Estimation of a long run regime for growth and demand through different filtering methods

April 2020
Working Paper 04/2020
Department of Economics
The New School for Social Research
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Abstract

This paper discusses the possibility of estimating a long run relationship between income distribution and growth. As emphasized by Blecker (2016), the neo-Kaleckian empirical literature has focused on the estimation of a short run relationship. This paper contributes to the debate by looking at a long term relationship through the use of filtering methods. We first estimate the long run component (or "trend" component) of the relevant variables using various types of filters. Second, we run causality tests and frequentist estimations to test for the relationship between the estimated trend components. We find that there is little difference between the results of each filter and there is empirical evidence for long run relationship between the rate of capacity utilization and income distribution. We also find that there is some empirical evidence for long run wage-led growth.

Keywords: demand-led growth models, estimation of growth and demand regimes, functional income distribution, filtering methods;

JEL Classification: E11, E12, O41, C10;

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1. Introduction

McAdam et al. (2019) argue that looking at long run data can be a useful tool to assess the nature of the labor share in the long run and its connection to growth. They find empirical evidence for labor share impacting growth positively in the long term, but claim that growth theory has not accounted for these long term effects of income distribution on growth. With that in mind, the first section of this paper starts with a review of the existing literature on demand-led growth models. In this first section we can see that the neo-Kaleckian growth model predicts the wage share can have positive long term results on growth. However, as emphasized by Hein (2014) and Blecker (2016), even though the neo-Kaleckian empirical literature tests the growth and demand regimes of different economies, none of them have focused on the long run aspect of it.

This paper suggests the use of filtering methods as a way to estimate movements in the data attributable exclusively to its long run component. This is the approach taken in the mainstream empirical literature when dealing with the long run aspects of the Phillips Curve. More recently the Hodrick-Prescott filter has also appeared in the debate over the long run behavior of the rate of capacity utilization in the neo-Kaleckian empirical literature. However, many concerns have been raised about the best filtering method to be used in such an empirical long run analysis. Consequently, the second section starts with presenting four different filtering methods: i) the Hodrick-Prescott filter; ii) the Hamilton (2018) filter; iii) the Baxter and King filter and iv) a moving average, emphasizing and discussing its fit as estimators of long run trends.

In the second section, we also present an empirical work focusing on the long run relation-
ship between growth and income distribution. We apply four different filtering methods to estimate the relationship and compare the results, using data on output and income distribution for the United States from 1950 to 2014. We find that our empirical results do not significantly vary across different filtering methods. We also find some empirical evidence to claim that there is a long term relationship between output and distribution.

2. Alternative theories of growth

The relationship between income distribution and output can be theoretically approached through many demand-led growth models. This section is a very broad review of two of these models: the neo-Kaleckian model and the supermultiplier model. The choice for these two models has been based on the fact that they are the models widely referred to in the recent demand-led growth literature.

It is also important to emphasize at this point that the focus of this theoretical review is to understand models that associate the long run with a steady state position. This is not a point of agreement for demand-led growth theories. Many consider it more appropriate to think of long run growth as inherently cyclical, as is the case of Goodwin type models and neo-Harrodian models, or just inherently unstable [see Foley et al. (2019) and Blecker and Setterfield (2019) for different approaches to growth and its relationship to income distribution]. However, in this paper we want to focus our attention on models that predict a long run steady state behavior for growth and see if the use of filtering methods can be useful to estimate this type of models.
2.1 - Neo-Kaleckian Models

According to Lavoie (2014) there are a few crucial aspects to all Kaleckian models of growth. First, capacity utilization is assumed to be generally below unity and is always one of the variables that influence investment decisions. Second, prices are assumed to be set by firms as mark-up over costs, which implies that income distribution is given. And finally, it is also assumed here that there is no savings out of wages².

In this paper we will focus on the version of neo-Kaleckian model developed by Bhaduri and Marglin (1990), which is often adopted by Post Keynesian growth theory. In this version of the model, investment decisions become a function of the profit share, \( \pi \), and the rate of capacity utilization, \( u \). The basic equations of this neo-Kaleckian model then becomes:

\[
\begin{align*}
g^s &= s_r \pi; \\
r &= \dfrac{\pi}{u}; \\
g^i &= h(u, \pi)
\end{align*}
\]

Where \( g^s \) is the savings function, \( s_r \) is the savings rate out of profits, \( r \) is the rate of profit, \( \pi \) is the profit share, \( u \) is the rate of capacity utilization, \( v \) is the capital-output ratio and \( g^i \) is the investment function which is a function, \( h() \), of the capacity utilization rate and the profit share.

