the combination of different 'materials', treated most commonly as flows of inputs per unit of time. In making its decision to produce, firms will face different constraints, that will constitute the limits for its production possibilities. One set of limitations is given by the technological constraints firms face when organizing its production processes. As there are only certain feasible ways to produce outputs, neoclassical economics customarily describe these production possibilities by the production function, the maximum amount of output (Y) that can be produced from a vector of inputs (X_i), defined as:

$$f(x) = \{\text{y in R: is the maximum output associated with X in Y}\}$$

A possible way to represent a production function will be the so-called perfect complement or Leontieff production function, whose central assumption is that inputs can only be optimally used in the same proportion for a given level of production. We write this function in the case of two inputs x_1, x_2, and one output as:

$$f(x_1, x_2) = [\min(ax_1, bx_2)]$$

where a and b are respectively the proportions of inputs x_1, x_2.

We know that the Leontieff technology will present constant returns to scale (CRS), i.e., it is possible to increase output by a factor λ by simply scaling up each input by the same factor. In addition the isoquants of a Leontieff production function will have the form of a L, representing the fact that a given level of profit maximizing output can only be attained with a fixed combination on inputs. Thus, with this production function there is only one available technique and therefore, the marginal products of inputs are undetermined, as substitution among factors is not possible.

While the Leontieff representation of technology is formally seen as a particular case of more flexible functional forms, where substitutability of inputs is the norm, the question here is what kind of evidence is provided by our data for the U.S. manufacturing regarding the form of returns to scale and the combination of inputs in actual production processes.

Regarding the first of our problems, part of the answer was already given in the previous sections, when we found evidence that cost curves for most of our industries in the sample present a horizontal shape, suggesting the idea of constant returns to scale in the relevant range of production.

In figure 10 we plot the ratio between the wage bill and material costs (*both in levels, not filtered*) against capacity utilization for the manufacturing sector. Although in the long-run this ratio has decreased, when we adjust for the secular technical change and look at the short-run movements in output, represented by our measure of capacity utilization, the combination of inputs is quite stable, showing that we cannot reject the hypothesis of constant returns at the sectoral level. We should remark that this result is a necessary but not sufficient condition for CRS, as we are only considering components of the average variable costs, and therefore disregarding the effects of fixed capital. However, we believe that for a significant range of output - what we are calling the normal level - this results is a strong evidence of such form of returns to scale.

