Super Cycles and Common Features in the U.S. Profit Rate Since the Mid-Nineteenth Century

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Abstract
This document is an endeavor to identify super cycles in the general profit rate in the U.S. spanning 1869–2015. With the help of an asymmetric band-pass filter, we decompose the profit rate into cycle and trend components. The filter reveals four and a half long-term cycles in the general rate of profit since the late nineteenth century. Regarding the profit rate long term trend, the filter yields a trend with smooth breaks revealing that the law of the tendency of the rate of profit to fall has been episodic. We analyze co-movements between the profit rate, the rate of surplus value, and the organic composition of capital. The analysis shows that effect of the rate of surplus value has been the dominant over the sample.

JEL Classification: E11, E32

Keywords: rate of profit, band pass filter, super cycles, common trends and cycles

1. Introduction

Economic ideas rise and fall just as the economic activity does. This is the case of profit rate long cycles theory, which after a period of intense debate by the end of the 20th century, has received less attention in recent times. Nonetheless, Marxist political economy has always considered that the archetypal law of capitalism is its cyclical nature, and thus, the rate of profit is the prime suspect to look at. In this sense, the close connection between the profit rate and the business cycle has been periodically tested. This literature, however, is mostly focused on analyzing short-term fluctuation in the profit rate as an explanation to economic crisis (see, e.g.,

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Weisskopf 1979, and Cámara Izquierdo 2013). Hence, this previous literature needs to be complemented and strengthened by additional studies that examine the cyclical behavior of the profit rate in the long run.

The combining circumstances of sophistication of the econometric techniques and reliability of data have generated a renewed interest in Marxist political economy classic themes from a new methodological perspective (Basu 2017). In the 1990s, when the literature on long waves was on the wane, Kleinknecht (1992:2) complained that "econometrics have not provided us with techniques that can be used in a straightforward way for the analysis of long waves." This study employs robust econometric techniques to bridge this gap in the literature. We use, first, an asymmetric band pass filter to identify the magnitude and trajectory of the long-run cyclical and trend components of the profit rate. Second, with the theory of common features we test for the presence of common trends and cycles to assess Marx's theory on tendencies and countertendencies of the profit rate. In general, this new methodological approach to classical Marxist themes provides a new dimension to test empirically some Marxist principles.

Toward the end of the 20th century, there was intense debate and profound contributions on long cycles, mainly in three aspects: on whether long cycles exist, on the length of the cycle, and on the endogeneity/exogeneity nature of the cycle. Kondratieff's long waves theory was viewed with skepticism and met resistance in academic economics, leading some academicians (including Marxists) to question whether long cycles actually exist (Wallerstein 1992). Marxists generally did not accept the Kondratieff concept of mechanical cycles since it emphasized long waves of price fluctuation and was built in a mechanism through which an expansive phase of twenty-five years leads automatically to a stagnating phase of the same length, and so on.

Regarding the length of the cycle, there was a lack of consensus due mainly to technical aspects related to how to measure the profit rate and the lack of adequate statistical tools to date cycles accurately. While, in essence, Marxist scholars agreed on the existence of long cycles in economic activity, there was a high degree of disagreement regarding the nature of those cycles. For instance, Mandel (1976, 1992, 1995) was a prominent defender of the exogenous nature of long cycles, where the law of the tendency of the profit rate to fall had a crucial role.

Mandel, following Marx, conceived the stepwise deterioration of the profit rate as the natural long-run trajectory of the capitalistic mode of production. Nonetheless, he acknowledged that the economy is exposed to exogenous positive shocks that in the throes of a depression triggers a sudden rise in the rate of profit. In the upturn of the cycle, both the organic composition of capital and the rate of surplus value rise although the latter outpaces the former. Eventually, unemployment drops, real wage accelerates, the organic composition of capital outstrips the rate of surplus value, the rate of profit falls, and the economy enters a downturn phase of the cycle waiting for a new exogenous positive shock. Note, first, that there is no symmetry between the turn from expansion into depression, and, second, that depressions are essentially endogenous, while expansions require exogenous shocks.

In opposition to Mandel's view, a branch of the Marxist thought conceived cycles as an endogenous phenomenon (see, Menshikov 1992). This notion is a long-wave theory based on up-and-down endogenous oscillations in the rate of profit. Oscillations are created endogenously by technological change, which responds to upswings and downswings of the profit rate. A rising profit rate discourages capitalists from introducing technical innovations, but eventually, the current technology reaches its peak of profitability, and the profit rate falls. A fall of the profit rate below a certain minimum compels entrepreneurs to resort to new technology to boost their profitability, and thus, the lower turning point in the long wave is reached. There are strong similarities to Schumpeter's theory of technological change where innovation occurs toward the end of the depressive phase of the cycle.

In this document, we spend most of the effort in measuring the cycle, and in emphasizing the major stylized facts rather than attempting to contribute directly to any of these debates. We rely on the observation that the profit rate is cyclical and that several forces, endogenous and exogenous, influence the rhythm and trajectory of it. Hence, a super cycle, as defined here, is a regular cyclical pattern that can be ignited by several forces. In this regard, the aim of this document is twofold: on the one hand, to identify the duration and magnitude of succeeding super cycles in the aggregate rate of profit in the U.S., and, on the other hand, to provide insights for the profit rate cycles from a long-term perspective by analyzing the long-run relationship between the profit rate, the rate of surplus value, and the organic composition of capital.