² This is not a required hypothesis. What is actually required is that workers' savings rate is smaller than capitalists' savings rate. However, for simplicity of the argument we will assume that there is only savings out of profits.
As emphasized by Blecker (2002), the model described by the equations above establishes a well known relationship between income distribution and aggregate demand. More specifically, demand, which is usually measured by the rate of capacity utilization, is wage-led if there is a positive effect of a higher wage share on demand, and is profit-led in the opposite case. However, if, on one hand, when demand is wage-led, economic growth, which is usually measured by the rate of capital accumulation, can be either wage-led or profit-led. Blecker (2002) and Blecker and Setterfield (2019, p. 188 and 189) emphasize that the result of profit-led demand, often referred to as “exhilarationist”, implies that growth will also necessarily be profit-led.

From the above discussion it can be seen that the rate of capacity utilization rate plays a fundamental role in the neo-Kaleckian model and is taken to be endogenously determined. We can also see from the set of equations describing the model that in order to have equilibrium in the goods market \( g^i = g^s \), we need capacity utilization rate to be flexible. This feature of the model has been criticized as it results in Harrodian instability as we will see in the next section.

2.2 The issue of an endogenous rate of capacity utilization

One of the existing criticisms of the neo-Kaleckian model is the issue of Harrodian instability. As described in Lavoie (2014) and Skott (2010), Harrodian instability appears as

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3 In other words, “if the positive effect of a higher wage share on consumption dominates the potentially negative effects on investment and net exports” (Blecker 2016, p. 1)

4 "[D]epending on whether the positive effect of a higher wage share on capacity utilization is strong enough to outweigh the direct negative impact of profitability on investment" (Blecker 2016, p. 1)
capital accumulation, or investment decisions, reacts to capacity utilization being different from its so called normal level, $u_n$:

$$g^i = \phi(u - u_n)$$ \hspace{1cm} (2)

As emphasized by Steindl (1952), firms will constantly try to keep their capacity utilization rate below one so that they can respond to demand picks without losing market share. Therefore, firms will try to keep their capacity utilization at a certain normal level and will react and change investment decisions whenever it is different from that normal level. This dynamic generates an instability problem to Kaleckian growth models that cannot reach a fully steady state growth rate, as was pointed out by Auerbach and Skott (1988) and Committeri (1986).

However, as shown in Lavoie (2014) and Hein et al. (2012) many neo-Kaleckian models have suggested possible adjustment mechanisms that would allow the model to reach a long run steady state growth characterized by an equalization of the capacity utilization rate to its normal level. One of these attempts has been to suggest an endogenous normal rate of capacity utilization as is done in Dutt (2010) and Lavoie (2010). This first type of closure suggests that the concept of a normal capacity utilization is not fixed across time and can actually vary and adapt to the general economic activity. In technical terms this is written as:

$$u_n' = \alpha(u - u_n)$$ \hspace{1cm} (3)
Skott (2012) however argues that although Equation 12 above is a possible mathematical solution to the Harrodian instability problem, it lacks behavioral explanation. Another attempt has been to consider an autonomous component of demand that is non-capacity generating as the driver of growth, as is done, for example, in Freitas and Serrano (2015), Al-lain (2015), Serrano et al (2019), Nah and Lavoie (2017) and Hein (2018). This approach is better explained in the following section.

2.3 The supermultiplier model

Freitas and Serrano (2015) suggests the existence of an autonomous non-capacity generating component of demand, denoted by $Z_t$, which grows at an exogenously given rate equals to $g_Z$. Following their contribution, investment becomes endogenous to current income, $I_t = hY_t$, with $h$ being the marginal propensity to invest. Under the supermultiplier approach, output level, $Y_t$, is determined by the exogenous component, $Z_t$:

$$Y_t = \frac{Z_t}{s - h} \quad (4)$$

It is important to observe that in the supermultiplier model the savings ratio, $\frac{S_t}{Y_t}$, is no longer determined by the marginal propensity to save, $s$. As
Additionally, if we define \( f = \frac{I_t}{I_t + Z_t} \) such that \( S_t = \frac{Y_t - C_t - Z_t}{Y_t} = s - \frac{Z_t}{Y_t} \), we have that this approach allows for an adjustment of the goods market through \( f \) which Freitas and Serrano (2015) calls ‘the fraction’.