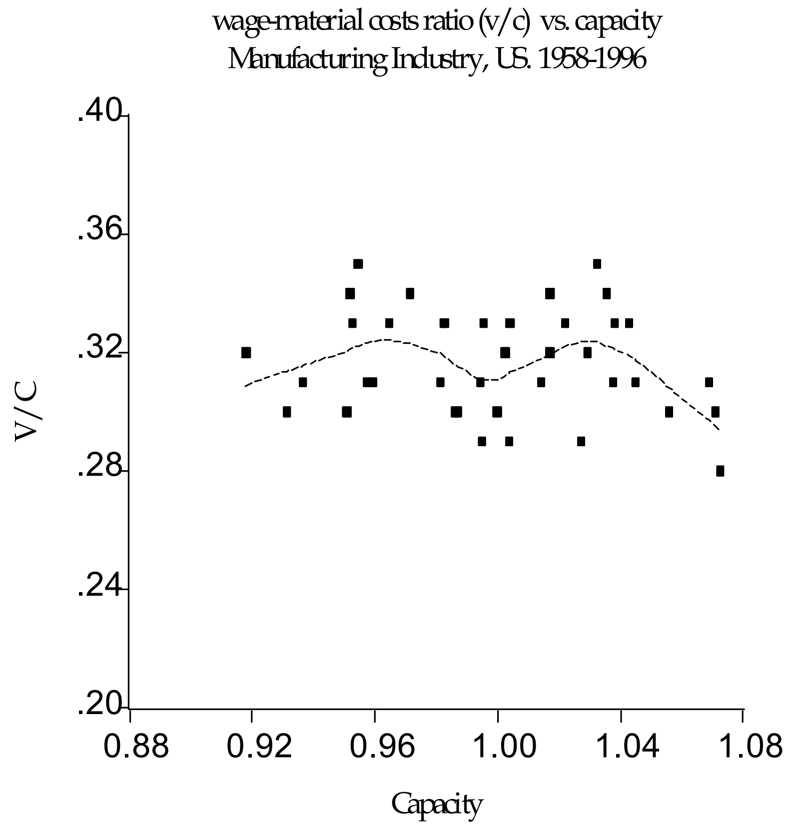

Figure 10: Wage-material costs ratio vs. capacity utilization, U.S. manufacturing, 1958-1996

When we plot the same ratio for a set of selected industries (figure 11), the picture is not different. In all of them the ratio Wage-Material costs decreased over time (not shown here), but when we plot it against capacity, we have a quite flat curve. This phenomenon was observed in all two-digit industries of the manufacturing sector.

When we try to approximate the isoquants of the production processes shown above, we have in figure 12 three sets of points expressing the long-run changes stand out, and we observe the secular rise in labor and capital productivity occurred in the 1958-1996 period. If we look closer at each circled set of points, as a rough way to control for the same level of output, we could ague that their main feature is the lack of short-run patterns, as if they gravitated around some imaginary fixed point. Again, we cannot reject the idea that such figures could be well-represented by the Leontieff-type isoquants, where fixed inputs will be combined in fixed proportions for a given level

