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ABSTRACT

The Monetary Roots of Exploitation*

This paper proposes a theory of the mark-up that is embedded in a circuit model of the capitalist mode of production. The model and the theory are built on Keynes's principle of effective demand, Graziani's monetary theory of production and Pivetti's monetary theory of distribution. The price-setting mechanism is conceived as driven by a Kaleckian rule. The rate of interest on bank loans and the propensities to save of different macro-players are shown to affect the level of the mark-up, thus contributing to explain "labour exploitation" as measured by the average gap between worker's pay and productivity. In other words, "labour exploitation" is seen as being in part originated by monetary phenomena, such as the rentability of bank credit and the macro-players' propensities to accumulate money in a bank account.

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1 Introduction

In a recent article in the *Review of Political Economy* (Andini 2020), I have proposed a model that aims at explaining the basic functioning of a modern capitalist economy where money is neither backed by gold nor by any other physical asset. The model can be seen as an attempt to integrate Keynes's principle of effective demand, the monetary theory of production by Graziani (1994, 2003) and the monetary theory of distribution by Pivetti (1985, 1991) into a single heterodox framework. The simple two-equation nature of the model is inspired by an earlier work due to Lavoie (2003).

One limitation of my 2020 framework is that a key variable, namely the mark-up, is treated as an exogenous variable. No analytical theory stands behind the level of the mark-up, besides the idea that it must be logically larger than the interest rate (see also Brancaccio and Fontana 2013). Since all the equilibrium variables in my 2020 model are functions of the mark-up, the reader is left with no precise indication of the predicted magnitudes of employment, real wages and other variables, in a long-period position. Nevertheless, the model establishes interesting relations among macro-variables and it allows for a number of inferences. For instance, in a long-period position, the levels of real output and real wages are both seen as *inverse* functions of the mark-up. Thus, despite reducing the level of real wages, a higher mark-up does not necessarily lead to an increase in real profits.

In this paper, I fill the above gap by showing that my 2020 model is consistent with an endogenous determination of the mark-up. I obtain a closed-form solution establishing a formal link between the mark-up that maximizes the real profits of the economy and its determinants, including the interest rate. The solution is embedded with some variations in the standard Graziani's circuit theory, being also compatible with Pivetti's theory of the interest rate as a regulator of the price level. This happens because the interest rate is shown to have a positive impact on the profit-maximizing mark-up, provided that financial capitalists have a higher propensity to save than industrial capitalists.

It shall be argued, indeed, that the propensities to save of workers and capitalists play a key role in the determination of the mark-up, once it is assumed that firms are able to maximize real profits in a long-period position. If the propensities to save of financial capitalists and industrial capitalists are equal, then the interest rate loses its power to affect the mark-up and the price level, despite being a component of the unit cost of production. Every increase in the interest rate is fully compensated by a decrease in the so-called "rate of profit of enterprise" (Pivetti 1985, 1991). The case of identical propensities to save among capitalists is, however, unlikely to be the general case.

The rest of this paper is organized as follows. Section 2 describes the baseline framework of my 2020 model, which applies to this paper's model too. Section 3 introduces the basic equations that are needed to understand the contribution of this paper. Section 4 presents my theory of the mark-up.

Section 5 describes the implications of my theory for the rates of profit of the economy, including the rate of profit of enterprise. Section 6 presents simulated effects of a permanent change in the interest rate, using the theoretical findings of the previous sections. Section 7 analyzes the implications of removing a key assumption about labour productivity. Section 8 discusses how a basic version of my mark-up theory fits available data. Section 9 discusses my theory in the light of the legacy of Graziani and Pivetti. Section 10 concludes.

2 Baseline framework

The baseline framework in my 2020 article is inspired by Graziani's circuit approach (see also Realfonzo 2006). The private sector of the capitalist economy is seen as populated by three types of macro-players: bankers, entrepreneurs and workers. Bankers and entrepreneurs are the owners of the means of production, i.e. they belong to the class of capitalists. Bankers are also called financial capitalists and entrepreneurs are also called industrial capitalists. Workers have no other choice than selling their labour force in order to fund most of their living expenses (access to bank credit is a limited option).

In the case of financial capitalists, the means of production consist in a licence that makes bank liabilities, namely deposits, legally issued as money (Smithin 2013a, 2013b, 2016). As a related feature of the licence, banks have the privilege to create money *ex nihilo* in the form of deposits when issuing loans (Moore 1988). In other words, a bank creates money by increasing its liabilities towards the public (bank deposits) and, at the same time, by increasing its assets towards the public (loans) in the same amount. Hence, the basic bank activity simply consists in double-entry book keeping, of which financial capitalists can take care by themselves. I thus assume that the basic bank activity does not require to employ any worker.[1] In addition, I assume that the "status of bankers", i.e. the licence, is inherited from the remote past. That is, pre-capitalistic disparities are at the roots of financial capitalists' privileges.