Freitas and Serrano (2015) also assumes that \( h = h_t \gamma (u - u_n) \), the marginal propensity to invest adjusts when the capacity utilization rate is different from its normal level. In their model then, the rate of growth of output, \( g \), and, consequently, the rate of growth of investment, \( g^i \), are given by:

\[
\begin{align*}
g^i_t &= g + \gamma (u - u_n); \\
g_t &= g_z + \frac{h_t \gamma (u - u_n)}{s - h_t}
\end{align*}
\tag{5}
\]

Finally, in steady state, when \( u = u_n \) and \( h = 0 \) we have that the steady state growth is given by: \( g = g^i = g_z \). Consequently, in the supermultiplier model steady state growth is given by the rate of growth of the autonomous component of demand and it is not \textit{a priori} affected by changes in income distribution.

Nonetheless, under the supermultiplier model income distribution does have a level effect on output and consequently a short run effect on growth. Lavoie (2014) then argues that the paradox of cost\(^5\) holds in the supermultiplier model as long as it is interpreted in terms

\(^5\) An increase in costs, wages, has a positive effect on output.
of the average growth rate in the time period in which the shock in income distribution happened. However, when the paradox of costs is interpreted as the effect of distribution on steady state growth one cannot have a wage-led or a profit-led regime under the supermultiplier model, Lavoie (2014).

To stress the difference on the predictions of the effect of distribution on growth between the neo-Kaleckian model and the supermultiplier model, one needs to focus on the long run effect that income distribution can have on steady state growth.

From the discussion above we can emphasize, first of all, that the rate of capacity utilization is expected to be fixed at a normal level in the long run in the supermultiplier model. While in the neo-Kaleckian model we must have a variable long run rate of capacity utilization. Secondly, when it comes to the relationship between income distribution and growth we have also seen that income distribution is exogenous in both models described above. Furthermore, income distribution affects long run steady state growth in the neo-Kaleckian model. Finally, as emphasized by Freitas and Serrano (2015), in the supermultiplier model, the functional income distribution can only have an output, level, effect. In other words, there is no relationship between the wage share and the rate of economic growth in the long run. These long run results can be summarized in the table below:
2.4 Estimation of growth and demand regimes in the empirical literature

Blecker (2016) and Hein (2014) provide a comprehensive survey of the neo-Kaleckian empirical literature that was developed after the original contribution of Bhaduri and Marglin (1990). Hein and Vogel (2009), Stockhammer (2009) and Onaran and Galanis (2012), among many others, have tried to determine whether different countries follow wage-led or profit-led demand regimes and some of these results have actually been conflicting with each other. For instance, Onaran and Galanis (2012) find that the US economy has a wage-led demand regime while Barbosa-Filho and Taylor (2006) find it to be profit-led. Blecker (2016) suggests that a possible explanation for these conflicting results is that profit-led demand regimes tend to be stronger in the short run, over business cycles, and wage-led if a longer time horizon is considered: “the idea that a higher average profit share would lead to chronically depressed aggregate demand, [...] was not intended as an explanation of business cycles, but rather as a hypothesis about long term secular stagnation.” (Blecker

<table>
<thead>
<tr>
<th></th>
<th>Neo-Kaleckian Model</th>
<th>Supermultiplier Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long run behavior of capacity utilization rate</td>
<td>variable</td>
<td>fixed</td>
</tr>
<tr>
<td>Steady State GDP Growth affected by income distribution</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Factors that affect steady state GDP Growth</td>
<td>$s, \pi$ and $v$</td>
<td>$g_Z$</td>
</tr>
</tbody>
</table>

Table 1 - Expected steady state results
Blecker (2016) shows that the neo-Kaleckian empirical literature can be divided into two main approaches: 1) The structural approach estimates a relationship between growth and distribution through the individual components of aggregate demand; 2) the aggregative approach which relies on estimation of a reduced form solution for output and calculates the derivative directly by regressing output on the wage share and other control variables. However, none of these approaches have focused on identifying long run relationships. Blecker (2016) then concludes that the neo-Kaleckian empirical literature finds short run regimes for different economies but doesn’t have much to say about the longer term effects of distribution on income. The aim of this paper is to separate the short run outcome from the long run. This is done through the use of filtering methods.