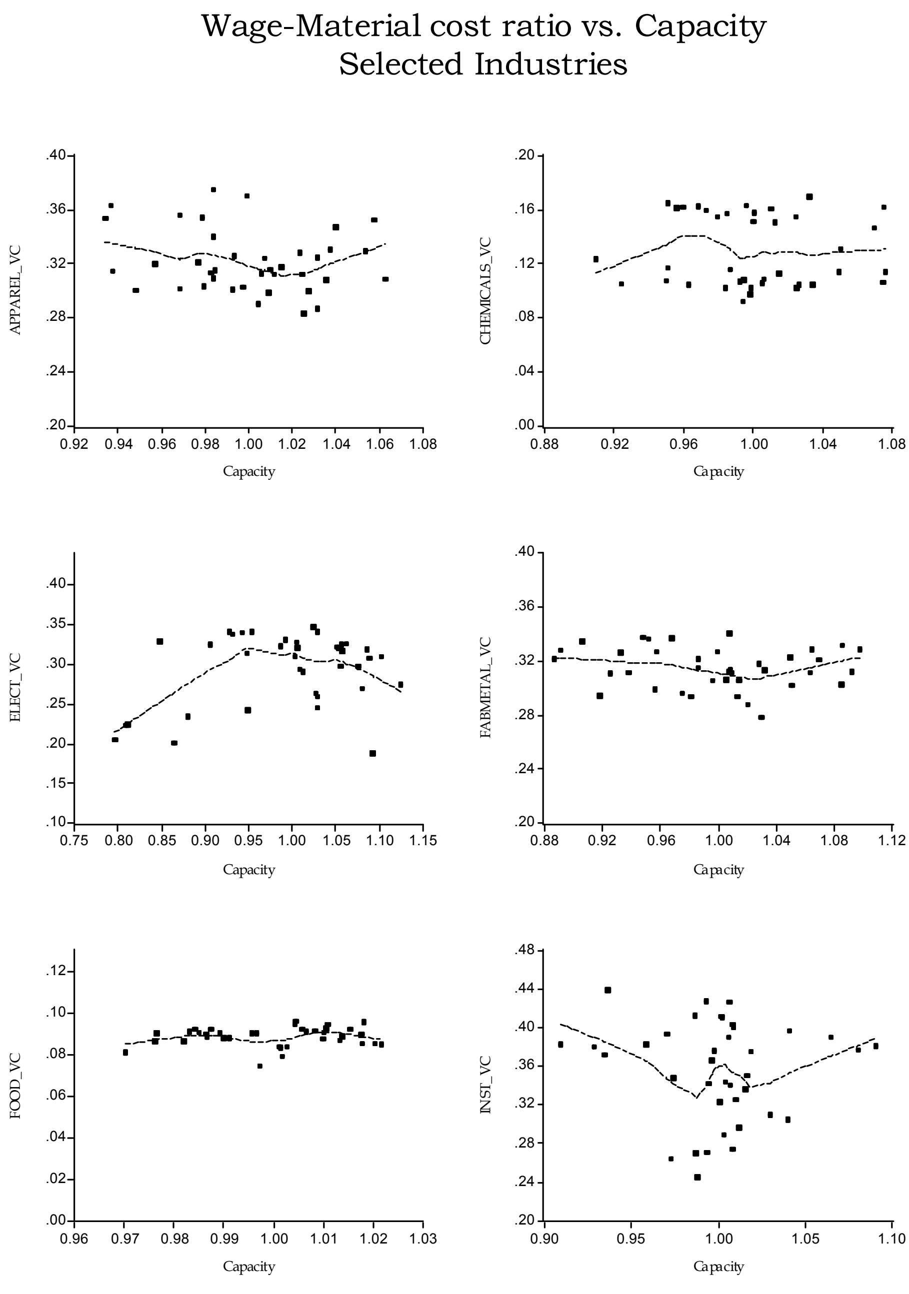

Figure 11: Wage-material costs ratio vs. capacity utilization, Selected Industries, 1958-1996

of output and technology, therefore creating concentration of observations around the single point where the quantity of each input is at its minimum.

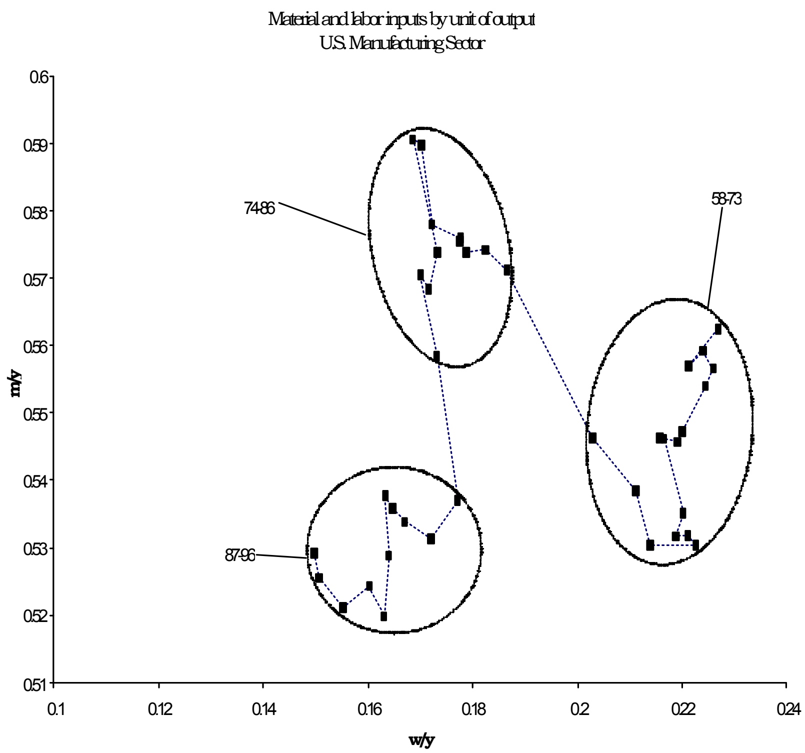

Figure 12: Isoquants, U.S. manufacturing.

3.2 Technical change in the business cycle

Now we are in condition to address the problem technical change in the business cycle. The first question we should ask is whether there is any sense in studying this phenomenon in the short run, as technical change has been treated in most economic models as the quintessential secular phenomenon.

Our answer to this question is partially positive, not because we believe it is possible to fully apprehend the dynamics and implications of technical change over the restricted span of time covered by a business cycle. It is mostly due to the particularity of the process that leads to a cycle - when sudden changes in the functional distribution of income and relative prices (represented, among other things, by the rapid depreciation of capital stock) take place - that could indeed trigger faster changes in the best-practice techniques in use, as an expression of the increased competition among capitals and the necessity to cut costs to reestablish previous levels of valorization under new patterns of input usage. This is therefore the main reason behind the present investigation.