In the case of industrial capitalists, the means of production are endowments of goods and services that, combined with manpower, produce new quantities of goods and services. So, industrial capitalists need to hire workers in order to produce new units of output as well as in order to earn profits, both in real and money terms. Again, I assume that the "starting" means of production are inherited from the remote past. In other words, the endowments of goods and services in the hands of industrial capitalists at the very beginning of the capitalist production process are seen as an inheritance of

[1] This assumption is clarified in Section 9 where I distinguish between the basic bank activity and the non-basic bank activities in a comparison of my model with the Sraffian approach. On the role of banks in the economy, see also McLeay et al. (2014), Werner (2014), Veronese Passarella (2017) and Smithin (2018).

pre-capitalistic disparities, such as those embedded in the feudal system.[2]

The nominal wage is bargained between industrial capitalists and workers. The industrial capitalists set the price of the output by taking labour cost and productivity into account. It follows that the level of the real wage can be manipulated by the pricing behaviour of firms.

Both workers and capitalists spend their incomes to buy units of output. Any amount of unspent income is saved in monetary terms. Every macro-player keeps its savings in liquid form, e.g. bank deposits. This assumption, which is at the core of Keynes's principle of effective demand and related matters (e.g. unemployment arises from monetary savings), allows us to analyze how the capitalist economy is affected by different degrees of liquidity preference.

Both industrial capitalists and workers can borrow from banks in order to acquire consumption products. Yet, only industrial capitalists can spend their incomes or borrow from banks in order to buy investment products. Otherwise, there would be no functional characteristic of industrial capitalists (defined as the owners of goods and services that are needed for production).[3]

3 Key equations

To summarize the key equations in my 2020 model, this section partly reproposes the notation adopted. The labels for the long-period averages of the macro-variables that are discussed in this paper are as follows: Y for the real output, w for the nominal wage, L for the level of employment, P for the price level, $a = Y/L$ for the real output per worker, μ for the mark-up, c_w for the marginal propensity to consume of workers, $b_{\pi(i)}$ for the marginal propensity to spend of industrial capitalists (these can buy products both for consumption and for investment), $c_{\pi(f)}$ for the marginal propensity to consume of financial capitalists, C_0 for the level of autonomous consumption made by workers and industrial capitalists, I_0 for the level of autonomous investment made by industrial capitalists, and G_0 for the level of autonomous government expenditure.

It is assumed that $1 > c_w > b_{\pi(i)} > c_{\pi(f)} > 0$, i.e. $s_{\pi(f)} > s_{\pi(i)} > s_w$ where $s_{\pi(f)} = 1 - c_{\pi(f)}$, $s_{\pi(i)} = 1 - b_{\pi(i)}$ and $s_w = 1 - c_w$ refer to the long-period averages for the marginal propensities to save of financial capitalists, industrial capitalists and workers, respectively.

All the above long-period averages are viewed in this paper as the long-period averages of stochastic variables that are defined across multiple dimensions. For instance, μ_{jhct} is the mark-up set by firm j manufacturing product h in country c at time t, while G_{0ct} is the autonomous government expenditure

[2] Marx and his followers have written many interesting pages on the so-called "original accumulation". I do not deal with this issue in this paper.

[3] For sake of simplicity, I assume that bankers do not borrow from their own banks. They just spend their incomes in consumption products. They do not need to buy any investment products because the basic bank activity does not require the use of goods and services as means of production (this point is clarified in Section 9).

in country c at time t. This means that the variable μ_{jhct} is distributed with a long-period average μ and a long-period variance Θ_μ. Similarly, the variable G_{0ct} is distributed with a long-period average G_0 and a long-period variance Θ_{G_0}. This logic also applies to the macro-variables that are introduced hereinafter. And, the number of dimensions can be increased when required. In sum, the approach is able to handle the mentioned forms of heterogeneity (i.e. firms, products, countries and time) as well as additional forms if necessary (e.g. workers and banks).

The aim of this paper's model is to characterize the long-period average mark-up μ and all the other long-period averages that depend on μ, with a special focus on the rates of profit of the economy.

In line with the circuit approach, every macro-player starts with zero money.[4] Since industrial capitalists need workers for production to take place, they borrow the total amount of nominal wages from banks, which are able to create money *ex nihilo*. Hence, the long-period average "initial finance" in the model is given by $B_I = wL$.[5] If we label i the long-period average interest rate on bank loans, then $iB_I = iwL$ is the long-period average amount of interest payments that firms make to banks.