For the purpose of this document, we perform a univariate analysis of the aggregate profit rate of the U.S. economy for the period 1865-2015 using the asymmetric band pass filter developed by Christiano and Fitzgerald (2003)[2]. The filter reveals the presence of four and a half super cycles throughout the sample. The methodology helps to bring out the profit rate long term trend, which reveals that the tendency of the profit rate to fall has been episodic. Next, we use the common cycle and common trends methodology in the context of the multivariate Beveridge and Nelson (1981) decomposition to evaluate the presence of common serial correlation patterns between the profit rate, the rate of surplus value, and the organic composition of capital. In general, our conclusions are positive to Marxian analysis on the cyclical nature of capitalism.

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[2] The use of filters to decompose the profit rate into its basic components is not new in the literature of long waves (see, Metz 1992).

2. Cycles in the U.S. Profit Rate: an inventory of the empirical findings

It is a matter of common knowledge that economic dynamic is not simple and linear, but rather it is complex and cyclical, as Kondratieff (1935) pointed out. Marxist political economy emphasizes the cyclical nature of the capitalist mode of production that takes the form of successive expansion and contraction of economic activity. Thus, recurrent episodes of crises become an inherent and irreducible characteristic of this intrinsically unstable mode of production where upturns and downturns shape the long-term dynamic of capitalism. The profit rate is considered to be a primary indicator of general economic activity. In this sense, the rate of profit should reflect the cyclical behavior of contractions and expansions of the economic activity.

The pursuit of profits as an economic motivation is well established in the economic theory. For instance, the mainstream school considers that capitalists produce as a response to a profit maximization process. The Schumpeterian economic growth theory that rationalized Schumpeter's notion of creative destruction (Aghion, Akcigit, and Howitt 2015) states that in the long run, entrepreneurs' profit seeking drives economic activity. The centrality of profitability within the Marxist political economy is such that in general, long cycles of accelerated and decelerated accumulation are considered as direct expressions of corresponding long cycles in the rise and decline of the rate of profit (Shaikh 1992, Mandel 1995).

Mandel (1976) suggests that the cyclical course of capitalism is induced by competition among capitalists and hence, by the production of surplus value. Competition leads capitalists to continually made efforts to lower the costs of production and cheapen the value of commodities through technical improvements. The race for technical improvements provokes a cyclical movement of the system as a consequence of accelerated capital accumulation, over-accumulation, decelerated capital accumulation, and underinvestment. The upward and downward movements of capital accumulation in the course of the cycle, are commanded by fluctuations of the profit rate.

In this sense, Mandel conceives cycles as acceleration and deceleration of accumulation determined by rises and declines of the profit rate.

Mandel (1995:3) presents his chronology of U.S. industrial production cycles since the late nineteenth century as associated with cycles in the profit rate. He found three cycles (from trough to trough) in the U.S. industrial output spanning 1849-1975. The first cycle starts in 1849, peaks in 1873, and finishes in 1893. The second begins in 1894, peaks in 1913, and ends in 1938. The last one starts in 1939, peaks in 1967, and dies off in 1975. On average, the U.S. industrial production cycle length was 41 years.

Shaikh (1992), following a similar argument to Mandel's, presents a study on profit rate long waves. Shaikh distances himself from Mandel by considering that Marx's theory of a secularly falling rate of profit provides a natural foundation for a theory of long waves. Thus, Shaikh presents an alternative approach to the matter where he distinguishes the actual profit rate from the basic profit rate. The latter represents the gravity center around which the former gravitates. The basic profit rate should exhibit a declining trend, as Marx suggested. Shaikh draws attention to the centrality of capacity utilization on profitability. He then develops a nonconventional definition of capacity utilization to adjust his profit rate in the U.S. from 1899 to 1984.

The time interval encompasses two long cycles in the profit rate. The first begins in the mid-1890s and culminating in the Great Depression of 1929-33, and the second begins in the 1930s until the end of the sample. The drawback to using the capacity utilization to adjust the profit rate is that it is challenging to disentangle specific profit rate cycles from cycles arising from capacity utilization.

Poletayev (1992) examines the profit rate series to discern long waves since the 1900s. He concludes that there exist long-wave movements of the profit rate with tentative peaks at the beginning of the twentieth century, and in the 1950s; and troughs in the 1930s and 1970s. He recognizes that because of the intensity of short-term cyclical fluctuations, the exact dating of the long waves remains very tentative. Additionally, Poletayev explores the connection between the profit rate and theoretical factors that affect the long-term dynamics of it. He arrives at the tentative conclusion that profit rate, the share of profits in national income, and the output-capital ratio are synchronous. Despite some vagueness connected with the dating of the turning points, and with the selection of the starting points, he states that there exist long-term fluctuations of the profit rate with a period of approximately fifty years.

Li, Xiao, and Zhu (2007) analyze the long-term movements of the profit rate in the U.S. economy using ten years moving averages to smooth out short-term fluctuations. By removing short-term cycles, Li et al. seek to avoid that those fluctuations prevent them from dating turning points, as in Poletayev's work. Between 1869 and 2005, they found four long waves in the movement of the U.S. profit rate. The profit rate reaches its peaks in 1873, 1926, 1950, and 1969. The cycles on the average, have a length of 31 years from peak to peak.

In the next section, we propose a plausible statistical approach to analyze the presence of super cycles in the profit rate.