Data filtering methods are popular tools used to estimate the long run behavior of variables in different empirical discussions. For example, in the Harrodian instability debate around the neo-Kaleckian and the supermultiplier models an extensive empirical literature has emerged as an attempt to understand the long run behavior of the rate of capacity utilization [See Nikiforos (2016) and Haluska (2020) for an overview on the debate]. Part of this literature suggests that filtering methods can be used to capture the long run behavior of the rate of capacity utilization. This paper suggests that the long run behavior of growth can also be studied through the use of filtering methods. Additionally, since part of the debate is about the best filtering method to be used, this paper also shows that we cannot find a significant difference of estimation results across filters.
3. **Empirical estimations**

The use of filters to estimate the long run behavior of variables is a very common practice in the economics empirical literature. For example, Ball and Mankiw (2002) use the Hodrick-Prescott filter to separate the long term shifts in the unemployment inflation relation from the short run fluctuations. Logeay and Tober (2006) use state space estimation, through the Kalman filter, to estimate the same relation. Our empirical estimation will use four different types of filters: i) The Hodrick-Prescott filter; ii) the filter suggested by Hamilton (2018); iii) a Band-Pass filter as suggested by Baxter and King (1999); iv) a four year moving average. The purpose is to compare the results and see if they are robust to different plausible methods of calculating the long run (or trend) component of the observed time series.

The empirical study of the relationship between growth and distribution is done here using data provided by the Federal Reserve. The income distribution variable, \( w \), used is the Share of Labor Compensation in GDP at Current National Prices for the United States extracted from PWT (Penn World Table). The output variable, \( y \), used is the Real Gross Domestic Product, Billions of Chained 2009 Dollars. Finally, the data for the rate of capacity utilization is a data on the total industry percentage of resources used by corporations and factories to produce goods in manufacturing, mining, and electric and gas utilities for all facilities located in the United States produced by the Federal Reserve System.
3.1 Hodrick-Prescott filter

The Hodrick-Prescott Filter as suggested by Hodrick and Prescott (1997) attempts to divide a given time series, $y_t$, into a growth component, $g_t$, and a cyclical component, $c_t$, such that: $y_t = g_t + c_t$. The "trend" component then is presented at Hodrick and Prescott (1997) as the solution to the problem:

$$\text{Min}_{\{g_t\}_{t=1}^T} \left\{ \sum_{t=1}^T c_t^2 + \lambda \sum_{t=1}^T [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \right\}$$

(6)

Where $\lambda$ represents the smoothness parameter. In order to be able to interpret the equation one can look at what happens when $\lambda = 0$ or $\lambda \to \infty$. In the first case the solution is $y_t = g_t$, that means the "trend" would just be the series itself. In the second case the solution to the problem above would result in a regression on a linear time trend. (Hamilton 2018, p. 831)

As the Hodrick-Prescott Filter is often used in the empirical literature to estimate long run steady state values of different variables this is the first filter that is used in this empirical work. The first graph below shows the Hodrick-Prescott filtered values for output growth plotted against the Hodrick-Prescott filtered values for income distribution. The second graph shows the Hodrick-Prescott filtered values for the rate of capacity utilization plotted against the Hodrick-Prescott filtered values for income distribution.
However, it is important to emphasize here that a few critiques have been raised to the HP filter, as noted by King and Rebelo (1993) and Hamilton (2018) and Drehman and Yetman (2019). Hamilton (2018) first critique is that if the true data generating process was of the
type \( y_t = y_{t-1} + \epsilon_t \) where \( \epsilon_t \) is a white noise, it can be shown that the cycle estimated by the HP filter would be highly dependable on lags of \( \epsilon \) and, therefore, highly predictable. The second critique is that the HP filter trend and cycle have an artificial ability to "predict" the future because they are by construction a function of future realizations. As a third critique Hamilton (2018) emphasizes that the minimization problem posed in equation 6 can also be motivated through a state space representation [See Hamilton (1994) on state space representation and Kalman Filtering]:

\[
y_t = g_t + c_t; \quad g_t = 2g_{t-1} - g_{t-2} + v_t \tag{7}
\]

Where \( c_t \) and \( v_t \) are uncorrelated white noise processes that are also uncorrelated with \((g_0, g_{-1})\). If we then take \( \lambda = \frac{\sigma_c}{\sigma_v} \), it can be shown that the estimated trend of this state space representation of equation 7 would converge to the estimated trend of equation 6. What Hamilton (2018) emphasizes then is that if we are comfortable with a state space representation as in equation 7, instead of assuming \( \lambda = 1600 \), as is often done in the literature, then "we could use the Kalman Filter to evaluate the likelihood for the observed sample and find the values for \( \sigma_v^2 \) and \( \sigma_c^2 \) that maximize the likelihood function." (Hamilton 2018, 840).