Autonomous consumption and autonomous investment are funded through bank credit. So, both C_0 and I_0 are long-period averages of loans that banks make to workers and industrial capitalists. These loans are part of what I have referred to as the "final finance" in my 2020 work, playing a role for the sale of real output. The sum $C_0 + I_0$ is basically the long-period average amount of bank credit that workers and entrepreneurs use to buy *new* products.[6]

For simplicity, as in my 2020 work, I assume that the government does not impose any taxes. To fund its autonomous expenditure, the government borrows from the central bank, which is able to create government deposits *ex nihilo* in any amount equal to its credits with the government. It does not really matter whether these credits are held in the form of newly-issued government bonds or not. As a result, the long-period average "final finance" includes G_0, i.e. the long-period average amount of central-bank credit that the government uses to buy *new* products. In short, the long-period average "final finance" is given by $B_F = C_0 + I_0 + G_0$.

Though indirectly, the government creates money supply. It does so by ordering the central bank to make government payments to the sellers of new goods and services, and specifically to their bank

[4]Note that the circuit theory aims at explaining, among other things, the process through which the macro-players end up with money in the capitalist system, e.g. how monetary incomes are generated.

[5]The long-period average "initial finance" coincides with the long-period average nominal wages because the payment of wages is the only monetary payment that industrial capitalists must do *outside* of their own group, in order to ensure that the production of new goods and services takes place. While short-run deviations are possible, average employment tends to a predictable value in a long-period position (see expression (3) in this section).

[6]Two things are worth noting at the current stage of abstraction. First, my view of "final finance" is different from the view of Augusto Graziani, who defines "final finance" as the monetary savings that workers provide to firms in exchange for firm-issued financial assets (see Graziani 1994, p. 82). Second, my definition of "final finance" is in line with Richard Werner's view of bank credit for GDP transactions (its long-period average is called $C_0 + I_0$ in my model) as a driving force of the real economy (see Werner 2012, p. 31), though I do not share his inflationary view of consumption credit.

accounts. The central bank executes these orders by reducing government deposits and, at the same time, by increasing its liabilities towards the banks that, in turn, increase their liabilities towards the sellers, namely bank deposits. The liabilities of the central bank, which are banks' liquid assets, are called central-bank reserves. In this process of money creation (the overall amount of bank deposits increases as the government spends), for simplicity, I assume that the sellers coincide with the firms.[7]

Following Smithin (2018, p. 92), among others, I assume that the central bank is able to affect the long-period average interest rate on bank loans i by manipulating the long-period average overnight rate, i.e. the rate at which a bank makes overnight loans of central-bank reserves to another bank.

This paper's model is intended to be a simplified model of the world capitalist economy, under the current geopolitical situation. This has at least two implications. First, I do not consider imports and exports.[8] Second, I assume that the Federal Reserve and the U.S. government are strongly able to influence the levels of two variables of the world economy that matter for the analysis: the long-period average interest rate on bank loans i and the long-period average "final finance" B_F.[9]

Using the above notation, the long-period average aggregate supply of the world economy is given by the equation $AS = PY$, while the long-period average aggregate demand is given by the equation $AD = c_w wL + b_{\pi(i)}(PY - wL - i\,wL) + c_{\pi(f)} i\,wL + C_0 + I_0 + G_0$.[10]

The industrial capitalists set the price of the output by following a Kaleckian rule, i.e. the equation $P = (w/a)(1+\mu)$ explains the long-period average price level (P) in the economy. It follows that, given the long-period average levels of real labour productivity (a) and nominal wage (w), the long-period average real wage (w/P) is fully determined − through the long-period average mark-up (μ) − by the pricing behaviour of industrial capitalists (see also Bellofiore et al. 2000):

$$\frac{w}{P} = \frac{a}{1+\mu} \tag{1}$$

[7] Two additional things are worth stressing. First of all, in line with Randall Wray and other fellows of modern money theory, I believe that government's expenditure (taxation) does create (destroy) bank deposits, through the central bank (see also Wray 2015). This is in contrast both with the IS-LM model, which does not recognize any impact of fiscal policy on money supply (bank deposits) and thus on the LM schedule, and with the view of the government as having no involvement in the process of money-supply creation, which is proposed among others by Richard Werner and co-authors (Ryan-Collins et al. 2012, p. 8). The second point is that, again in line with modern money theorists, I basically see central bank's independence as a government's self-imposed constraint. Wherever or whenever it applies, I interpret such independence as an expression of the bankers' bargaining strength in the class conflict between bankers and non-bankers.

[8] Let X_0 and M_0 be the long-period averages of the autonomous levels of a country's exports and imports, respectively. If one models a single country's economy, then the long-period average "final finance" includes the long-period average amount of net loans from residents to the foreign sector, i.e. $X_0 - M_0$. If $X_0 - M_0 > 0$, foreign residents are borrowing on average from country residents. If $X_0 - M_0 < 0$, country residents are borrowing on average from foreign residents.

[9] For instance, assuming that the U.S. government decides to permanently increase its autonomous expenditure funded through central-bank credit, such a decision induces an increase in the long-period average level of "final finance" in the world economy.

