Comparative Growth Dynamics in a Discrete-time Marxian Circuit of Capital Model

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Abstract

In this paper, a discrete-time version of the Marxian circuit of capital model in Foley (1982, 1986a) is used to address two important theoretical issues of general interest to the heterodox economics tradition: profit-led versus wage-led growth, and the growth-reducing impact of non-production credit. First, it is demonstrated that both profit-led and wage-led growth regimes can be accommodated within the Marxian circuit of capital model. Second, it is demonstrated that, if the total flow of credit is large, the steady-state growth rate of a capitalist economy is negatively related to the share of consumption credit in total net credit.

1. Introduction

The determining motive of capitalist production is profit. In volume I of *Capital*, Marx provided a consistent explanation of the phenomenon of profit, at the aggregate level, as arising from the exploitation of the working class by capitalists through the institution of wage labor. To establish this path-breaking result, Marx borrowed and further extended the labor theory of value of classical political economy.

Marx demonstrated that the classical economists' category of value is nothing but objectified (socially necessary, abstract) labor, that value is expressed through the social device of money (so that money is intrinsic to commodity production), and that capital is self-valorizing value (Marx 1992). Capital, self-expanding value, was represented by Marx as:

$$M - -C \ldots \left(P\right) \ldots C' - -M'$$

(1)

In this well-known formula, M represents the sum of money that a capitalist enterprise commits to the process of production by purchasing a bundle of commodities C. C is composed of

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two very different kinds of commodities, labor power and the means of production.[1] These are brought together in the process of production, represented by P, which leads, after a period of time (the production time) to the emergence of finished products, C′. These commodities are then sold in the market for a sum of money M′=M+ ΔM, to not only recoup the original sum thrown into production but also a surplus, ΔM, the proximate determinant of the whole process.

Marx's analysis in volume I of *Capital* (Marx 1992) demonstrated that the secret of surplus value is the exploitation of labor by capital. In volume II of *Capital* (Marx 1993), he highlighted the fact that the process of self-valorization of capital can only complete itself by traversing a circular movement, during which value assumes and discards three different forms. Marx called this circular movement of value the circuit of capital which has three distinct phases (or stages):

1. the flow of capital outlays to start the production process, M--C;
2. the flow of finished commodities emerging from the process of production, (P)--C′; and
3. the flow of sales, C′--M′, which sets the stage for another round of capital outlays and production (and also finances consumption of capitalist households, unproductive labor households, and the state).

As a representation of the flow of value through the capitalist economy, the circuit of capital model highlights two crucial aspects of the self-expanding movement of value. First, it pays close attention to the *forms* that value alternatively assumes and discards, at different stages of the circuit, as it tries to expand itself quantitatively (a dialectical interaction of quality and quantity). Second, it highlights the crucial aspect of turnover, of how the different forms of value complete their own circuits at different speeds and how capital re-creates its own conditions of existence and growth through the amalgam of the three circuits.

Attending carefully to the issue of aggregation, the circuit of capital model in volume II of *Capital* can be extended to an ensemble of capitals or even the whole capitalist economy. The analytical move to construct a circuit of capital model for the aggregate economy involves dealing with at least two conceptual issues. The first issue that one needs to deal with is the cross-sectional heterogeneity across capitalist enterprises. At any point in time, different individual capitalist enterprises would be at different stages of the three phases of their individual circuit.

The issue of cross-sectional heterogeneity can be dealt with by aggregating across individual circuits of capitals at any point in time over the three phases to arrive at corresponding aggregate *flows of value*:

1. the aggregate flow of capital outlays
2. the aggregate flow of finished commodities
3. the aggregate flow of sales.

The second issue is more subtle but also more important. As stressed by Marx in chapters 9, 12, 13, and 14 of the second volume of *Capital* (Marx 1993), the process of production and circulation takes finite amounts of time.

Thus, for instance, a sum of money laid out as capital outlays will only emerge as finished products with a definite time lag; the finished products will be sold after a number of periods; and the sales revenue will be recommitted to production, once again, with some time lag. Thus, each of the three phases of the circuit comes with its own time lag (Marx 1993; Foley 1982).

The existence of time lags has two important implications. First, they establish definite relationships between each of the flows (involved in the three phases of the circuit) over time.

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[1]Strictly speaking, labor-power is a quasi-commodity with some features of a commodity – it has use value and value – but since it is not produced for the purpose of exchange (but rather to keep the worker alive), it is not an ordinary commodity.
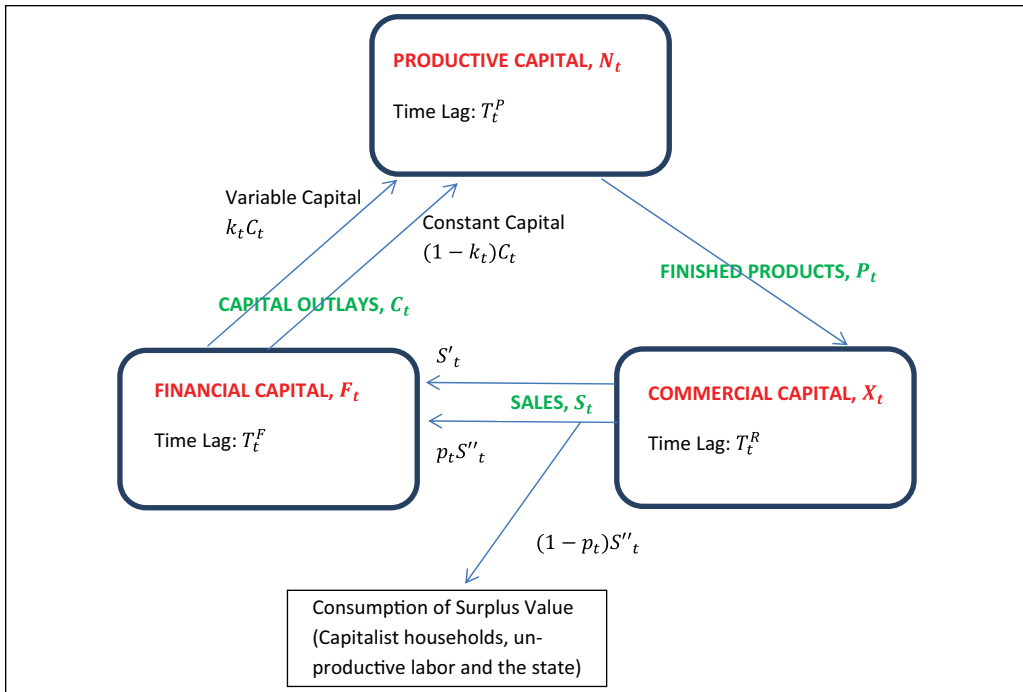
Figure 1. The circuit of capital is a representation of the flows of value and the accumulated stocks of value due to various types of lag involved in the production and circulation of capital.

Second, positive time lags imply that at any point in time, there will be a build-up of stocks of value, in three different forms (corresponding to the three flows), in the economy: productive capital, commercial (or commodity) capital, and financial (or money) capital.