Before even looking at more data, we could already affirm that the degree to which capital and labor productivity change will depend on time, that is, on the specificity of the period under consideration. In other words, technical change can only be properly framed when we consider the particular historical conditions that produced it. Moreover, exactly because it is difficult to study technical change in abstract, we should be aware that, depending on the length of the particular cycle, we will have patterns that can express with more or less closeness the secular tendencies that are working in the background of the short run accidents.

Hence, we should start by looking at the long-run tendencies shown by our data. Figures 13 and 14 show that in the period between 1958 and 1996, the US manufacturing industry was marked by a pattern of technical change that produced with more capital usage and less labor input, as represented by the wage share on output. This labor saving-capital using bias in input usage over time, normally called Marx-biased technical change, therefore determines the main secular dynamics of in our sample.

A simple way to test if business cycle accelerates in relation to the general pattern of technical change in the period is by observing the peak-trough variation of the wage/material ratio over the five business cycles spanned by our data set.

Table A3 (see data appendix) shows the results of such calculation, followed by figures corresponding to the total period. We can promptly see that for every industry in the sample, the ration wage-material ratio decreased over the 1958-1996 sample, confirming the hypothesis of Marx-biased technical change. However, when we compare how the same ratio evolved during the business cycle years, we notice that, although there is some reflection of the overall labor-saving technical change, yearly averages are smaller than the corresponding averages for the entire period[6]. We then conclude that the general pattern of technical change in the business cycles covered by our sample did not accelerate. It actually was quite neutral in comparison to the long-run tendencies, presenting a relative proportional labor and material augmenting pattern of the Hicks-neutral type.

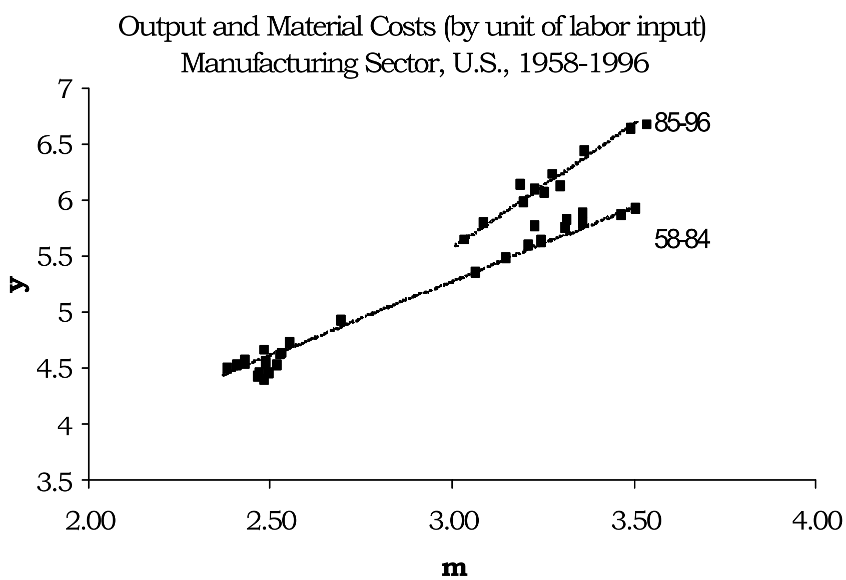

Figure 13: Intensive production function: U.S manufacturing, 1958-1996

[6]Yearly peak-trough average variation figures are presented in table A3 in absolute numbers, but all of them presented negative signs.