[10] A single-country version of this paper's model can incorporate i) current-account transactions, ii) proportional taxes on gross incomes and iii) imports depending on after-tax incomes. The long-period average aggregate demand becomes $AD = (c_w - m_w)(1-t_w)wL + (b_{\pi(i)} - m_{\pi(i)})(1-t_{\pi(i)})(PY - wL - i\,wL) + (c_{\pi(f)} - m_{\pi(f)})(1-t_{\pi(f)})(i\,wL) + C_0 + I_0 + G_0 + X_0$, where t_w and t_π are the tax rates paid by workers and capitalists, respectively, and m_w and m_π are the marginal propensities to import of workers and capitalists, respectively.

In my 2020 article, I have proceeded as follows. First, I have labeled equation (1) as the "real wage line". This equation is plotted in Figure 1. The long-period average price level is affected by the long-period average cost of production, which is given by $(wL + iB_I)/Y = (wL + iwL)/aL = (w/a)(1 + i)$. Hence, the interest rate is seen as a component of the unit cost of production.[11] The condition $\mu > i$ ensures that the average price is higher than the average cost of production.[12]

Second, I have focused on a long-period equilibrium in which time does not matter in the sense that all equilibrium variables are independent of time. The consequence of adopting this equilibrium approach − which is in line with Lavoie (2003), Dalziel and Lavoie (2003) and Andini (2009), besides Graziani's work − is that all the endogenous variables in the model can be determined simultaneously.

Third, I have defined a "capitalist equilibrium" as a state of the economy in which aggregate monetary profits are positive and I have highlighted the conditions required for the generation of long-period average positive monetary profits in the economy: i) a positive long-period average final-finance debt of some sort $(B_F > 0)$[13] and ii) a positive long-period average mark-up $(\mu > 0)$, i.e. a long-period average gap between real wage and real labour productivity. These two conditions must hold together, i.e. they are not alternative to each other. The implication is that a "healthy" capitalist economy requires both indebted buyers of final output $(B_F > 0)$ and "labour exploitation" $(\mu > 0)$ in a long-period perspective (on the meaning of "labour exploitation", see further in Section 4).

Using the above definitions for AD and AS, after some algebra, it is possible to show that the so-called "effective demand for labour" (see also Lavoie 2003) is given by:

$$\frac{w}{P} = \frac{as_{\pi(i)}}{s_{\pi(i)} - i(s_{\pi(f)} - s_{\pi(i)}) - s_w} - \frac{1}{L[s_{\pi(i)} - i(s_{\pi(f)} - s_{\pi(i)}) - s_w]} \frac{B_F}{P} \tag{2}$$

[11] In the original version of Graziani's work, the interest rate on bank loans is not viewed as a component of the unit cost of production (this point is clarified in Section 9).

[12] A relevant aspect is why the money cost of non-labour inputs can be disregarded in a no-taxes circuit model, like this paper's model, for the world capitalist economy (and not for a single country's economy). The answer is that, if the "world of firms" could avoid the use of manpower, then the final output would be produced at a zero money cost per unit. In other words, the "world of firms" is seen as a big integrated production unit (Graziani 2003, p. 27) in which a department provides goods and services to another department, and so on. Of course, the production of final output does involve firms' costs in real terms, such as a reduction of available non-labour inputs. However, these costs in real terms are not costs in money terms, defined as monetary payments that industrial capitalists as a macro-group must do *outside* of the "world of firms". As it shall be argued in Section 4, the costs in real terms are covered by firms through a part of the final output that is not sold to non-firm buyers (i.e. workers, bankers, and governments). Another relevant aspect is that viewing the "world of firms" as a big integrated unit does not mean disregarding the existence of a conflict *within* the "world of firms", e.g. among departments. The point is that this conflict neither increases nor decreases the amount of monetary payments that industrial capitalists as a macro-group must do *outside* of the "world of firms".

[13] This condition does not mean that loans are not paid back. It means that there must be some persistent debt in a long-period perspective. Real-world observation suggests that the U.S. government debt held by the Federal Reserve is one way of keeping the system going.

This equation is represented as a curve in Figure 1. It suggests (among other things) that the central bank, by manipulating the overnight rate and thus the interest rate i, can shift the curve in the desired direction even if the "final finance" B_F is not sensitive to a change in the interest rate i.[14]

The long-period average levels of employment and real output in my 2020 model are given by:

$$L = \frac{1}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w} \frac{B_F}{w} \tag{3}$$

$$Y = \frac{a}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w} \frac{B_F}{w} \tag{4}$$

From the above expressions, it is easy to see that an increase (a decrease) in the average mark-up reduces (increases) the average levels of employment and real output.

4 Endogenous mark-up

This section starts with a key question: Why does the average mark-up matter? As one can see from expression (1), the average mark-up is a parameter that sets the way in which the average productivity of labour is shared between the firm (as surplus) and the worker (as salary). If the worker's average productivity is 100 output units and the average mark-up is equal to 1, then the average real wage is 50 output units, and so is the average firm's surplus from one worker. In a way, the average mark-up is a parameter that sets the average level of "labour exploitation" for the single worker.