Aggregating across individual capitalist enterprises at any point in time, we can arrive at the corresponding aggregate stocks of value:

1. the aggregate stock of productive capital (labor-power that has been bought but not yet expended, inventories of unfinished products, raw materials, and un-depreciated fixed assets);
2. the aggregate stock of commercial (or commodity) capital (inventories of finished products awaiting sales); and
3. the aggregate stock of financial capital (money and financial assets).

The circuit of capital model can, therefore, be conveniently represented as a circular flow of expanding value with three nodes, each node representing stocks of value in a different form, connected by three flows. Figure 1, adapted from Foley (1986b), is a graphical representation of the circuit. It is important to note that each element of the circuit of capital corresponds to observable quantities in real capitalist economies. While the flows of value in the circuit are recorded in the profit-loss statements of capitalist enterprises, the stocks are recorded in their balance sheets. This implies that a circuit of capital model can be empirically operationalized and used to study tendencies in "actually existing capitalism."

An elegant continuous-time formalization of Marx's analysis of the circuits of capital was developed in Foley (1982, 1986a). This model was empirically operationalized for the U.S. manufacturing sector in Alemi and Foley (1997), and the non-financial business sector in Alemi and

Foley (2010), and has been used recently in dos Santos (2011) to study the impact of consumption credit on economic growth. Matthews (2000) develops an econometric model of the circuit of capital model. A different, but related, strand of the literature emerged from Kotz (1988, 1991), who used a circuit of capital model to analyze crisis tendencies within capitalist economies. Loranger (1989) used the circuit of capital model to offer a new perspective on inflation.

This paper uses a steady-state version of the Marxian circuit of capital model in Foley (1982, 1986a) to address two important theoretical issues of interest to a broad range of heterodox economists: wage-led versus profit-led growth regimes, and the impact of growing consumption credit on economic growth. But before developing these results, it seems worthwhile to reflect on the relative strengths and weaknesses of the Marxian circuit of capital model as a framework for macroeconomic analysis.

There are many advantages of the Marxian circuit of capital model. First, it offers an extremely rigorous and realistic framework to address the knotty issue of time within macroeconomics. While it is recognized that the production and circulation of commodities take finite amounts of time, it has not been easy to incorporate this simple but profound fact in macroeconomics. Both neoclassical and Keynesian economics have opted for the abstraction of short and long runs as a way to deal with the passage of time. The most commonly used conceptual basis of separating the two "runs" is the impact of investment expenditure, what we have called capital outlays, on the economy. Within this framework, the short run is defined by a fixed capital stock, i.e., by a fixed productive capacity. Hence, in this framework, investment expenditure has only a demand-side effect in the short run. When we allow for changes in the capital stock due to investment expenditures, it is only then that we are assumed to be operating in the long run. But this distinction is clearly *ad hoc*. Investment expenditure includes the purchase of equipment and structures by capitalist enterprises and their incorporation into the production process; this increases the productive *capacity* of the economy. Hence, some forms of investment expenditure have, at the same time, both demand- and supply-side effects. The typical neoclassical and Keynesian frameworks do not take this into account. The Marxian circuit of capital model, on the other hand, allows for this fact very naturally.

Second, the Marxian circuit of capital model, as developed by Foley (1982, 1986a), is an accounting framework that carefully works out the relationships between flows and stocks of value. Thus, it is, by construction, a stock-flow consistent model. Since it is an accounting framework, it is potentially consistent with a wide range of behavioral assumptions about the economic agents populating the model. Hence, the Marxian circuit of capital model offers a rich set of choices to researchers in terms of specifying the behavior of key sectors of the capitalist economy and developing and testing empirically meaningful and theoretically sophisticated macro models. This work of extending the existing version of the Marxian circuit of capital model can draw on behavioral economics, computational economics, agent-based simulation, and other such emerging fields.[2]

Third, the Marxian circuit of capital model is firmly anchored in the labor theory of value tradition. Hence, unlike both neoclassical and Keynesian economics, the fact of exploitation of the working class by capitalists is never ignored. Since surplus value, at the aggregate level, is the monetary equivalent of unpaid labor time of the working class, the dynamic of capital accumulation that is modeled by the circuit of capital model always has exploitation at the center of the analytical framework.

The main challenge of using the Marxian circuit of capital approach to macroeconomics is the difficulty of empirically operationalizing the model due to lack of suitable data. Key parameters

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[2]The main body of work in heterodox macroeconomics builds models by specifying behavioral assumptions about different agents in the economy. For instance, different savings behavior is often assumed for workers and capitalists; behavior of capitalist enterprises is modeled to give an investment function, etc. The circuit of capital model does not contradict this stream of heterodox macroeconomics. Rather, it provides a larger stock-flow consistent, value-theoretic framework within which such behavioral assumptions can be fruitfully embedded.
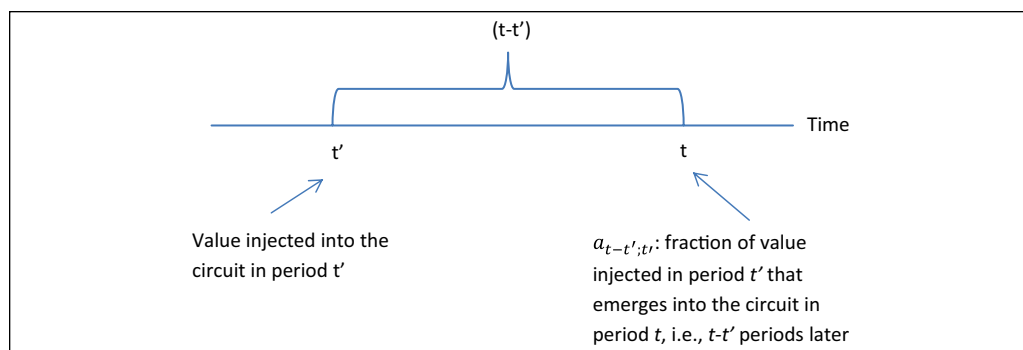
Figure 2. Value emergence function, the fraction of value injected into the circuit in period t' that emerges t-t' periods later back into the circuit.

of the model, such as the production, realization, and finance lags, are not observed and need to be estimated. Innovative approaches to empirical analysis of the Marxian circuit of capital model as developed, for instance, in Alemi and Foley (1997, 2010) and Matthews (2000) need to be extended in several directions. As more researchers come to adopt this framework, it can be hoped that some of these issues will be naturally addressed in the course of time.

The rest of the paper is organized as follows. Section 2 discusses the main conceptual innovation in Foley's (1982) model of the Marxian circuit of capital: the time lags. Section 3 sets up and solves the baseline model (i.e., model without aggregate demand considerations). Section 4 extends the baseline model by explicitly incorporating aggregate demand. Section 5 presents the main results of the paper relating to conditions for wage-led versus profit-led growth and the effects of nonproduction credit on economic growth. Section 6 concludes the discussion.

2. Structure of Time Lags

One of the main conceptual innovations of the circuit of capital model is the time lag structures that attach to each of the three phases of the circuit. To conceptualize the time lag structures rigorously and to develop the rest of the argument in this paper I will work in a discrete-time setting. The main reason to choose a discrete-time set-up over a continuous-time set-up as in Foley (1982, 1986a) is that all economic variables are recorded only at discrete points in time. Since empirical operationalization of the Marxian circuit of capital model will need to work with discrete-time data, it seems analytically suitable to develop the model in a discrete-time set-up from the outset. More importantly, key variables of the circuit are flows, and flow variables in economics can only be meaningfully conceptualized over finite stretches (periods) of time. A discrete-time framework, therefore, seems natural to use rather than a continuous-time framework which might be more suitable in a fluid dynamics setting.