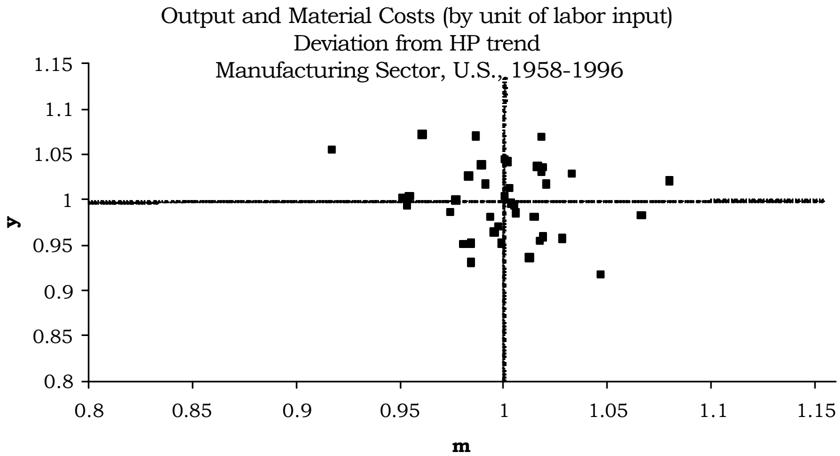

Figure 14: Intensive production function, HP filtered variables: U.S manufacturing, 1958-1996

Conclusion

In this paper we have investigated the short-run behavior of unit direct cost through the use of what we called a historical and virtual cost-capacity schedule, a proxy for conventional microeconomic cost curves. We initially observed that when those curves were built with current dollar ratios (historical cost curves), we have a general downward sloping curve for the the manufacturing sector and its twenty constitutive industries. This result reproduced, at the cost side, the evidence that mark-ups are pro-cyclical at the aggregated sectoral level.

When costs are decomposed, we observe that labor cost and material costs in all industries of the sample behaved differently. While unit material costs bore a nearly symmetrical relation to capacity, unit wage costs of total workers were more capacity-inelastic than the average total costs, showing support for the idea that production in all industries is marked by some form of generalized labor-hoarding process.

We have also built cost-capacity curves with constant dollars (the virtual cost curve), replicating more closely the assumption of given input prices. The local regression fit for our industries shows a greater tendency toward constancy around the trend of the output series, giving some support for the post-Keynesian idea that, at the aggregate level, there is a range of constancy in unit direct cost curves around some point of normal capacity utilization. This constancy around normality in the cost side did not always corresponded to a constancy in the mark-up, as relative prices may also have moved and contributed for changes in profit margins.

While investigating the technical strucuture of production, we have found evidence that the combination of inputs for different levels of output in the short-run was quite stable, showing that the hypothesis of constant returns at the sectoral level could not be rejected. When we tried to approximate the isoquants of the production processes, we found evidence of strong secular marx-biased technical change in the period. Controlling for output changes, we argued that their main feature of our proxied isoquants wass the lack of short-run patterns, as if they gravitated around some imaginary fixed point and hence we could not reject the idea that such figures could be well-represented by the Leontieff-type isoquants, where fixed inputs will be combined in fixed proportions for a given level of output and technology.

Finally, a simple test of technical change over the business cycle found that, although the ratio wage-material ratio decreased over the 1958-1996 sample, the percent variation of this ratio over the peak-trough range of five business cycles showed a different pattern, one that presented a relative proportional labor and material augmenting pattern of the Hicks-neutral type.

References

[1] Bishop, R. L. "Cost Discontinuities, Declining Costs and Marginal Analysis". American Economic Review, 38, 1948, pp. 607-617.

[2] Blair, J. M. Economic Concentration: Structure, Behavior and Public Policy. New York: Harcourt Brace Jovanovich, 1972.

[3] U.S. Department of Commerce, Bureau of Economic Analysis. "Business Conditions Digest". Washigton, D.C.: U.S. Government Printing Office, July, 1984.

[4] Bils, M. "The Cyclical Behavior of Marginal Cost and Price". American Economic Review, 77, 1997, pp. 838-855.

[5] Coutts, K., Godley, W. and Nordhaus, W. Industrial Pricing in the United Kingdom. Cambridge: Cambridge University Press, 1978.

[6] Dolan, R. C. "Price Behavior in Tight Oligopoly". Review of Industrial Organization. Fall 1984, pp. 160-88.