The mark-up theory developed in this paper starts from the assumption that firms are pieces of a big integrated production unit (see Graziani 2003, p. 27) and from the idea that the average levels of employment and real output are inverse functions of the average mark-up (see Section 3). So, in making mark-up decisions, the industrial capitalists as a macro-group take into account not only that a bigger average mark-up lowers the average real wage, but also that it lowers the average levels of employment and real output. Hence, the average surplus from one worker is balanced against what really matters for industrial capitalists, which is the average amount of real profits from production.

If the industrial capitalists are able to maximize the long-period average level of real profits, i.e.:

$$\frac{\Pi}{P} = \frac{\mu}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w} \frac{B_F}{(w/a)(1+\mu)} \tag{5}$$

[14] This is one reason behind the choice of disregarding the interest rate that is paid on final-finance loans. The purpose is to make this paper's model as simple as possible to highlight the fundamental relations in the capitalist economy. Of course, the model can incorporate other forms of interest payments. For instance, one could introduce long-period average final-finance loans that depend on the interest rate i, i.e. a function $B_F(i)$ in equation (2). Such introduction, however, would contaminate this paper's model with Hicksian features (e.g. the sensitivity of the investment expenditure to a change in the rate of interest) that are not coherent with the heterodox nature of this work.

then the profit-maximizing mark-up, given the interest rate (among other things), is provided by the following expression (see Appendix A for details):

$$\mu = \sqrt{\frac{i(s_{\pi(f)} - s_{\pi(i)}) + s_w}{s_{\pi(i)}}} \tag{6}$$

That is, under the model's assumptions in this paper, expression (6) gives the long-period average mark-up that arises if the industrial capitalists − acting as a macro-group (in other words, acting as a class) − are able to maximize the long-period average amount of real profits from production.

As the average mark-up affects the average gap between worker's pay and productivity, which is a measure of "labour exploitation", expression (6) contributes to explain the underlying exploitation's drivers and mechanisms. In particular, it suggests that "labour exploitation" is in part originated by monetary phenomena, such as the rentability of bank credit (associated with the bankers' privilege to create bank money out of nothing) and the propensities of different categories of income recipients to accumulate money in a bank account. More specifically, expression (6) provides four key insights.

First, the propensity to save of bankers is positively associated with the mark-up, and so is the propensity to save of workers. An increase in the liquidity preference of bankers "forces" the firms to set a higher mark-up in order to keep the amount of real profits at the maximum level in a long-period position. The same happens if the workers' propensity to save increases, for instance due to a change in the employment protection legislation causing a lower job stability and a more uncertain future.

Second, the propensity to save of industrial capitalists negatively affects the mark-up, i.e. the propensity to spend of industrial capitalists positively affects the mark-up. Explaining the mechanism for the propensity to spend of industrial capitalists is also useful to explain the mark-up effect of a change in the propensity to save of workers or bankers. One way to proceed is as follows.

The starting point is to note that, while the propensity to save of workers or bankers is a "propensity of not buying" units of output from firms, the propensity to spend of industrial capitalists corresponds to a "propensity of not selling" units of output to non-firm buyers (for industrial capitalists, buying their own products is the same as retaining production for their own use). So, for any given level of real output, an increase in one of these propensities (s_w, $s_{\pi(f)}$ or $b_{\pi(i)}$) reduces the units of output that firms sell to non-firm buyers. To avoid a fall in revenues, firms must sell each unit of output at a higher price, i.e. firms must increase the mark-up.

Third, the interest rate on bank loans is an additional source of exploitation because it positively affects, in general, the profit-maximizing mark-up (see Appendix B for details). In a way, a positive

value of the overnight rate − by setting the lowest possible interest rate on bank lending − defines a "minimum" level of worker's exploitation. As a result, from the worker's perspective, the traditional emphasis on the "technical nature" of central-bank decisions should be looked at with suspicion.

Last but not least, expression (6) suggests that, even in the extreme case in which the interest rate on bank loans is equal to zero, the mark-up must still be higher than zero if the workers' propensity to save is positive. This result suggests that the workers (whose propensity to save is mainly motivated by precautionary reasons) in a way "contribute" to their own exploitation.

Focusing on the assumptions behind expression (6), perhaps the key one is that the industrial capitalists, once agreed upon the interest rate with the banks, are fully able to exploit their dominant position in the real sector of the economy, in a long-period position (i.e., not necessarily in the short run).[15] This means that they are able to obtain the biggest possible slice of the cake made by the workers. The fact of sharing it with financial capitalists is a separate issue (see further in Section 5).