In a discrete-time setting, we can use a value emergence function (VEF) to capture the time lags involved in the different phases of the circuit of capital in the most general fashion. The VEF gives the time structure of emergence of value within the circuit of capital for value that has been injected into the circuit in some past time period; as a mathematical object, a VEF resembles a probability density or mass function depending on whether one considers a continuous- or discrete-time setting. To fix ideas, suppose the process of injection of value occurred in period t'; then the most general form of a VEF would be the function $a_{t-t';t'}$ which represent the fraction of the injected value that emerges back into the circuit ($t-t'$) periods later. The first subscript in the VEF refers to the number of periods that have elapsed since value was injected into the circuit; the second refers to the period when the value was injected into the circuit. A VEF is represented graphically in Figure 2.

Since all the value that was injected in period t' has to eventually emerge back into the circuit, we have

$$\sum_{t=t'}^{\infty} a_{t-t';t'} = 1$$

(2)

Note that I have used the convention that value can also emerge back into the circuit in the period in which it was injected into the circuit; an alternative convention would be to assume that value can emerge only in future periods, in which case the sum in (2) would run from $t = t' + 1$ to $t = \infty$. The substantive results are not affected by which convention is chosen. There are four different ways to operationalize the VEF.

1. Fixed time lead (FTL): This is the simplest VEF, where value emerges after a fixed number of periods all at once.
2. Variable time lead (VTL): In this case I relax the assumption that the time structure of emergence is fixed across periods so that the value emerges, all at once as before, but after a variable number of periods.
3. Finite distributed lead (FDL): In this case I relax the assumption that the value emerges all at once (which, for instance, is clearly relevant to the case of investment in long-lived fixed assets); hence value emerges gradually but over a finite number of future periods.
4. Infinite distributed lead (IDL): This generalizes FDL further by allowing the injected value to emerge gradually over all future periods.[3]

Returning to (2), it is obvious that for FTL, $a_{T;t'} = 1$, and for VTL $a_{T't';t'} = 1$ so that the sum in (2) will have only one term for both characterizations (the only difference being the time dependence of T_t, in the case of VTL). For FDL and IDL, on the other hand, the sum will have a finite and infinite number of terms, respectively.

We can now use the VEF to conceptualize the time lag structures involved in the circuit of capital. Let us start by *looking back*, from the vantage point of period t, and consider value injections (capital outlays, say) t' periods ago. Let us denote this value injection into the circuit in period $(t-t')$ by $C_{t-t'}$. Now consider the VEF for period $(t-t')$, $a_{t';t-t'}$ where we are interested in the fraction of value emerging back into the circuit t' periods later. Since $a_{t';t-t'}$ gives the fraction of value committed in period $(t-t')$ that emerges back into the circuit t' periods later, i.e., in period t, the product of the two, $a_{t';t-t'} \times C_{t-t'}$ represents the quantum of value emerging in period t due to value committed in period $(t-t')$. In the most general case, i.e., using an IDL type of VEF, the flow of value emerging in period t will be the result of values injected into the circuit in *all* past periods (because value emerges, with an IDL type of VEF, over an infinite number of periods). The relationship between value emerging in period t and value injected into the circuit in period $(t-t')$ mediated through the VEF is represented in Figure 3.

To see this through an example let P_t and C_t denote the flow of finished products and capital outlays, respectively, in period t; then, for the most general case of VEF, we have

$$P_t = \sum_{t'=0}^{\infty} a_{t';t-t'} \times C_{t-t'}$$

(3)

While this provides a very general framework to conceptualize the lag processes involved in any circuit of capital, in this paper I will only work with a FTL, which involves an all-at-once value emergence. Thus *time lags will be assumed to be invariant across time*. This will simplify the exposition considerably without reducing the analytical content of the main results.

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[3]Foley (1982, 1986a) uses a continuous time analog of the IDL-type of VEF.
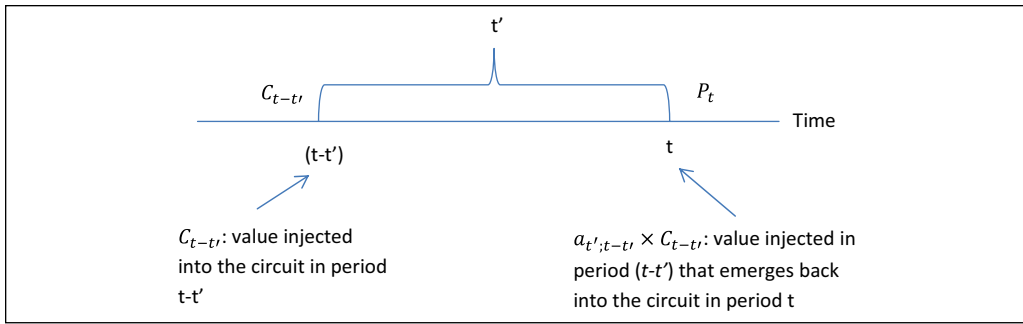
Figure 3. Value emerging into the circuit in period t (P_t) and its relationship to value injections in period t-t′ ($C_{t-t'}$) and the value emergence function in period t-t′ ($a_{t';t-t'}$).

3. The Model without Aggregate Demand

3.1. Basic set-up

The circuit of capital model, as represented graphically in Figure 1, involves the relationships between three flow variables, three stock variables, and five parameters. The three flow variables are: C_t, the flow of capital outlays; P_t, the flow of finished products; and S_t, the flow of sales. The three stock variables are: N_t, the stock of productive capital; X_t, the stock of commercial (or commodity) capital; and F_t, the stock of financial capital. The five parameters are: p_t, the proportion of surplus value recommitted to production; q_t, the mark-up over costs; and T^P, T^R, and T^F, the production, realization, and finance lags, respectively.[4]

On a steady state growth path, all the flow and stock variables of the circuit of capital model grow at the same rate, g, and the parameters are constant over time. Thus, on a steady state growth path

$$p_t = p, q_t = q \tag{4}$$

A "period," in this model, is a span of calendar time, for instance a month or a quarter.[5] The production lag, T^P, is the number of periods that is required, on average, for an atom of value contained in capital outlays to emerge as a finished product; the realization lag, T^R, is the number of periods, on average, required for value in the form of finished products to become sales flow; and, the finance lag, T^F, is the number of periods, again on average, that is required for value in the form of sales flows to become fresh capital outlays.[6]

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[4]Note that the time lags do not have time subscripts. This is because, in this paper, I have assumed the VEF to be a FTL. This makes the time lags invariant across time.

[5]It is a matter of convention as to what span of time is used to define a period. Since profit rates are usually defined annually, one can choose to define a period as a year.