3. Identification of Super Cycles by the Band-Pass Filter

3.1. The band pass filter

This presentation borrows heavily on the work of Christiano and Fitzgerald (2003). Band pass (BP) filters are statistical techniques focused on the decomposition of time series into some essential components. BP filters are sophisticated two-sided moving averages of the time series where the weights are determined analytically using spectral analysis to extract cyclical components within a specified range of frequencies. That is, the BP filter is applied to a time series to let specific frequencies 'pass through' the filter while removing or 'filtering out' higher and lower frequency components. Baxter and King (1999) develop symmetric filters, which assume equal weights on each lead and its corresponding lag.

The advantage of symmetric filters is that they ensure that there is no phase-shifting of the filtered series relative to the original series. The use of symmetric filters, however, inevitably implies the loss of a few observations at both the beginning and the end of the data sample. The longer the cycle one wishes to study, the more the data points lost. Christiano and Fitzgerald (2003) address this issue by developing asymmetric filters, which allow calculating the filtered series over the complete data sample. This is a crucial advantage to look for possible super cycles that emerge near the end of the currently available data sample. Christiano and Fitzgerald show that the phase-shifting using an asymmetric filter is relatively minor.

In this document we use the asymmetric Christiano-Fitzgerald (ACF) BP filter to decompose the profit rate into three components: (1) the long-term trend (RoP_T), (2) the super-cycle component (RoP_SC), and (3) other shorter cyclical components (RoP_O):

$$RoP_t = RoP\_T_t + RoP\_SC_t + RoP\_O_t \quad (1)$$

A crucial question is how long a super cycle lasts. Considering the discussion on the profit rate cycles presented in previous sections, we might interpret that those super cycles have upswings from 10 to 30 years, implying that the complete cycle (if symmetric) has a period of roughly twice that amount. We, however, keep the cycle span more flexible to allow for the possibility of even longer cycles. Additionally, unlike Li, Xiao, and Zhu, who removed short-term fluctuation, we include shorter cycles since it is precisely the integration of the super cycles with the short and medium-term fluctuations that help to bring out the long-term trend, as Shaikh suggests. Those short cycles typically have a length of 3 to 10 years.

Thus, the BP filter can be used to extract super cycles that have periodicities ranging from 20 to 70 years. On the other hand, we filter out the remaining short-term cycles as cycles with 2–20 years periodicities. The summation of the super cycles with the other shorter cycles yields the total "non-trend" components, which are conceived as the total deviation from the long-term trend. Accordingly, the long-run trend is then defined as all cyclical components whose periodicities exceed 70 years; this assumption allows the long-term trend to change gradually over time in contrast to the more restrictive assumption that the long-term trend is constant over the sample.

The cycle-trend decomposition in equation (1) can thus be written in BP filter notation as follows:

$$RoP_t = RoP\_BP(70, \infty)_t + RoP\_BP(20{,}70)_t + RoP\_BP(2{,}20)_t \qquad (2)$$

3.2. Results from the band-pass filter decomposition

The ACF BP filter is applied to the aggregate profit rate in the U.S. economy to extract the long-term trend, non-trend, and super-cycle components. How to compute the numerical magnitude of the profit rate is a matter of considerable technical debate. In this document, the profit rate is measured as the ratio of profits to the capital stock, and the data comes from Duménil and Lévy (2016). Profits are defined as the difference between net domestic product and total compensation of workers. For its part, capital stock is the net stock of fixed capital.

It is noteworthy to mention that the definition of profit rate employed here is relatively insensitive to estimation procedures. For example, the definitions of Poletayev (1992) and Li, Xiao, and Zhu (2007) yield a series with a similar dynamic in terms of its apparent stability and the lack of a declining trend. A different definition of the profit rate proposed by Li and Hanieh (2006) that considers the effects of both wage costs and taxation costs, produces a profit rate with a declining trend according to them. However, what they interpret as a tendency of the profit rate to fall, is merely a break in the intercept, which does not affect the series trend.

Figure 1 illustrates the decomposition of the profit rate. In the top section, the figure displays the profit rate, and the long-term trend superimposed on it. Note that the profit rate trended downward from 1869 to the mid 1905s, trended upward until the late 1950s, and then trended very slightly downward toward the 1990s through the end of the sample.