Of course, in line with the Marxian tradition in political economy, the primary source of "labour exploitation" should still be linked to the real (i.e. non-monetary) phenomenon of the workers' separation from the ownership of both the means of production and the output itself. Firms' ownership allows industrial capitalists to decide what to do with final output. In a way, a monetary parameter in the model, namely $s_{\pi(i)} = 1 - b_{\pi(i)}$, captures this primary source of exploitation by allowing industrial capitalists to retain real output for their own use, instead of selling it to non-firm buyers. That is, $b_{\pi(i)}$ is a measure of this "propensity to retain" output units either for consumption or for investment.

5 Implications for the rates of profit

This section begins with another key question: What does a theory of the long-period average mark-up imply? The answer is that it implies at least two important things. First, a theory of the long-period average mark-up μ implies a theory of the long-period average rate of profit r because the values of μ and r coincide in a circuit model of the world economy, where the only monetary anticipation/cost is represented by the wage bill:

$$r = \frac{PY - wL}{wL} = \frac{PY}{wL} - 1 = \frac{Pa}{w} - 1 = 1 + \mu - 1 = \mu \tag{7}$$

Second, a theory of the long-period average mark-up μ also implies a theory of the long-period average rate of profit of enterprise r^e. To see this, the initial step is to note that, by construction, the

[15] This paper proposes a theory of the mark-up when firms maximize profits in the long run, not only for being a novel contribution to the circuit approach but also for comparison with the neoclassical theory.

value of μ is a function of both the long-period average rate of profit of enterprise r^e and the long-period average interest rate i. Indeed, if the long-period average price level P reflects the long-period average rate of profit of enterprise r^e and the long-period average cost of production $(w/a)(1+i)$, i.e.:

$$P = [(w/a)(1+i)](1+r^e) = (w/a)(1+r^e+i+ir^e) \tag{8}$$

it immediately follows that:

$$\mu = r^e + i + ir^e = r^e(1+i) + i \tag{9}$$

Looking at expression (9),[16] the second point of this section becomes self-evident, i.e. the economy tends to generate a long-period average rate of profit of enterprise that is equal to:

$$r^e = \frac{\mu - i}{1+i} \tag{10}$$

where the level of μ in expression (10) is given by expression (6). The beauty of a formula is that it helps to see important relations among macro-variables. Specifically, under the model's assumptions in this paper, expression (10) suggests that there is, in general, an inverse relation between the interest rate i and the rate of profit of enterprise r^e (see Appendix B for details).

Both expression (6) and expression (10) have very interesting implications for the monetary theory of distribution. These implications are analyzed in the next section. Of course, a change in the model's assumptions changes the theoretical levels of μ in expression (6) and r^e in expression (10). For instance, one might set up a model that allows for the existence of tax rates, in the spirit of footnote (10). In particular, a model with taxes would be more in line with the view of Wray (2015) that "taxes drive money", which I partly agree with.[17] Yet, I do not analyze specific variations of my model here as I want to focus on the properties of the theory in its basic world-economy version with no taxes.

6 Effects of a change in the interest rate

This section presents two graphs that are based on the results obtained so far. In particular, following the monetary theory of distribution, I analyze how the interest rate affects the mark-up, the rate of profit of enterprise and the real wage, assuming that the real labour productivity is 100 units and that

[16] Using expressions (7) and (9), one can also write $r = r^e + i + ir^e$ which is a decomposition of the long-period average rate of profit in a circuit model of the world economy. Note that, in a model for a single country's economy, the average monetary cost of imported non-labour inputs must be included in the average monetary cost of production.

[17] I believe that "enforcement drives money" and taxes are just an instrument of enforcement that works at country level. For instance, the position of the U.S. dollar as an international liquidity is not explained by U.S. taxes. Geopolitical enforcement resulting from military supremacy is likely to be a more powerful explanatory factor.

the marginal propensities to save are as follows: $s_{\pi(f)} = 0.40$, $s_{\pi(i)} = 0.30$ and $s_w = 0.10$. Needless to say, the findings are robust to different parameters that are consistent with the model's assumptions.

Let me stress that a change in a macro-variable in this paper must always be interpreted as a permanent change in the long-period average level of the macro-variable, even if this is not explicitly written in one section or another. Indeed, this paper adopts a long-period perspective that is in line with Pivetti's work and, I believe, it is coherent with Graziani's work too (though Graziani does not emphasize this point). Of course, the effect that a permanent change in a macro-variable produces on another macro-variable must also be interpreted as a long-period average effect.

The results in Figure 2 suggest that, when the interest rate is equal to zero, the mark-up and the rate of profit of enterprise coincide, with the latter becoming the rate of profit of the economy. As the interest rate increases, the mark-up and the rate of profit of enterprise diverge: the mark-up increases, while the rate of profit of enterprise decreases.