[6]Here, I will rapidly go over the basic concepts related to the circuit of capital; for a more detailed exposition, see Foley (1986b). Note, in passing, that I have followed Foley (1986b) in defining the time lags. This manner of defining time lags is close to the analysis in volume II of *Capital*, especially chapter 9; but it is slightly different from the presentation in chapter 15, volume II, and chapter 9, volume III of *Capital*. In the former, the turnover time is determined by both fixed and circulating capital; for instance, refer to the example from the American economist Scrope that Marx quotes (page 265, Volume II). In the latter presentations, fixed capital is excluded from consideration and Marx works with a pure circulating capital model. I have adopted the analysis of chapter 9, volume II because it is more general and encompasses the other presentations of the subject as a special case.

The existence of a production lag of T^P periods means that the flow of finished products in any period is equal to the flow of capital outlays T^P period ago:

$$P_t = C_{t-T^P} \tag{5}$$

In a similar manner, the presence of the realization lag implies that the flow of sales in any period is equal to the flow of finished products T^R periods ago:

$$S_t = (1+q)P_{t-T^R} \tag{6}$$

where q is the mark-up over cost arising from the exploitation of labor by capital.[7] The mark-up over cost is, in turn, defined as the product of the rate of exploitation, e, and the share of capital outlays devoted to variable capital, k: $q = e \times k$ (for details see chapter 2, Foley 1986b).

It is useful to break up the flow of sales into two parts $S_t = \left(1+q\right)P_{t-T^R} = S'_t + S''_t = \dfrac{S_t}{1+q} + \dfrac{q \times S_t}{1+q}$

where S'_t is the flow of sales corresponding to the recovery of capital outlays, and S'_t is the part of sales flow that corresponds to the realization of surplus value.

Capital outlays, in turn, are financed by the flow of past sales but only with a time lag, the finance lag, T^F; hence,

$$C_t = S'_{t-T^F} + pS''_{t-T^F} \tag{7}$$

where T^F is the finance lag (the number of periods that is required for realized sales flows to be recommitted to production), and p is the fraction of surplus value that is recommitted to production, the rest being consumed by capitalist households, unproductive labor households, and the state.

Positive production, realization, and finance lags imply that there will be build-up of stocks of value at any point in time.[8] If N_t denotes the stock of productive capital in period t, then the accumulation (or decumulation) of the stock of productive capital will be given by

$$\Delta N_{t+1} \equiv N_{t+1} - N_t = C_t - P_t \tag{8}$$

Similarly, letting X_t denote the stock of commercial capital, we will have

$$\Delta X_{t+1} \equiv X_{t+1} - X_t = P_t - \left\{ \frac{S_t}{1+q} \right\} = P_t - S'_t \tag{9}$$

If F_t denotes the stock of financial capital in period t, then

$$\Delta F_{t+1} \equiv F_{t+1} - F_t = S'_t + pS''_t - C_t \tag{10}$$

The basic circuit of capital model is defined by the six equations, (5) through (10), with $q, p,$ and the three lags T^P, T^R, T^F being the parameters governing the behavior of the system.

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[7]Surplus value is generated in production and realized through circulation. Thus, we could count the surplus value in the flow of finished commodities or in the flow of sales. In this paper, I have adopted the convention, following Foley (1982), of valuing the flow of finished commodities (and the inventories of finished goods awaiting sale) *at cost*; hence, I account for the surplus value in the flow of sales, S_t.

[8]In this paper, I follow the following dating convention: stocks are dated at the beginning of the period and flows occur throughout the period.

3.2. Baseline solution: Expanded reproduction

What determines the rate of profit? How fast does this system expand? Is the rate of expansion related to the exploitation of labor and the periodicity of the flow of value? These questions were analyzed by Marx in part two of volume II of *Capital* and are presented here as

> **Proposition 1.** *On a steady state growth path with time-invariant parameters, the circuit of capital represented by (5) through (10), grows at the rate g given by*

$$g = \frac{pq}{T^P + T^R + T^F}$$

and the aggregate rate of profit is given by

$$r = \frac{q}{T^P + T^R + T^F}$$

so that the Cambridge equation holds true: g = pr.[9]

An immediate corollary is that the system does not grow when all the surplus value is consumed (i.e., when the system is undergoing simple reproduction). According to the notation of the model, simple reproduction requires that $p = 0$. But, if $p = 0$, this implies, by the expression for the growth rate, that $g = 0$.

Proposition 1 is crucial for the Marxian understanding of capitalism because it provides an intuitive explanation of the rate of profit in capitalism, arguably the most important variable governing the dynamics of a capitalist system. The result shows clearly that the rate of profit rests on two factors, the rate at which surplus value is extracted from labor (captured by q), and the speed with which each atom of value traverses the circuit of capital (captured by what Marx termed the turnover time of capital, $(T^P + T^R + T^F)$. Social relations of production and class struggle impact q through the rate of exploitation, e; technological factors relating to production impact both q (through the proportion of capital outlays devoted to variable capital, k) and the production time lag T^P, and technological factors relating to circulation impact the time lags, T^R and T^F. Thus, this formulation makes it clear that the rate of expansion of the system is directly impacted by the rate of profit, and the rate of profit, in turn, is affected by both social and technological factors.

How does the rate of expansion of the system respond to changes in the distribution of aggregate income? Is the system a wage-led or profit-led growth regime? It can be seen that the baseline Marxian circuit of capital model (without aggregate demand) is a pure profit-led regime. This can be immediately seen from Proposition 1:

$$\frac{\partial g}{\partial q} = \frac{p}{T^P + T^R + T^F} \geq 0$$

Hence, a shift in the income distribution towards the capitalist class increases the growth rate of the system in the baseline model.[10] Though there is some evidence that advanced capitalist

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[9]Proofs of all results in this paper are available from the author upon request. They have been excluded from the paper to save space. For an introduction to the Cambridge equation, which plays an important role in modern growth theory, see Foley and Michl (1999).

[10]An increase in the mark-up, q, is a way to capture the shift of income towards the capitalist class. Recall that $q=ek$, where e is the rate of exploitation, and k is the share of capital outlays that is devoted to the purchase of labor power. If k remains constant, q and e move together, making the former a good proxy for income distribution.

economies have profit-led growth regimes (Barbosa-Filho and Taylor 2006), it seems analytically unsatisfactory to rule out wage-led growth; it seems intuitive that growth-impacts of income distribution in capitalist economies should parametrically allow for both wage-led and profit-led growth regimes (Bhaduri and Marglin 1990; Bowles and Boyer 1995; Foley and Michl 1999; Taylor 2006). We will see in a later section, and this is one of the main results of this paper, that this is indeed the case: as soon as we incorporate aggregate demand in the circuit of capital model, we recover the possibility of both wage-led and profit-led growth.

4. The Model with Aggregate Demand

The results in Proposition 1 were derived under the admittedly unrealistic assumption that an adequate amount of aggregate demand was forthcoming in each period to realize all the value contained in the commodities offered for sale.[11] This is unrealistic because, under capitalism, there is no automatic mechanism to ensure that aggregate demand (arising from all expenditures in the economy) will equal aggregate supply (the total value contained in the commodities offered for sale). To explore the issue we need to explicitly account for the sources of demand.