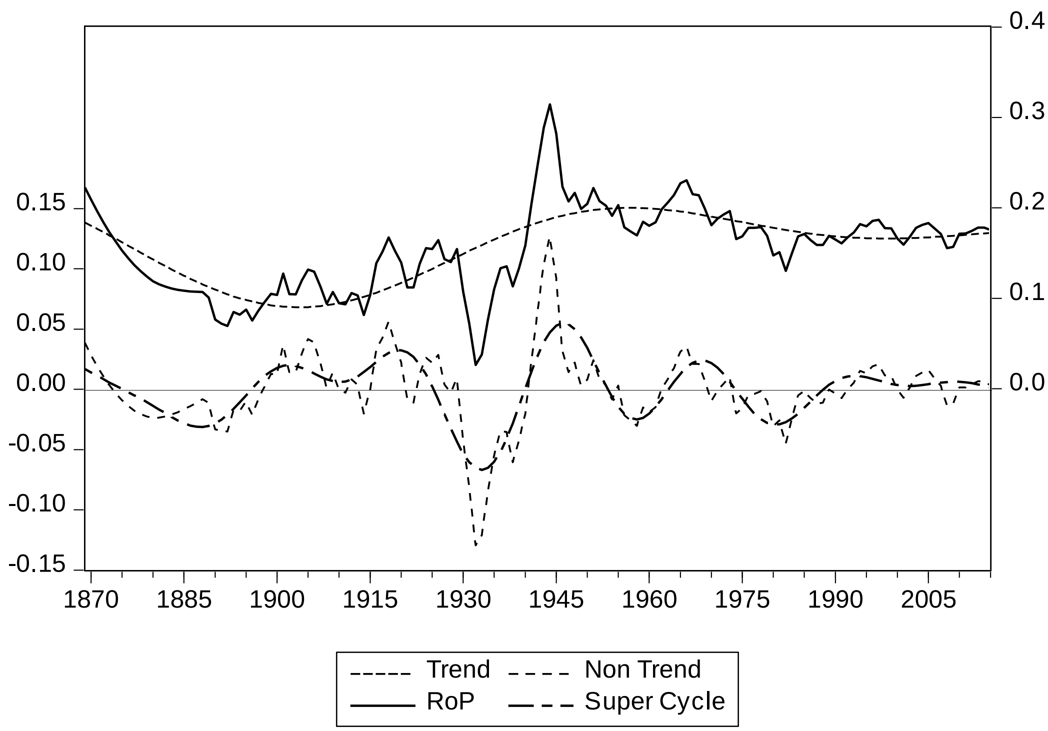

Figure 1. Decomposition of the profit rate in the U.S., 1869-2015

The non-trend component representing the difference between the original series and the long-run trend is shown in the bottom portion of Figure 1. Note that cyclical fluctuations illustrated by the non-trend component are rather significant in size measured as deviations from the long-term trend. These fluctuations contain shorter-term as well as the super cycles, which are not always symmetrical. The latter are estimated to be in the 20–30 years range (on the basis of a possible 20–

70 years range). The super-cycle component is shown in the bottom section of Figure 1 and reveals four and a half long-term cycles in aggregate profit rate since the late nineteenth century.

The first long cycle begins in the late 1890s, peaks around the first decade of the twentieth century, and ends around the beginning of World War I and shows a robust upward phase but a weak downward one. The second takes off at the end of the first decade of the twentieth century, peaks in the 1920s and bottoms with the great depression. The second cycle exhibits the most potent downward phase. The third cycle initiates in the late 1930s, peaks during the post-war reconstruction of Europe, and fades away in the late 1950s. It shows a strong upward phase. The early 1960s marks the beginning of fourth cycle, which peaks around the 1970s and ends in mid-1980s. This cycle shows symmetric upward and downward phases. Since then, is the beginning of the latest cycle, which has shown a robust upward phase that does not seem to have been exhausted so far. In general, cycles are quite irregular.

Table 1 reports the descriptive statistics of complete super cycles measured from trough to trough and extracted by the ACF BP filter.

Table 1. Descriptive statistics of super cycles in the profit rate (from trough to trough)

	1882–1910	1911–1934	1935–1959	1960–1981	1982–ongoing
Peak year	1905	1918	1944	1966	1997
Percent rise in RoP during upswing	16.7%	79.3%	185.9%	27.8%	43.5%
Percent fall in RoP during downswing	-28.3%	-54.3%	-41.3%	-34.5%	---
Length of the cycle (years)	28	23	24	21	---
Upswing	23	7	9	6	15
Downswing	5	16	15	15	---
Mean (of the full cycle)	10.1%	11.8%	19.6%	18.9%	17.0%
Standard deviation	1.7%	3.9%	5.2%	2.3%	1.2%
Coefficient of variation	16.5%	33.0%	26.3%	11.9%	6.8%
Skewedness	-0.17	-0.83	0.41	0.07	-1.26
Kurtosis	2.41	2.80	2.95	2.33	5.21

The found super cycles seem to illustrate the major upturns and downturns of the U.S. economy such as the great depression and the rise and fall of Keynesianism accurately. Interestingly, the super cycle associated with the neo-liberal era (1982-ongoing) exhibits a peculiar plateau pattern that corresponds to the same pattern in the profit rate. Since the 1990s, the profit rate exhibits a lack of dynamism that might be enlightening us on the current stalemate of the U.S. economy. This plateau pattern, however, entails some questions regarding whether crises happen because the profit rate declines in the long run.

In particular, consider the crisis of 2007. Before the crisis it is not possible to discern a profound decline in the profit rate; there was a fall, but it seems a purely circumstantial phenomenon not associated to a long-term effect. Some crises (1873, 1929, 1975) fit into the framework of the fall in the profit rate as a cause of the crises. However, the neo-liberal era entails a more general explanation where the law of the tendency of the profit rate to fall articulates as a piece of it.

One unanticipated finding is the rising mean of the profit rate throughout the cycles. Table 1 shows that the mean rose during cycles 1 through 3 and then slightly decreased during cycles 3 and 4. This finding could imply that the mean of the profit rate across cycles could be increasing, thus contradicting the view that the profit rate should exhibit a stepwise deterioration over time, as the law of the tendency of the profit rate to fall states.

3.3. Is there a tendency for the profit rate to fall?

In a widely cited fragment of Marx's Grundrisse, Marx argues that "the most important law of modern political economy" is the law of the tendency of the profit rate to fall. It is acknowledged that Marx's underlying preoccupation was to establish laws of motion of capitalist accumulation and the rate of profit was the heart of those laws. The importance of the law relies upon the connection between it and a possible theory of crises. In some way, most radical theories of crises are based on the theory of a gradual fall of the general rate of profit as the primary channel through which crises manifest. For instance, both supply-driven crises of over-accumulation and demand-driven crises of realization, are connected to a fall in the profit rate (see, Gordon, Weisskopf and Bowles 1987).