Finally, a few points can also be raised about the HP filter from King and Rebelo (1993). First, as has already been mentioned, the HP Filter will render stationary series that are in-
tegrated up to the fourth order, but not beyond that. Also the HP filter removes substantial low frequency variation from the cycle (King and Rebelo 1993, 221).

Following these initial results and critiques we decided to look further into filtering methods. We decided to do a similar analysis, using, first, the filter suggested by Hamilton (2018). Secondly, we will use a Band-Pass filter suggested by Baxter and King (1999). Finally, we will also present an analysis with a four years moving average in order to be able to better compare the different estimations.

3.2 Hamilton’s filter

Following his critique of the HP filter, Hamilton (2018) then suggests a filtering method, which we will call here the Hamilton Filter. The Hamilton Filter suggests that the cycle component should be modeled using available data. More precisely it suggests for quarterly data the estimation of an AR(4) with $h$ lookahead periods:

$$y_{t+h} = \beta_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+h};$$

$$v_{t+h} = y_{t+h} - [\beta_0^* + \beta_1^* y_t + \beta_2^* y_{t-1} + \beta_3^* y_{t-2} + \beta_4^* y_{t-3}]$$

(8)

Hamilton (2018) further suggests that for quarterly data one should use $h = 8$. In the case of this empirical work, since we are dealing with yearly data, we chose $h = 3$. Applying the Hamilton (2018) filtering methods to our times series results in the following graphs. Again, in the first graph we show the filtered trend values for growth plotted against the
trend for income distribution and in the second graph we plot the filtered values for the capacity utilization rate in the y-axis.

Figure 2 - Hamilton Filter Results

Hamilton Filter Results, 1950–2017
The trend of the growth of GDP is plotted against the trend of the labor share.

Hamilton Filter Results, 1967–2017
The trend of the rate of capacity utilization is plotted against the trend of the labor share.

Source: FRED database
It is interesting to observe that while the positive relationship observed between wage-share and a long run growth seems to not hold for this filter, the negative relationship between the trend of capacity utilization and wage-share still seems to hold.

### 3.3 Band-Pass filter

Furthermore, after the paper of King and Rebelo (1993), a few filtering methods have tried to keep lower frequency dynamics in the cyclical component of the filter. First, Baxter and King (1999) suggest a linear filter which eliminates very slow moving ("trend") components and very high frequency ("irregular") components while retaining intermediate ("business cycle") components. (Baxter and King 1999, p. 5) The graphs below show again the trend data for growth and capacity utilization against income distribution. It seems there is not much difference from the estimated trend of the HP filter.

Even though there are other types of band-pass filter that are commonly used in the literature, such as the one suggested by Christiano and Fitzgerald (2003), we did not think there was a purpose of further looking into band pass filtering methods. The reason for that is that they are focusing on estimating the cycle, while we are more interested in estimating the trend, long run behavior. Instead, we thought it would be more useful to compare the results so far with a moving average, as is done in the following section.
3.4 Moving average

Simple calculations of moving averages or first differences are also commonly used filtering techniques to estimate the trend of a time series. In our case we decided to calculate a moving average of four years as a final empirical attempt. As is emphasized by Baxter and
King (1999) this is again a filter that doesn’t retain in the cyclical component the low frequency cycles.

Figure 4 - Moving Average Results

Moving Average Results, 1950–2017
The trend of the growth of GDP is plotted against the trend of the labor share.

Moving Average Results, 1967–2017
The trend of the rate of capacity utilization is plotted against the trend of the labor share.

Source: FRED database

Figure 4 - Moving Average Results
The results of the moving average presented in the two graphs above do not seem significantly different from the previous results. In general, it seems we can observe a positive relationship between steady state growth and wage share and a negative relationship between the capacity utilization rate and income distribution. While the negative relationship between income distribution and capacity utilization seem to hold across different filtering methods, we cannot say the same thing for the relationship between long run growth and income distribution.