4.1. The realization problem

In a capitalist economy closed to trade and *without the mechanism of credit* available to workers and capitalists, there are three sources of aggregate demand, all deriving ultimately from expenditures of capitalist enterprises: (a) the part of capital outlays that finances the purchase of the non-labor inputs to production (raw materials and long-lived fixed assets), (b) the consumption expenditure by worker households out of wage income, and (c) the consumption expenditure of capitalist households, unproductive labor households, and the state out of surplus value. Thus, if D_t denotes aggregate demand in period t, then

$$D_t = (1-k)C_t + E_t^W + E_t^S \tag{11}$$

where E_t^w denotes consumption expenditure out of wages, E_t^s denotes consumption expenditure out of surplus value, and C_t denotes capital outlays (as before).

Just like the re-committal of surplus value designated to production occurs with a time lag, the finance lag (T^F), consumption expenditure out of wages, and surplus value will also occur with a time lag. If T^w denotes the time lag of expenditure out of wages, then

$$E_t^W = kC_{t-T^W}$$

similarly, if T^S denotes the time lag of expenditure out of surplus value, then

$$E_t^S = (1-p)S_{t-T^S}^{''}$$

The three spending lags, $T^F, T^W, T^S,$ are crucial variables of the system. When the system is out of steady state, an increase in any of the spending lags implies that the amount of aggregate demand is falling relative to supply so that the ability of capitalist enterprises to sell finished

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[11]In this paper I will abstract from changes in the value of money.

products declines; when these fall, the opposite is implied. Thus, these spending lags can be understood as parameters capturing the state of aggregate demand in the system (Foley 1986a: 24).[12]

After incorporating the spending lags, the expression for aggregate demand becomes

$$D_t = (1-k)C_t + kC_{t-T^W} + (1-p)S''_{t-T^S} \tag{12}$$

Hence, normalizing by the capital outlay in the initial period, C_0, on a steady-state path with growth rate g we have

$$D_0 = (1-k) + \frac{k}{(1+g)^{T^W}} + \frac{(1-p)S''_0}{(1+g)^{T^S}} < \frac{1+q}{(1+g)^{T^P+T^R}} = S_0 \tag{13}$$

where the strict inequality holds when g, T^F, T^W, T^S are all strictly positive. This classic result about realization problems in capitalist economies, proved in Foley (1982) in a continuous-time setting and in a different, but related, framework in Kotz (1988), is summarized here as

> **Proposition 2.** *In a capitalist economy where all capital outlays are financed from past sales revenue and there is no consumption credit in the economy, there will always be insufficient aggregate demand relative to the flow of sales on any steady-state growth path with a positive growth rate unless the three spending lags, T^F, T^W, T^S, are identically equal to zero.*

Since the spending lags cannot all be identically equal to zero, growing capitalist economies without the mechanism of credit will be perpetually plagued with the problem of insufficient aggregate demand.[13] While this crucial insight about capitalist economies is usually attributed to Keynes (1936), it is interesting to note that Marx anticipated more or less the same result half a century ago.

A possible misinterpretation of this result would assert that there is really no realization problem. What this result shows, the argument would go, is that there will obtain a fixed ratio of inventories to production on a steady-state growth path. Such an interpretation would miss the crucial point that there is no way for the system, as set out in this section, to bring the ratio of inventories and production to the "desired" ratio of capitalist firms. The fact that firms are stuck with a given ratio is precisely the realization problem.

It is intuitively clear that there are two ways to "solve" the realization problem. In a commodity money system, the production of the correct amount of gold (the money commodity) can cover the deficiency in aggregate demand (because the money commodity does not need to be sold to realize the value contained in it). In a non-commodity money system, new borrowing by households and capitalist enterprises can bridge the gap between aggregate supply and demand. Since, unlike Marx's times, we no longer operate in a commodity money system, we will only deal with the case of new borrowing.

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[12]On the other hand, aggregate demand problems will be reflected in the lengthening of realization and finance lags. For instance, it seems intuitive that when aggregate demand is weak and enterprises are unable to sell their products, the level of inventories will rise; this implies that the realization lag will increase. This will have at least two effects. First, faced with larger inventories of finished goods firms will slow down production, thereby increasing the production lag. Second, fresh capital outlays will be deferred, thereby increasing the finance lag. In this paper, I abstract from such feedback effects of aggregate demand. Investigating these, and other, determinants of the lags will be taken up in future research. Note also that I do not deal with out-of-steady-state behavior in this paper.

[13]A capitalist economy undergoing simple reproduction, where the rate of growth is zero, will not face aggregate demand problems even when the lags are positive.

4.2. Solution to the realization problem with exogenous credit

To allow for positive amounts of *net credit* in the system in each period, let B_t denote the new borrowing by capitalists to finance capital outlays, i.e., production credit, so that

$$C_t = S'_{t-T^F} + pS'_{t-T^F} + B_t \tag{14}$$

On simplification, and normalizing by capital outlays in period 0, this gives,

$$1 = B_0 + \frac{(1+pq)S_0}{(1+q)(1+g)^{T^F}} \tag{15}$$

where B_0 is the amount of production credit in the initial period as a proportion of capital outlays in the initial period; we will assume that $0 \le B_0 < 1$, where the strict inequality ensures that production credit is never larger than capital outlays.[14]

Similarly, let B_t' denote new borrowing by households (worker, or capitalist) or the state to finance consumption expenditure, i.e., consumption credit, so that aggregate demand becomes

$$D_t = (1-k)C_t + kC_{t-T^W} + (1-p)S''_{t-T^S} + B_t' \tag{16}$$

Normalizing by capital outlays in period 0 and simplifying, we have

$$D_0 = \frac{1 - k\left\{1 - \dfrac{1}{(1+g)^{T^W}}\right\} + B_0'}{1 - \left\{\dfrac{q(1-p)}{\left[(1+q)(1+g)^{T^S}\right]}\right\}}$$

where B_0' denotes the amount of consumption credit in the initial period normalized by capital outlays. If, on a steady-state growth path, the realization problem is to be solved every period by new borrowing, i.e., if new borrowing is to cover the gap between sales and production, we must have

$$S_t = D_t, \; i.e., \; S_0 = D_0$$

Since credit is exogenous, implicit changes in the realization lag (which is now endogenous) ensures the balance of demand and supply (sales). On simplification the equality of demand and supply gives us the "characteristic equation" of the system with positive net credit as

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[14]In this paper I am analyzing the impact of *exogenous* credit on the steady-state growth paths of the system. Two issues that will be taken up in future research are: (a) to endogenize credit, and (b) to keep track of the balance-sheet impacts of credit, i.e., keeping track of the stock of debt and the flow of debt-servicing.

$$1 = B_0 + \frac{1+pq}{(1+g)^{T^F}} \times \frac{1 - k\left\{1 - \dfrac{1}{(1+g)^{T^W}}\right\} + B_0'}{1 - \left\{\dfrac{q(1-p)}{(1+q)(1+g)^{T^S}}\right\}}$$

(17)

Re-arranging the characteristic equation, we see that the value of the steady-state growth rate, *g**, solves

$$H\left(g; p,q,k,T^W,T^S,T^F,B_0,B_0'\right) \equiv G\left(g; p,q,k,T^W,B_0,B_0'\right) - F\left(g; p,q,T^S,T^F\right) = 0$$

(18)

where

$$F\left(g; p,q,T^S,T^F\right) = (1+g)^{T^F}(1+q) - \frac{q(1-p)}{(1+g)^{T^S-T^F}}$$

(19)

and

$$G\left(g; p,q,k,T^W,B_0,B_0'\right) = (1+q)\frac{1+pq}{1-B_0} \times \left\{1 - k\left(1 - \frac{1}{(1+g)^{T^W}}\right) + B_0'\right\}$$

(20)

It is obvious that (18) defines the steady-state growth rate as an implicit function of the parameters of the system. Hence, we can use the implicit function theorem (IFT) to work out the effects of changes in the parameters on the steady-state growth rate, i.e., comparative dynamic results.