As a law, it is supposed to be an empirical regularity of modern capitalist societies, and therefore, the law has become in a fertile research field within the Marxist political economy. A considerable number of man hours have been devoted to research whether the theory of the falling rate of profit is an empirical regularity in the U.S. as well as in other major capitalistic economies. The law, indeed, has received more attention than the study of long cycles. In a recent attempt, Basu and Manolakos (2012) present a modern approach using time series techniques. They conclude that there is "weak evidence of a long-run downward trend in the general profit rate for the U.S. economy for the period 1948-2007." The result, however, is interesting, since they use as the starting point of their study the exceptionally high profit rate of the late 1940s. The difficulty here is that Basu and Manolakos contemplate a linear trend and neglect possible nonlinearities.

Table 2. Descriptive statistics of the profit rate long term trend

	Downward trend	Upward trend	Downward trend	Upward trend
RoP	1869–1904	1905–1958	1959–1998	1999–ongoing
Annual compound growth rate	-2%	1.50%	-0.50%	0.23%
Cumulative growth rate	-51.04%	121.44%	-16.80%	3.77%
Duration (years)	35	53	39	16

Table 2 shows that downturns in the profit rate have been discontinuous, with a couple of periods for which declines were particularly notable. Upturns in the long-term trend, which have also been substantial, have tended to balance the trajectory of the profit rate throughout the sample.

The shifting trend phenomenon explains why the profit rate does not show a clear decreasing trend and supports the observation that deteriorations in the profit rate have been discontinuous and episodic. This reveals that the law is not arbitrary, but dependent on specific socio-economic frameworks that determine the trajectory of the profit rate such as the labor supply and workers' bargaining power. We shall interpret this profit rate trend as Mandel's long-term curve of development of capitalism upon which different tendencies may provoke countertendencies that neutralize their own effect for a considerable period.

Marx himself encapsulated the tendencies and countertendencies in his definition of the profit rate as a relation between surplus value and the total capital invested. In equation form: $r = s/c + v$, where s represents the surplus value, and c and v stand for constant and variable capital, respectively. Dividing by v yields $r = \frac{s}{v}/\frac{c}{v} + 1$. Thus, the organic composition of capital $\left(\frac{c}{v}\right)$ acts as a force that drags the profit rate downwards, and the rate of surplus value $\left(\frac{s}{v}\right)$ acts as a counteracting force that balances out the fall in the profit rate.

In chapter 13 of the third volume of Capital Marx (1967[1894]: 212-213) writes that "This mode of production produces a progressive relative decrease of the variable capital as compared to the constant capital, and consequently a continuously rising organic composition of the total capital. The immediate result of this is that the rate of surplus-value, at the same, or even a rising, degree of labor exploitation, is represented by a continually falling general rate of profit." Marx implicitly assumes that throughout the development of capitalism, the effect of a rising organic composition of capital is the most dominant. Even though he does not reveal any exact and regular proportions between these tendencies, the rise of the organic composition of capital ought to outstrip the rise of the rate of surplus value, and consequently, the profit rate ought continuously to fall (see, Dobb 1972). Nevertheless, Figure 1 and Table 2 compel us to confront the abstract formulation of the law with what we observe, because those impressive surges of the profit rate have tended to break the declining trend temporarily.

Those significant upsurges in the profit rate seem to controvert the law in abstract. Okishio (1961) showed how technical innovations in basic industries raise the general rate of profit, assuming constant real wages. Okishio stated that capitalists innovate guided by a cost criterion that leads them to adopt modern production techniques to cut down production cost rather than to raise labor productivity. The result is a definite rise in the general rate of profit. Okishio's reasoning does indeed satisfy conventional microeconomic wisdom and might explain those upsurges, although it cannot explain the downward phases of the profit rate.

Downturns in the profit rate might be, then, explained by the Marx-biased technical change where increases in real wages lead capitalists to invest in labor-saving innovations guided by productivity criterion. As a result, the organic composition of capital rises and offsets the rise in the rate of surplus value, which causes a decline in the profit rate. The complete story, however, seems to indicate an alternation between periods of adoption of cost-reducing and productivity-increasing techniques, as Marquetti (2002) found in his empirical study. Marquetti (2002:194) found that "the Marx-bias pattern is not uniform for the whole period of modern capitalist development," which confirms Duménil and Lévy's (1995) insight. Ultimately, the long-term curve of development of capitalism comes determined by the struggle between conflicting classes that determines the movements of the profit rate and the technique adopted.

A single analysis of the profit rate cycles is incomplete if no effort is made to investigate the influence of those tendencies and countertendencies that acts on the long-term of the profit rate. Hence, we analyze the underlying dynamic of the rate of surplus value (RSV) and the organic composition of capital (OCC) in connection with that of the profit rate. The rate of surplus value is measured as the ratio of profits to total compensation. For its part, the organic composition of capital is computed as the capital-labor ratio given by the net stock of fixed capital divided by total compensation. Figures 2 and 3 present the results.