Two aspects are worth stressing at the current stage of analysis. First, the increase in the mark-up μ is less than proportional to the increase in the interest rate i. Second, the inverse relation between i and r^e is coherent with the view of a class conflict between bankers and entrepreneurs. It is, however, in contrast with Pivetti's claim that the rate of profit of enterprise can be considered as being invariant − a "stable magnitude" in Pivetti's words − to a permanent change in the interest rate (see Pivetti 1991, p. 24).

As an increase in the interest rate leads to a higher mark-up, then the real wage decreases. This is represented in Figure 3. Although this inverse relation between the interest rate and the real wage is in line with Pivetti's view, it should be seen as a novel result of this paper for emerging in a framework that does not separate the analysis of income distribution from the analysis of employment and production. Instead, this separation is a necessary assumption to be made in the Sraffian framework as modified by Pivetti (see further in Section 9).

As expression (6) suggests, if the propensities to save of financial and industrial capitalists coincide (i.e. $s_{\pi(f)} = s_{\pi(i)} = s_\pi$, which is in contrast with Section 3's assumptions), then the profit-maximizing mark-up becomes the square root of the ratio between the propensity to save of workers (s_w) and the propensity to save of capitalists (s_π). In such a case, the mark-up becomes independent of the interest rate. So, every increase in the interest rate is fully compensated by a decrease in the rate of profit of enterprise.[18] This is, however, unlikely to be the general case.

[18] In other words, firms have no incentive to increase the mark-up and the price level in response to an increase in the interest rate because this would imply a loss in real profits, with respect to the case in which the mark-up is kept equal to the square root of the ratio between the workers' propensity to save (s_w) and the capitalists' propensity to save (s_π).

7 Interest rate and real labour productivity

The argument that an increase in the interest rate leads to a decrease in the real wage is conditional on an important assumption. The assumption in the previous section's simulations, and in Pivetti's theory as well, is that the long-period average real labour productivity in the economy does not change as the long-period average interest rate increases.[19] This is, however, an assumption that can be challenged in at least one way. I shall explain why in this section with an example.

Suppose the economy is populated by two groups of firms: "good" firms, in a number N_g, that are characterized by a higher real labour productivity a_g, and "bad" firms, in a number N_b, that are characterized by a lower real labour productivity a_b. Suppose now that the long-period average real labour productivity in the economy is a weighted average of these two groups of firms, i.e. $a = a_b(N_b/N) + a_g(N_g/N)$, where $N = N_b + N_g$ is the total number of firms. Then, the long-period average productivity can be written as:

$$a = a_b + (a_g - a_b)(N_g/N) \tag{11}$$

being an increasing function of the share of "good" firms N_g/N. So, an increase in the long-period average interest rate i can induce the insolvency of several "bad" firms (i.e. a decrease in N), generating an increase in the share of "good" firms N_g/N (see also Brancaccio and Fontana 2013). This automatically increases the long-period average real labour productivity a. Hence, an increase in the interest rate does not necessarily reduce the long-period average real wage, provided that it does also lead to an increase in the long-period average real labour productivity.

More generally, as stressed in Section 3, all the long-period averages of the macro-variables in this paper are viewed as the long-period averages of stochastic variables, defined across multiple dimensions. For instance, the average margin μ should be interpreted as the long-period average of a distribution of mark-ups implied by the stochastic variable μ_{jhct}, while the average interest rate i should be seen as the long-period average of a distribution of interest rates implied by the stochastic variable i_{jhct}. As a consequence, there are firms in the economy that set lower-than-average mark-ups and firms that pay higher-than-average interest rates.

A firm closes its doors if the condition $\mu_{jhct} < i_{jhct}$ holds for a sufficiently long sequence of time periods t. This is why an increase in the long-period average interest rate i, by shifting towards the right the whole distribution of interest rates, can increase the probability of firm closure. To prove this statement, the first step is to look at the probability of firm closure in Figure 4.

In particular, while my model suggests that the rightward shift in the interest rates' distribution is

[19] Of course, the long-period average real labour productivity can change for many other reasons, such as technological progress. This section focuses on the interest-rate channel.

accompanied by a rightward shift in the mark-ups' distribution (note that μ increases as i increases), the increase in μ is, in general, *less than proportional* to the increase in i (see Section 6). Therefore, provided that the shape of the distributions does not change, the probability of firm closure depicted in Figure 4 gets larger. A caveat is that, to make the graph simpler, the median is assumed to coincide with the mean in each of the plotted distributions. Yet, the argumentation holds in general.

In short, the firms that are more likely to disappear − as the average interest rate increases − are the so-called "bad" firms where lower mark-ups and higher interest rates are typically accompanied by lower levels of labour productivity. As a consequence, the average level of labour productivity in the economy is likely to increase.

To summarize, the average real wage's effect of an increase in the average interest rate turns out to be an empirical issue. The effect can be either positive or negative once it is seen as the sum of two different effects: a positive effect on the average mark-up, which reduces the average real wage, and a positive effect on the average productivity of labour, which increases the average real wage.