The solution to (18), (19), and (20) can also be represented graphically as Figure 4, where the intersection of the two curves gives the steady-state growth rate, *g**, and changes in the parameters shift the curves to produce new steady-state growth rates.[15]

Graphical representation of the steady-state solution by Figure 4 immediately allows us to derive some interesting results about comparative steady-state growth paths; these results are summarized as

Proposition 3. *Let g* represent the unique, non-negative solution of (18). The following comparative dynamics results hold true*:

1. *If B_0 (new borrowing to finance capital outlays) increases* ceteris paribus *then the steady-state growth rate of the system, g*, increases.*

2. *If B_0 (new borrowing to finance consumption expenditures) increases* ceteris paribus *then the steady-state growth rate of the system, g*, increases.*

3. *If either of the spending lags, T^W, T^S, T^F, increase* ceteris paribus *then the steady-state growth rate of the system, g*, falls.*

These comparative dynamics results can be re-stated more concretely with reference to two imaginary capitalist economies. First, between two identical capitalist economies, the one with

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[15]The F and G curves in Figure 4 are mathematical objects that make the analysis of steady-state growth paths easy to understand. As far as I can see, the curves do not have any deeper economic meaning.

$$G(0) = \frac{(1+pq)(1+B_0')}{1-B_0}$$

$F(g; p, q, T^S, T^F)$

$G(g; p, q, k, T^W, B_0, B_0')$

$F(0) = 1 + pq$

g^*

g
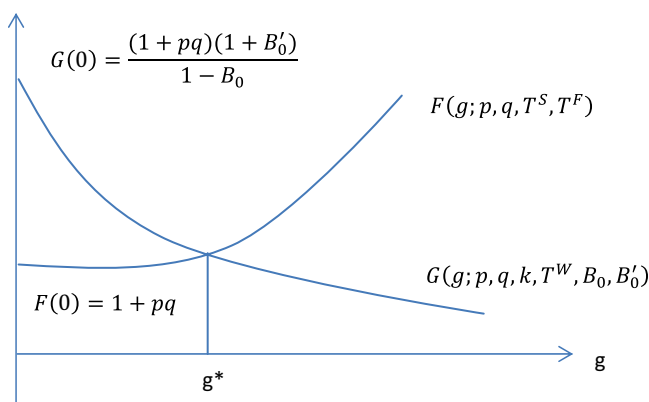
Figure 4. Steady-state growth rate of the system with credit.

higher amounts of credit will be on a higher steady-state growth path; this is simply because net credit solves the problem of insufficient aggregate demand by reducing the realization lag.

Second, the economy with lower time lags will have a higher rate of profit and expansion. This is because a lower time lag allows each atom of value to traverse the circuit relatively quickly and thereby self-valorize itself in a shorter time period. Hence, the system grows faster per unit of time.

5. Main Results

The discrete-time Marxian circuit of capital that has been developed in the previous sections will be used in this section to address two important issues of interest to a broad range of heterodox economists: (a) growth impacts of changes in the class distribution of income, and (b) growth impacts of non-production credit.

5.1. Wage-led versus profit-led growth regimes

Analyzing the impact of changes in the distribution of income between social classes on the rate of growth of the capitalist system has been one of the critical features that distinguish the heterodox tradition in macroeconomics from the mainstream, neoclassical, one (Foley and Taylor 2006). The basic heterodox idea that distinguishes it from the neoclassical tradition is to see wage income as playing a dual role in capitalist economies. One the one hand it appears as a cost to capitalist enterprises and impacts the rate of profit, investment decisions, and thereby aggregate demand (profit effect); on the other hand, it furnishes the revenue to finance consumption expenditures by worker households, thereby functioning as a crucial component of aggregate demand (wage effect). Hence, a shift of income towards the worker class has an ambiguous effect on the overall expansion of the system, depending on whether the wage effect is stronger than the profit effect.[16]

In the Marxian circuit of capital model, this issue can be addressed by analyzing the effect of changes in the mark-up over costs, q, which can be understood as a proxy for the share of total

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[16]There is a huge, and growing, body of literature devoted to the issue of wage-led versus profit-led growth regimes; see Bhaduri and Marglin (1990), Bowles and Boyer (1995), Foley and Michl (1999: chapter 9), Taylor (2006), Bhaduri (2008), and the references therein for a relatively comprehensive list of contributions to this emerging area of research. The list of references contained in this paper is neither exhaustive nor comprehensive.

income accruing to the non-working class. Since the mark-up is given by $q=ek$, an increase in the rate of exploitation e increases q and captures the shift in income away from productive workers, *assuming that the proportion of capital outlays devoted to variable capital, k, remains unchanged.* Increases in q, therefore, can capture the increasing share of income appropriated by the capitalist class. How does this impact the growth rate of the system? Note that if the growth rate and q are positively related, the system is a profit-led growth regime because a shift in income away from workers (as a result of the increase in q) leads to higher growth of the system; if, on the other hand, the growth rate and q are negatively related, then the system is a wage-led growth regime.[17] We have already seen in section 3.2 that the baseline Marxian circuit of capital model (without taking account explicitly of aggregate demand) is a pure profit-led growth regime. This result changes as soon as we bring aggregate demand into the picture.

To see this we can use the IFT on (18) to find the impact of changes in q on the steady-state growth rate of the system. Let x denote the vector of parameters, i.e., $x = (p, q, k, T^W, T^S, T^F, B_0, B_0')$; then the IFT shows that the growth rate is a C^1 function of the parameters, i.e., $g = g(p, q, k, T^W, T^S, T^F, B_0, B_0')$. Let g^* denote the steady-state growth rate of the system; then, using the IFT on (18) we have

Proposition 4. *Suppose g^* denotes the steady-state growth rate of the circuit of capital model represented by (18), (19), and (20). If the finance lag is large enough, then the system is a wage-led growth regime, and if the finance lag is small enough, then the system is a profit-led growth regime, i.e.,*

$$T^F \geq T^* \Rightarrow \frac{\partial g}{\partial q}(x) < 0, and\ T^F < T^* \Rightarrow \frac{\partial g}{\partial q}(x) > 0$$

where the threshold for the finance lag is given by

$$T^* = \frac{1}{\ln\left(1+g^*\right)}\left\{\ln(\alpha) + \ln(1+2pq+p) - \ln\left(1 - \frac{1-p}{\left(1+g^*\right)^{T^S}}\right)\right\}$$

where

$$\alpha = \frac{k' + B_0'}{1 - B_0}, and\ k' = 1 - k\left[1 - \frac{1}{\left(1+g^*\right)^{T^W}}\right]$$

This proposition has at least two important implications. First, it demonstrates that the Marxian circuit of capital model is not a pure profit-led growth regime once aggregate demand has been explicitly modeled within the system. Since volume II of *Capital* deals explicitly with issues of aggregate demand and its relation to problems of realization, the common Keynesian assertion that Marxian economics lacks a proper appreciation of aggregate demand factors in the growth

[17]In this paper I treat the mark-up over costs, q, as a parameter. Hence, I abstract from the possible effects of aggregate demand on q. Since I am interested in comparing steady-state growth paths for different *given values* of q, this is not problematic. Analysis of the short-run behavior of the circuit of capital model would need to explicitly treat the cyclical fluctuations of q at business cycle frequencies part of which is driven by demand fluctuations.

process is erroneous.[18] By demonstrating that the Marxian circuit of capital model allows for a wage-led growth regime, Proposition 4 reinforces the Marxian case.