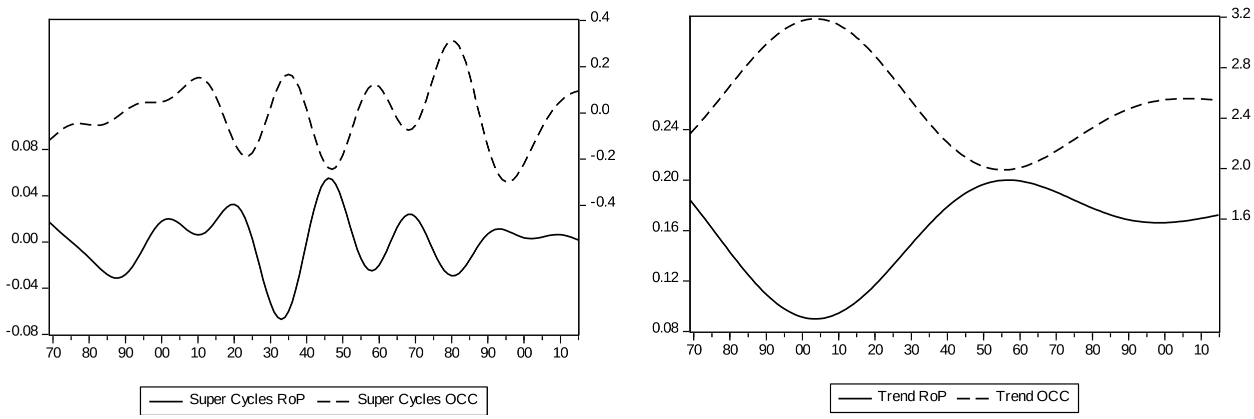

Figure 2. Super-Cycle and Trend components of RoP and OCC

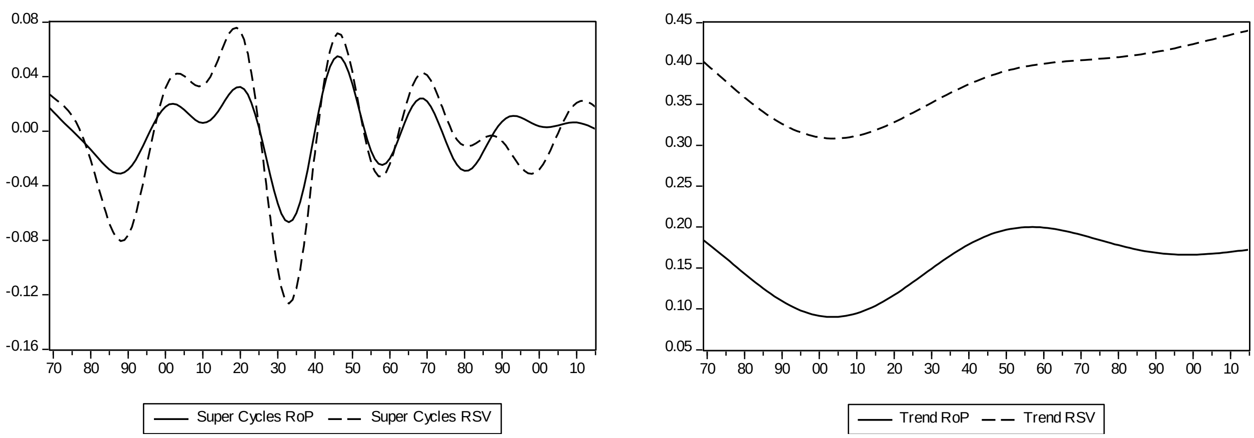

Figure 3. Super-Cycle and Trend components of RoP and RSV

The left-hand side of Figures 2 and 3 display the super-cycle components of RoP and OCC, and RoP and RSV that are extracted by applying the ACF BP (20, 70) filter to the original series, respectively. Similarly, the right-hand side of those Figures reports the trend component of RoP and OCC, on the one hand, and RoP and RSV on the other hand. Note how intimately related are those variables. In the case of RoP and OCC, RoP downturns are accompanied by upturns in OCC and vice versa. As for the case of RoP and RSV, note how upswings and downswings in RSV are followed by upswings and downswings in RoP. The correlation between RoP and OCC is rather large, as indicated by the Spearman correlation coefficient of -0.85 and 0.81 for RoP and RSV. Overall, Figures 2 and 3 show the close co-movements in the super-cycle components of RoP, OCC, and RSV. The close connection is evident not only for the cycle, but also for the trend, which implies that super cycles of the profit rate can be viewed as a result of the super cycles in OCC and RSV and that the long-term curve of development of capitalism is the synthesis of OCC and RSV trends.

4. Analysis of long-term Stability and Cocycles

In this section, we extend the analysis to examine the relationship between the profit rate and its tendencies and countertendencies. Hence, next, we analyze the cotrends and cocycles between RoP, OCC, and RSV.

4.1. Common trends and common cycles methodology

We follow the theory of common features developed initially by Engle and Kozicki (1993) and further extended by Vahid and Engle (1993), Cubadda and Hecq (2001), and Hecq et al. (2006). The theory determines the existence of common cycles within a group of non-stationary series, which is conditioned on the presence of cointegration in the system. The method starts by estimating a VAR model for the multivariate time series and then implements a test for cointegration. If cointegration is found, the number and form of the cointegrating vectors must be determined. Once the cointegrating vectors are established and identified, time series can then be separated into common trend and common cycle components (see appendix I).

4.1.1. Cointegration and common trends

A set of variables are said to be cointegrated if each variable features a stochastic trend, but a linear combination of those variables features no stochastic trend. More generally, if a linear combination of a set of I(1) variables is I(0), then the variables are cointegrated. Cointegration relies heavily upon the correct specification of the unit root tests to determine the presence of a stochastic trend, and those, in turn, hinges on the correct specification of the trend function (Perron 1988). Considering the underlying trend of the series plotted in Figures 1, 2, and 3, traditional unit root tests would lose power if those smooth structural breaks are ignored.