When it comes to the positive relationship between income distribution and steady state growth it is interesting to observe that it is steeper in the the Band Pass filter and the moving average results, but not as steep for the HP Filter and the Hamilton filter. Given these results, the first test we need to make then is to run causality tests to determine if the causality is from income distribution to growth and capacity utilization or if it is the other way around. For the following empirical analysis we will continue to use and compare the four different filtering methods and show that, once again, the results obtained are not significantly different.

3.5 Estimation of demand and growth regimes

The graphs shown above indicate the existence of a relationship between growth and the rate of capacity utilization with income distribution. This section further investigates this relationship through time series analysis. In the appendix, Table A.1 shows that we do not need to be concerned with the presence of unit roots in the filtered data and Table A.2 shows the recommended lags to be used on VAR estimations for each filter. Given these
results, we ran Granger-Causality tests for the filtered values. We ran Granger-Causality tests for both types of relationship: i) between the wage share and the capacity utilization rate; and ii) between the wage share and output growth. The p-value of the test for all the filtered values are presented in Table 2 below:

<table>
<thead>
<tr>
<th></th>
<th>HP</th>
<th>HF</th>
<th>BK</th>
<th>MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws does not granger-cause u</td>
<td>0.25</td>
<td>0.00</td>
<td>0.7</td>
<td>0.01</td>
</tr>
<tr>
<td>u does not granger-cause ws</td>
<td>0.15</td>
<td>0.45</td>
<td>0.27</td>
<td>0.32</td>
</tr>
<tr>
<td>ws does not granger-cause g</td>
<td>0.04</td>
<td>0.00</td>
<td>0.53</td>
<td>0.01</td>
</tr>
<tr>
<td>g does not granger-cause ws</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Table 2 - Granger Causality Tests

In Table 2 above, "HP" are the results of the Hodrick - Prescott filtered values, "HF" are the results of the trend calculated using the Hamilton (2018) method, "BK" are the results following Baxter and King (1999) method and "MA" the results from the moving average calculation. From the table above it seems that we are able to reject almost all of the null hypothesis at 10% of confidence, with the only exception being the null hypothesis that the rate of capacity utilization does not granger-cause the wage-share. It is also interesting to observe that once again these results obtained seem to hold across almost all filtering methods.

First, it is important to notice that the null hypothesis that the capacity utilization does not granger causes the wage share was not rejected by any of the filtering methods. It seems
then that the negative relationship between income distribution and capacity utilization observed in the graph above suggests a long run rate of capacity utilization endogenous to income distribution. This then suggests that in this relationship between labor share and capacity utilization rate, labor share is exogenously determined which allows us to estimate it through a simple equation regression.

However, since when we take into account all four filtering methods there is an unclear relationship between income distribution and growth, we then decided to estimate growth regimes using a Vector Autoregression (VAR) analysis. The reason for that is the granger-causality results seem to suggest an endogenous determination of income distribution.

Consequently, we continued our investigation of a growth regime by using a VAR method to estimate a relationship between growth and income distribution in the long run.6 The residual tests for the VAR can be found on Appendix Table A.3. In figure 5 below we report the orthogonal impulse response function from the labor share for the different filtering methods:

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6 Even though a VAR method is often associated with a short run estimation, in this case, it is estimating a long run relationship since we have previously filtered the data. Also, a Vector Error Correction Model would be inappropriate here as the series were found to be stationary.
The impulse response functions reported above show, first of all, that the variations on GDP given the shock on labor share are not significant for both the HP filter and the BK filter. Secondly, we see that a shock in the labor share results in a positive and significant movement in the GDP for the Hamilton Filter and the moving average results. In sum, the Granger causality tests with the results above provide some support for the hypothesis that income distribution is a statistically significant driver of long run growth. Furthermore, the results of this regression seem to suggest a wage-led growth regime. However, this last result only holds in two of the filtering methods used in the paper. It is interesting to observe that while we did find some empirical evidence of long run wage-led growth result, as was expected by Blecker (2016), these results are not very strong, as they do not hold across all filters, which is in line with the results found in Onaran and Stockhammer (2004).
As a final test we decided to run an estimation equation for the relationship between the labor share and the rate of capacity utilization. The results of the estimations are presented in the table below:

<table>
<thead>
<tr>
<th></th>
<th>HP</th>
<th>HF</th>
<th>BK</th>
<th>MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>134.54*</td>
<td>101.91*</td>
<td>125.65*</td>
<td>117.12*</td>
</tr>
<tr>
<td></td>
<td>(15.31)</td>
<td>(15.61)</td>
<td>(18.64)</td>
<td>(23.40)</td>
</tr>
<tr>
<td>Labor-Share</td>
<td>-88.77*</td>
<td>-35.74</td>
<td>-74.45*</td>
<td>-60.47</td>
</tr>
<tr>
<td></td>
<td>(24.57)</td>
<td>(25.38)</td>
<td>(30.27)</td>
<td>(37.95)</td>
</tr>
<tr>
<td>N</td>
<td>51</td>
<td>49</td>
<td>45</td>
<td>51</td>
</tr>
<tr>
<td>R2</td>
<td>0.21</td>
<td>0.04</td>
<td>0.12</td>
<td>0.05</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.19</td>
<td>0.02</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>Resid. Sd</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Standard errors in parentheses. * indicates significance at p < 0.05

Table 3 - Single Equation Estimation

In Table 3 above "HP" refers to the results from HP filtered values, "HF" of the Hamilton filtered values, "BK" the results of the Baxter and King filter and “MA” of the moving average. It is interesting to observe that while for the HP filter and the Band-pass filter the labor share was estimated negative and significant to explain the rate of capacity utilization, the estimated result is not significant for the Hamilton filter and the moving average. In sum, the Granger causality tests with the results of the estimations above seem to provide some support to, first, the hypothesis that the rate of capacity utilization is endogenous to growth. Second, we have also found some evidence of a profit-led demand result.
The results presented here in general seem to be more consistent with the neo-Kaleckian model in the sense that they suggest a long run rate of capacity utilization that is not exogenously determined. Additionally, we have also found some empirical evidence for a relationship between growth and income distribution. However, it is important to observe, first of all, that the estimation of a positive relationship between growth and labor share does not hold across all filters. Second, even though all the filtering methods seem to suggest a long run rate of capacity utilization that is endogenous to income distribution, the negative relationship from labor share and growth was only obtained in two of those filters. Finally, it is important to emphasize that a long run profit-led demand and wage-led growth empirical result is not consistent with the theoretical model developed by Bhaduri and Marglin (1990) and is, therefore, inconsistent with a neo-Kaleckian framework.

4. Conclusion

The contributions of this paper to the ongoing empirical debate concerning demand-led growth model can be summarized in two main points. First, it has shown that the use of filtering methods can provide an interesting tool to analyze the long run behavior of variables. More specifically, in this paper we have found a strong evidence that long run capacity utilization is endogenous to income distribution. This is also a result that holds across different filtering methods, as shown in the Granger causality tests presented in Table 2. This first outcome of the empirical work presented in this paper provides a strong contribution for demand-led growth theories arguing that the rate of capacity utilization is not fixed in the long run, as is the case in Dutt (2010), Nikiforos (2018), Setterfield (2018), Gahn
(2020) among others. It further shows that this result is not just a consequence of the chosen filtering method as it holds across different filters used in this paper.

Additionally, we have found some empirical evidence for profit-led demand regime as well as long run growth being positively affected by labor share. However, both of these results were not strong ones as they did not hold across all filters. Consequently, we have found some empirical evidence of a relationship between income distribution and growth in the long run, but there is space for further investigation. First, because as it is these results are actually not consistent with a neo-Kaleckian framework as a combination of profit-led demand and wage-led growth is not possible under a Bhaduri and Marglin (1990) model as is emphasized by Blecker (2002). Secondly, because the evidence of income distribution affecting long run growth is not as strong as an evidence that holds across all filters, as is the case of a non-fixed long run rate of capacity utilization.

Finally, it is important to remember that under a neo-Kaleckian framework the transmission mechanism from income distribution to growth is the rate of capital accumulation, in other words, the investment function. However, as emphasized by Brochier and Silva (2019) a relationship between growth and income distribution can emerge under other theoretical frameworks as a result of income distribution affecting other components of demand. Therefore, even though the empirical results of this paper do suggest that there is evidence for claiming the existence of a long run relationship between growth and income distribution further work can be done in looking at the transmission mechanisms through which this relationship is actually happening.
References


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