Second, it delivers the fairly intuitive result that the size of the finance lag, T^F, determines whether the system is profit-led or wage-led as far as growth is concerned. If, to start with, the finance lag is large, i.e., above a threshold value, then a shift of income away from wages would be tantamount to shifting income towards economic agents who wait for a relatively long period before converting realized sales revenues into new capital outlays. Hence, the level of aggregate demand would fall and the speed with which value traverses the circuit would go down. This would lead to a fall in the rate of profit and the steady-state growth rate of the system. If, on the other hand, the finance lag is relatively small the opposite happens: the rate of profit and the rate of growth increases when income is shifted away from workers and towards capitalists.

It is interesting to investigate the manner in which the parameters of the model, the flow of credit, and the spending lags of worker and non-worker households, impact the threshold, T^*. When the flow of credit, of either kind, increases the threshold becomes larger (i.e., shifts to the right). This is because a higher quantity of credit alleviates aggregate demand problems and can, therefore, support a relatively higher finance lag while still allowing for a profit-led growth regime. These results can be easily checked by computing the partial derivative of T^* with respect to relevant parameters.[19]

When the (consumption) spending lag of working class households increases the threshold, T^*, becomes larger. This is because with a larger spending lag out of wage income, the economy can support a relatively higher finance lag while still allowing for a profit-led growth regime. When income is redistributed to wage earners, the effect on growth is muted because the spending lag out of wage income has become larger. Since consumption spending out of wage and profit income play identical roles in the circuit of capital model, viz. to function as sources of aggregate demand, an increase in the (consumption) spending lag for non-worker households has the same effect: the threshold increases. Both these results can be checked by computing partial derivatives of T^* with respect to T^W and T^S respectively.

5.2. Growth impacts of rising consumption credit

The consolidation of the neoliberal regime in the United States and elsewhere, since the early 1980s, went hand in hand with the growing dominance of finance over the economy.[20] One peculiar form of this dominance has been the explosion of debt levels, relative to aggregate income flows, in these advanced capitalist countries. A large part of the new borrowing has been incurred by working-class households (a component of consumption credit), as opposed to capitalist enterprises (production credit). Though the growth-reducing impact of financialization has been recently analyzed (Onaran, et al. 2011), very few studies have been devoted to understanding the impact of consumption credit on growth, in the overall context of increasing net credit.

An exception is dos Santos (2011), which has used a continuous-time Marxian circuit of capital model to demonstrate that the "maximal" rate of growth of a capitalist economy is negatively impacted by the growth of consumption credit.[21] This paper strengthens the result in dos Santos

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[18]For a recent statement of such a view in a different modeling context regarding the role of aggregate demand factors in classical-Marxian models of economic growth see Dutt (2011).

[19]The only thing to keep in mind while computing these partial derivatives is that the steady-state growth rate, g^*, is itself a function of the spending lags. Ignoring this might give incorrect signs of the partial derivatives.

[20]For analyses of neoliberalism, see, among others, Duménil and Lévy (2004, 2011), Harvey (2005), and Kotz (2009).

[21]Recall that the maximal growth rate of the system is the rate at which it grows when the realization lag is zero. Since the realization lag is bounded below by zero, the maximal rate of growth defines the upper bound of the rate of expansion of the system; it is the internally generated limit to how fast the system can expand.

(2011) further in two ways. First, I demonstrate that the growth-reducing impact of consumption credit, holding the total net credit constant, affects the actual growth rate too. This is important because the corresponding result about maximal growth rates does not imply the same about actual growth rates: an economy might have a lower maximal rate of growth compared to another at the same time as having a higher actual rate of growth. Second, I relax the assumption that total net credit is constant. Thus, even in the overall context of increasing net credit, I demonstrate that after a threshold is crossed, the negative growth impact of consumption credit kicks in, overcoming the positive growth impact of the increase of total net credit. The second point is important because, under neoliberalism, both total credit and the share of consumption credit have increased.

To see these results formally let us re-write the quantity of new consumption credit in the initial period as

$$B_0' = \lambda Z_0$$

and the quantity of production credit as

$$B_0 = (1 - \lambda)Z_0$$

where Z_0 is the total amount of new borrowing in the economy in the initial period normalized by capital outlays in the initial period, and $0 < \lambda < 1$ is the share of consumption credit in the total amount of new borrowing. To analyze the impact of changes in the share of consumption credit, we need to re-write (18) using λ and Z_0 in place of B_0' and B_0:

$$H\left(g; p, q, k, T^W, T^S, T^F, Z_0, \lambda\right) = G\left(g; p, q, k, T^W, Z_0, \lambda\right) - F\left(g; p, q, T^S, T^F\right) = 0 \qquad (22)$$

The F-curve does not depend on the quantity of new borrowing; hence it remains the same as before

$$F\left(g; p, q, T^S, T^F\right) = \left(1 + g\right)^{T^F}\left(1 + q\right) - \frac{q(1 - p)}{\left(1 + g\right)^{T^S - T^F}} \qquad (23)$$

but the G-curve changes to

$$G\left(g; p, q, k, T^W, Z_0, \lambda\right) = (1 + q)\frac{1 + pq}{1 - (1 - \lambda)Z_0} \times \left\{1 - k\left(1 - \frac{1}{\left(1 + g\right)^{T^W}}\right) + \lambda Z_0\right\} \qquad (24)$$

The IFT shows that around the equilibrium point, the growth rate can be viewed as a C^1 function of the parameters, i.e.,

$$g = g(p, q, k, T^W, T^S, T^F, Z_0, \lambda)$$

We are interested, first, in investigating the impact of an increase in the share of consumption credit (λ) holding total net credit (Z_0) constant on the steady-state growth rate, and second, in finding the effect on the growth rate of a positive change in *both* Z_0 and λ.

Using the IFT on (22), we get

Proposition 5. *Let Z_0 denote the level of total flow of net credit in the economy in period 0, and λ denote the share of consumption credit, with $(1-\lambda)$ denoting the share of production credit. If*

$$k\left[1-\frac{1}{\left(1+g\right)^{T^W}}\right]=Z^* < Z_0 < 0$$

then,

$$\frac{\partial g}{\partial \lambda}(x) < 0$$

Hence, under the condition that total net credit is above the threshold, Z^*, given in Proposition 5, the impact of increasing the share of consumption credit, with total net credit constant, on the steady-state growth rate is negative. Note that the partial derivative of the threshold, Z^*, with respect to the spending lag out of wage income, T^W, is positive.