Given the evidence in favor of nonlinear deterministic trends in the variables, we apply a new class of robust unit root tests that allow for a flexible Fourier form to approximate the pattern of slowly time-varying slopes of the trend. Those unit root tests capture more accurately the pattern of a slowly time-varying slope than typical unit root tests that assume a linear deterministic trend with constant slope parameters. Thus, we opt for applying the τ_{DF} unit root test of Enders and Lee (2012a), the τ_{LM} unit root test of Enders and Lee (2012b), and the τ_{GLS} test of Rodriguez and Taylor (2012). The three tests contrast the null of unit root process with an unknown number of level breaks against the alternative of stationary process with an unknown number of level breaks. Table 3 presents the results.

Table 3. Unit root test with a flexible Fourier form of the trend

Series	τ_{DF}	C.V. 5%	τ_{LM}	C.V. 5%	τ_{GLS}	C.V. 5%
RoP	-3.38	-3.81	-2.74	-4.10	-2.47	-4.17
OCC	-3.44	-3.81	-3.17	-4.10	-2.91	-4.17
RSV	-4.19	-3.81	-4.10	-4.10	-3.10	-4.17

The null of unit root process is rejected for RSV using τ_{DF}. However, we apply the majority rule to conclude that all variables are nonstationary at a 5% level of significance.

After the presence of a unit root has been verified, the next step entails testing whether there is a stable relationship through time between these variables. To test for potential linear cointegration, we employ the test of Johansen (1991), as suggested by Vahid and Engle. The

Johansen cointegration technique is an appropriate method for analyzing the long-term relationships among variables that may individually exhibit stochastic trends.

Table 4 reports Johansen's cointegration tests for a VAR(3), where we use the AIC information criterion to select VAR lag length. Table 4 reports the lambda-max and trace statistics of Johansen's cointegration test, where a time trend has been included in the cointegrating regression. The results suggest the presence of one cointegration vector among the three variables since we can reject the null hypothesis of no cointegration with the trace and maximum-eigenvalue tests at a 5% level of significance.

We do not consider the possibility of incorporating a break in the trend in the analysis since the shock observed at the great depression can be well captured by a discrete jump in the intercept, not affecting the estimated stochastic trend significantly.

Table 4. Multivariate cointegration tests for RoP, RSV, and OCC: 1869-2015

Eigenvalues	0.1646	0.1208	0.039839				
		Crit. and *p* values		Cointegration vector			
H_0	λ_{trace}	5%	*p*-value	RoP	RSV	OCC	Trend
r=0	50.300	42.915	0.008**	70.875	-43.119	4.608	0.021
r≤1	24.394	25.872	0.076	-101.336	29.798	-6.809	0.000
r≤2	5.854	12.518	0.479	-15.523	11.124	1.756	0.008
					Loadings		
H_0	λ_{max}	5%	*p*-value		RoP	RSV	OCC
r=0	25.906	25.823	0.049**		0.004	0.002	0.001
r≤1	18.540	19.387	0.066		0.013	0.003	0.000
r≤2	5.854	12.518	0.479		-0.001	0.007	-0.022

**5% significance level

Hence, there is strong evidence of cointegration, which suggests that RoP, RSV, and OCC have a long-run equilibrium relationship. The results imply that the system of variables shares two common trends that, in turn, implies that RoP, RSV, and OCC do not converge. In general, those results are consistent with our expectations and in accordance with Marx's analysis of tendencies and countertendencies acting on the profit rate. The convergence toward a unique trend would imply that only one force acted on the profit rate, which would contradict the analysis presented above. Marx's analysis treats all the basic categories of the capitalist mode of production simultaneously as partially independent variables, to be able to formulate long-term laws of development for this mode of production. A single long-term trend would negate the simultaneous independence and interdependence of these basic categories.

The estimated normalized cointegrating relation (standard errors in parenthesis) is:

$$RoP = \underset{(0.05)}{0.60} RSV - \underset{(0.007)}{0.06}\, OCC$$

The normalized cointegration equation shows that the impact of RSV on RoP is positive and significant, while the impact of OCC on RoP is negative and significant, as expected. This implies that a positive shock that induces a one standard deviation sustained raise in OCC will produce a permanent decrease in the long-run level of RoP equal to 0.025 percentage points, which represents a 62% decrease of a standard deviation. For its part, a positive shock that induces a one standard deviation sustained raise in RSV will produce a permanent increase in the long-run level of RoP equal to 0.042 percentage points that equals a 105% increase of a standard deviation. Our findings imply that the effect of a rising rate of surplus value has been the most dominant over the sample period. These results provide robust insights about why it is hard to discern a declining trend in the U.S. profit rate precisely because the countertendency provoked by the RSV has been the prevailing tendency.

4.1.2. Existence of common cycles

Having fixed *r=1* (the number of cointegrating equations), we use the three forms (SCCF, PSCCF, and WF) of common cyclical features to test for common cycles between RoP, RSV, and OCC. The estimated test statistics are reported in Table 5. The SCCF model found no cofeature vectors (*s=0*), while the PSCCF and WF models found one cofeature vector (*s=1*) or two common cycles using a 5 percent level of significance. The finding of two common cycles is in accordance with the expected cyclical behavior among the variables.