[7] Eckstein, O. "A Theory of Wage-Price Process in Modern Industry". Review of Economic Studies, October 1964, pp. 267-86.

[8] Eckstein and Fromm. "The Price Equation". American Economic Review. December 1968, pp. 1159-1183.

[9] Eichner, A. S. The Megacorp and the Oligopoly:. Cambridge: Cambridge University Press, 1976.

[10] Eichner, A. S. and Kregel, J. A. "An Esssay on Post-Keynesian Theory: A New Paradigm in Economics". Journal of Economic Literature, 13(4), December 1975, pp. 1293-1311.

[11] Goldstein, J. P. "Mark-up Pricing Over the Business Cycle: The Microfoundations of the Variable Mark-up". Southern Economic Journal, July 1986, pp. 345-361

[12] Gordon, R. J. "The Impact of Aggregate Demand on Prices". Brookings Papers on Economic Activity, 1975, pp. 613-62

[13] Hall, R.E. "Market Structure and Macroeconomic Fluctuations". Brookings Papers on Economic Activity, 2, 1986, pp. 285-322.

[14] Haskel, J., C. Martin and I. Small. "Price, Marginal Cost and the Business Cycle". Oxford Bulletin of Economics and Statistics, Vol 57, 1995.

[15] Kaldor, N. "Some Fallacies in the Interpretation of Kaldor". Review of Economic Studies, 37, January 1970, pp. 1-7.

[16] Kalecki, M. Selected Essays, 1933-1970. Cambridge: Cambridge University Press, 1971.

[17] Lavoie, M. "Mark-up Pricing Versus Normal Cost Pricing in Post Keynesian Models". Review of Political Economy, 8 (1), 1996, pp: 57–66.

[18] Lee, F.S. "Post Keynesian View of Average Direct Costs: A Critical Evaluation of the Theory and the Empirical Evidence". Journal of Post Keynesian Economics, 8 (3), Spring 1986, pp. 400-24.

[19] Lee, F.S. "From Post-Keynesian to Historical Price Theory". Part I. Review of Political Economy, 6 (3), 1994, pp. 303-336.

[20] Lee, F.S. "From Post-Keynesian to Historical Price Theory". part II. Review of Political Economy, 7 (1), 1995, pp. 72-124.

[21] Lee, F.S. Post Keynesian Price Theory. Cambridge: Cambridge University Press, 1998

[22] Machlup, F. A. "Marginal analysis and empirical research". American Economic Review, 36, 1946, pp. 519-554.

[23] Marcuzzo, M. C. "Alternative Microeconomic Foundations for Macroeconomics: the controversy over the L-shaped cost curve revisited". Review of Political Economy, volume 8, number 1, 1996, pp.7-22.

[24] Morrison, C. J. "The Cyclical Nature of Markups in Canadian Manufacturing: A Production Theory Approach". Journal of Applied Econometrics, Vol 9, No. 3, 1994, pp. 269-282.

[25] NBER. "NBER-CES Manufacturing Industry Database". 2000. Available Online at: http://www.nber.org/nberces/nbprod96.htm.

[26] Nordhaus, W.D. and W. Godley. "Pricing in the Trade Cycle". Economic Journal. 82(327). September 1972, pp: 853-882

[27] Pulling, K. A. "Cyclical Behavior of Profit Margins". Journal of Economic Issues, June 1978, pp. 287-305.

[28] Redman, D. Adam Smith and Isaac Newton. Scottish Journal of Political Economy, vol. 40, n. 02, May 1993, pp. 210-230.

[29] Ricardo, D. The Works and Correspondence of David Ricardo. 11 volumes, edited by P. Sraffa with the collaboration of M.H. Dobb. Cambridge: Cambridge University Press, 1951-73.

[30] Rotemberg, J. and M. Woodford. "Mark-ups and the Business Cycle". NBER Macroeconomic Annual, 1992.

[31] Sraffa, P. "Sulle Relazione fra costo e quantità prodotta". Annali di Economia, 1925, pp. 549-587

[32] Weintraub, S. A General Theory of the Price Level . Philadelphia: Chilton, 1959.