Next we would like to study the joint impact of increasing credit and a growing share of consumption credit on the steady-state growth rate. Assuming that other parameters of the circuit of capital model do not change, the total derivative of the growth rate, around the equilibrium point, is given by

$$dg = \frac{\partial g}{\partial Z_0} \times dZ_0 + \frac{\partial g}{\partial \lambda} \times d\lambda$$

If we wish to study the impact of unit positive changes in total credit, Z_0, and the share of consumption credit, λ, i.e., $dZ_0 = d\lambda = 1$, then the total derivative of the growth rate becomes

$$dg = \frac{\partial g}{\partial Z_0} + \frac{\partial g}{\partial \lambda}$$

Using the IFT on (22), we have

$$\frac{\partial g}{\partial Z_0}(x) = \frac{\dfrac{\partial H}{\partial Z_0}\left(g^*;x\right)}{\left[-\dfrac{\partial H}{\partial g}\left(g^*;x\right)\right]}, \text{ and } \quad \frac{\partial g}{\partial \lambda}(x) = \frac{\dfrac{\partial H}{\partial \lambda}\left(g^*;x\right)}{\left[-\dfrac{\partial H}{\partial g}\left(g^*;x\right)\right]}$$

Manipulating these expressions gives

Proposition 6. *Let Z_0 denote the level of total flow of net credit in the economy in period 0, and λ denote the share of consumption credit, with $(1-\lambda)$ denoting the share of production credit. If*

$$0 > Z_0 > Z_1^* = \frac{k\left[1-\dfrac{1}{\left(1+g\right)^{T^W}}\right]+\sqrt{D}}{2}$$

where

$$D = k^2 \left[1 - \frac{1}{(1+g)^{T^W}} \right]^2 + 4\lambda + 4(1-\lambda)k \left(1 - k \left[1 - \frac{1}{(1+g)^{T^W}} \right] \right)$$

then

$$dg = \frac{\partial g}{\partial Z_0} + \frac{\partial g}{\partial \lambda} < 0$$

What does this result imply? If we compare two identical capitalist economies (having the same amounts of total net credit), one with a higher share of consumption credit than the other, then Proposition 5 shows that the economy with a higher share of consumption credit can be expected to be on a lower steady-state growth path than the other economy if the total net credit is larger than some threshold value to begin with. Proposition 6 strengthens the result further: if we compare two identical capitalist economies, one with a higher total net credit *and* a higher share of consumption credit than the other, then the economy with higher net credit and higher share of consumption credit can be expected to be on a lower steady-state growth path than the other economy if the total net credit is larger than some threshold value to begin with.

There are two contradictory effects in play in the result of Proposition 6. Increase in total net credit has a positive impact on growth, as we have already seen in Proposition 3; on the other hand, according to Proposition 5, an increase in the share of consumption credit has a negative impact on growth. To understand the logic of the second part, it is important to distinguish between consumption and production credit. By definition, only production credit finances capital outlays. Hence, it is only production credit that creates the flow of value for the creation of more surplus value. Hence, only production credit has the capacity to increase the size of value flowing through the circuit, and thereby expand the size of the system. But both kinds of credit, consumption credit in particular, solve the realization problem by reducing the realization lag; but consumption credit cannot increase the size of the system by facilitating the generation of more surplus value (which production credit does). When the total net credit in the system is large (i.e., above the threshold value identified in Proposition 6), there is not much room to reduce the realization lag further; hence, a higher share of consumption credit will reduce the growth rate of the system, outweighing the positive impact of a further increase in total credit.

Note that the value of the thresholds in propositions 5 and 6, Z^* and Z_1^* respectively, are both increasing functions of the spending lag out of wage income, T^W. This is exactly what one would expect. If the spending lag out of wage income is large, there is relatively more room for alleviating aggregate demand problems by increasing the flow of net credit (because spending out of net credit occurs in the same period in which it is created, i.e., without any lags). Hence, a larger flow of net credit is needed to take the economy to the threshold beyond which the positive effect of net credit is swamped by the negative impact of an increase of consumption credit.[22]

7. Conclusion

Marx's analysis of the circuits of capital in volume II of *Capital* offers a unique framework for macroeconomic analysis of capitalist economies. This paper uses a discrete-time version of the

[22]Note that propositions 5 and 6 deal with situations where the flow of net credit is *positive*. Hence, these propositions are not relevant for studying the phenomenon of deleveraging. To study the latter phenomenon, we can return to Figure 4. Since deleveraging by households and firms is equivalent to a flow of *negative* net credit to these entities, we would have $B<0$, $B'<0$. From Figure 4 it is clear that a flow of negative net credit will reduce the steady-state growth rate of the system.

Marxian circuit of capital model in Foley (1986b) to address two theoretical results of interest to a wide variety of heterodox economists.

First, it is demonstrated that the Marxian circuit of capital model allows for both wage-led and profit-led growth regimes, a topic of lively research among heterodox macroeconomists. The crucial parameter of the system that determines whether the growth regime for a capitalist economy will be wage-led versus profit-led is the length of the finance lag (the period of time that elapses between realization of value, and surplus-value, through sales and its recommittal into production). When the finance lag is large, the economy is more likely to be wage-led; when the finance lag is small, the economy is more likely to be a profit-led growth regime.

Second, it is demonstrated that non-production credit has a negative impact on the rate of growth of the system when the total net credit is high to start with. Between two identical capitalist economies, the one with a higher proportion of non-production credit in total net credit will have a lower steady-state growth rate when the total net credit is higher than a certain threshold value.

Both these results could be brought together to offer a novel explanation of the slowdown of the U.S. economy in the neoliberal era since the mid-1970s: growing financialization might have increased the finance lag and pushed the economy towards a wage-led growth regime; redistribution of income away from workers, then, could have led to a fall in growth. The slowdown could have been further reinforced by an increase in the share of nonproduction credit, and partly offset by the positive growth impact of the increase in net credit. This explanation, along with its policy implications, needs to be explored in greater detail and with more rigor in future research.

While this paper has demonstrated the strength of the Marxian circuit of capital model as an alternative framework for macroeconomic analysis, there are several issues that will need to be addressed in future research. First: in this paper I have only analyzed the impact of *exogenous* credit on the steady-state growth paths of the system; I have not paid attention to the sources of credit and its evolution through time. Future research will need to address at least two sets of issues that relate to credit: (a) credit will need to be endogenized, and (b) the model will need to keep track of the balance-sheet impacts of credit, i.e., make the model stock-flow consistent by keeping track of the stock of debt and the flow of debt-servicing. Second: I have abstracted from changes in the value of money; future research will need to allow for changes in the value of money. Third: I have not imposed any behavioral assumptions on the basic circuit of capital model; this will need to be taken up in the future. Endogenizing credit and allowing for changes in the value of money will interact with each other to generate another internal limit of the system, the inflation barrier (Foley 1986a). In this endeavor, if analytical results are difficult to derive, a simulation framework might be adopted.

Author's Notes

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