Table 5. Common cyclical features tests using reduced rank regression

Model	H_0	$\hat{\lambda}$	χ^2	logL	*p*-value
SCCF					
	s≥1	0.084	12.622	1589.990	0.027**
	s≥2	0.267	57.276	1567.670	0.000**
	s≥3	0.364	122.343	1535.130	0.000**
PSCCF					
	s≥1	0.002	0.347	1596.130	0.841
	s≥2	0.119	18.598	1587.000	0.005**
	s≥3	0.221	54.554	1569.030	0.000**
WF					
	s≥1	0.045	6.594	1593.010	0.159
	s≥2	0.205	39.695	1576.460	0.000**
	s≥3	0.346	100.735	1545.940	0.000**

**5% significance level. $\hat{\lambda}$ is the estimated sample squared canonical correlations. logL is the log likelihood of the model under the specification

If the three economic cycles depend upon the same shocks, a single common cycle can be identified as evidence of business cycle synchronization. The methodology, however, identifies two common cycles, which implies an asynchrony of the three economic cycles. As in the case of a single common trend among the three variables, we interpret the finding of a single common cycle to be evidence supporting Marx's analysis on the profit rate. The rate of surplus value, as well as the organic composition of capital, are exposed to different types of shocks that lead those variables to develop unevenly. Thus, profit rate cycles are subject to those several forces that affect its various components and therefore, the relative balance of forces determines profitability cycles.

5. Concluding Remarks

In this document, we decomposed the profit rate in the U.S. into trend and cycle components spanning 1869–2015. We found four and a half super cycles in the U.S. profit rate, which depict the upturns and downturns of the economy, accurately. In general, our conclusions are positive to Marxian analysis on the cyclical nature of capitalism. The long-run profit rate trend exhibits a smooth-breaks pattern that suggests that the law of the profit rate to fall has been episodic. Even though Marx predicted a theoretical stepwise deterioration of the profit rate over time, he also anticipated potential empirical violations to his law.

Motivated by those swings in the long-run profit rate trend, we extended the analysis to test for the presence of common features. We found two common trends and two common cycles that we explain to be in accordance with Marxist analysis on the development of capitalism. The cointegration methodology performed in this study shows that the effect of the rate of surplus value on the profit rate has been the prevailing tendency. We interpret this interesting finding to be supporting the idea that the class struggle is being won by capitalists. In general, the conclusion is then drawn that there is robust statistical evidence to find empirical confirmation for Marx's laws of development of capitalism.

Finally, it would now be desirable to extend the investigation of super cycles in the profit rates and their determinants to other countries to analyze their tendencies in connection with the U.S.

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Appendix I

To start with, consider the vector error correction model representation of a *n*-vector of *I(1)* variables y_t:

$$\Delta y_t = \alpha\beta' y_{t-1} + \sum_{j=1}^{p-1} \phi_j \Delta y_{t-1} + \varepsilon_t \qquad (3)$$

with α and β both $(n \times r)$ matrices of full column rank *r* (the rank of the cointegrating space), and ε_t i.i.d. errors. The columns of β contain the cointegrating vectors, and the elements of α are the corresponding adjustment coefficients or factor loadings. The stationary process Δy_t has a Wold representation and can be written as $\Delta y_t = C(L)\varepsilon_t$, where $C(L)$ is a polynomial matrix with the properties $\sum_{j=1}^{\infty} j\left|C_j\right| < \infty$, and $C_0 = I_n$. Using the polynomial factorization $C(L) = C(1) + \Delta C^*(L)$, with $C_i^* = -\sum_{i+1}^{\infty} C_j$ for $i \geq 0$, it is possible to obtain the multivariate trend-cycle Beveridge and Nelson's (1981) decomposition of y_t proposed by Stock and Watson (1988):

$$y_t = \tau_t + \xi_t \equiv \text{Trend + Cycle}$$

where $\xi_t = C^*(L)\varepsilon_t$, and $\Delta\tau_t = C(1)\varepsilon_t$. The decomposition shows that the linear cointegration combinations consist of both cyclical and stochastic trend components.

Assuming the set y_t of I(1) variables are cointegrated, consider further an $n \times k$ matrix γ, where $k = n - r$, such that $\beta'\gamma = 0$, with k representing the number of common trends. The Stock-Watson trend-cycle decomposition is then given by

$$y_t = \gamma\tau_t + \xi_t$$

Additionally, the n-vector of I(0) variables Δy_t is said to have $l = n - s$ common cycles if there exists an $n \times s$ matrix $\tilde{\beta}$ (the cofeature matrix) of rank s such that $\tilde{\beta}'\Delta y_t \sim WN$. By considering a $n \times l$ matrix $\tilde{\gamma}$ it is possible to extend the Stock and Watson trend-cycle decomposition to include common cycles such that:

$$y_t = \gamma\tau_t + \tilde{\gamma}\xi_t$$

The existence of s serial correlation common feature (SCCF) of Vahid and Engle can be tested using the test statistic $-T\sum_{i=1}^{s}\log(1-\lambda_i)$, where λ_i are the sample squared canonical correlations. The test statistic follows an asymptotic χ^2 distribution with $s(np + r) - s(n - s)$ degrees of freedom under the null hypothesis that there exist at least s cofeature vectors. We also consider the polynomial serial correlation (PSCCF) and weak form (WF) common cycle specifications in the searching strategy for serial correlation common features.

The PSCCF was introduced by Cubadda and Hecq (2001) to allow for common serial correlation among non-contemporaneous elements of series Δy_t. Both SCCF and PSCCF implies that the number s of serial correlation common features cannot exceed the number of common trends (k). Hecq et al. (2006) proposed the weak form of SCCF to loosen the restriction $s<k$.