8 How does the theory fit the data?

Despite this section is not essential to the scope of the paper, I find of interest to discuss the difficulties that arise when confronting the model with the data.

First of all, it is very difficult to find reliable data on estimated propensities to save for the different macro-groups that are defined in this paper: salaried workers, industrial capitalists and financial capitalists. In addition, since this paper provides a model for the world capitalist economy, one would ideally need data at world level.

To the best of my knowledge, no world-level data on macro-groups' propensities to save are indeed available. What we do have, at best, are data on savings rates for different categories of income recipients and for one country. The best source that I have found is an old study by Kuznets, published in 1953, in which the author focuses on the case of the United States (see Kuznets 1953). The data provided by Kuznets are reproduced in Table 1 in this paper.

In the cited study, Kuznets reports savings rates at multiples and fractions of average income. Unlike a propensity to save, a savings rate can be negative. In a simple equation for private savings $S = -C_0 + sPY$, the relation between the savings rate S/PY and the propensity to save s is influenced by the percentage of autonomous-consumption debt over nominal income $-C_0/PY$, i.e. $S/PY = -C_0/PY + s$. The percentage $-C_0/PY$ can be significant. Thus, the difference between the savings rate S/PY and the propensity to save s can be quite relevant. However, as nominal income goes from lower-than-average levels to the mean level, the percentage $-C_0/PY$ gets smaller. As a result, the

savings rate S/PY gets closer to the propensity to save s. This suggests the use of data on savings rates at the mean-income level to proxy the propensity to save of workers. The use of data on savings rates at fractions of the mean-income level would probably underestimate the workers' propensity.

As data on savings rates for different types of capitalists (industrial vs. financial) are not available, this section uses expression (6) for the long-period average mark-up, under the hypothesis that $s_{\pi(f)} = s_{\pi(i)} = s_\pi$. This choice, which is in contrast with Section 3's assumptions, is motivated by the lack of alternatives. In particular, the propensity to save of workers s_w is assumed to be equal to the average savings rate of those with mean income (1.00), i.e. 8.1%, while the propensity to save of capitalists s_π is assumed to be equal to the average savings rate of those with three times the mean income (3.00), i.e. 22.3%. These averages are computed by using Table 1's data between 1929 and 1950.

If the marginal propensity to save of workers and the marginal propensity to save of capitalists are both measured with error but the error is proportional to the true parameter and the proportion is the same (say ±20% bias), then the ratio between the savings rates captures the ratio between the propensities to save because the percent bias (whatever it is) cancels out.[20] However, in general, the ratio s_w/s_π is measured with a bias when using savings rates instead of propensities to save.

Mark-up data for the world economy are also unavailable. Hence, this section uses available U.S. data, which implies assuming again that U.S. data are good proxies for world data. Figure 5 reports annual data on the mark-up in the United States from 1929 to 2022, generated by using price and cost data from the U.S. Bureau of Economic Analysis. The plotted mark-up series is based on data for nonfinancial domestic corporate business. It is obtained by subtracting one from the ratio between the unit price of real gross value added and the unit labour cost.[21]

With the above limitations in mind, Figure 5 suggests that the mark-up theory developed in this paper, despite the simplification imposed by this section's exercise, is consistent with the available mark-up data, at least when data for the United States between 1929 and 1950 are used as best proxies for world data. The predicted mark-up is 0.600, i.e. the square root of the ratio 0.081/0.223. The prediction could have been completely out of range, and it is not.

9 Discussion with giants

This section aims at clarifying similarities and differences between this paper's model and the theories which the model is built on. Other related theories are also discussed. Let me stress, from the upfront,

[20] Suppose $(S/PY)_w = s_w + er_w$ and $(S/PY)_\pi = s_\pi + er_\pi$, with $er_w = \pm 0.20 s_w$ and $er_\pi = \pm 0.20 s_\pi$. Then, it is easy to show that $(S/PY)_w/(S/PY)_\pi = s_w/s_\pi$ holds.

[21] NIPA Table 1.15 Price, costs, and profit per unit of real gross value added of nonfinancial domestic corporate business (base 2012 = 1).

that I feel in deep intellectual debt to all the authors cited in the rest of this section, in particular to Augusto Graziani and Massimo Pivetti. So, the discussion that follows is never aimed at devaluing the outstanding achievements of these giants of economic theory.

9.1 Pivetti's theory

I am very sympathetic with the monetary theory of distribution put forward by Pivetti. The central idea that the banking system can, by setting the interest rate, affect the real wage is in line with my own view. Unfortunately, however, the argumentation proposed by Pivetti is based on at least three assumptions that I ultimately consider as being questionable (see Appendix C for details).

To begin with, Pivetti's monetary theory of distribution assumes a Sraffian separation between income distribution and employment/production. The output quantities in real terms and the levels of employment in each industry are taken as given (among other things that are also taken as given) in the Sraffian system and in Pivetti's system. In other words, Pivetti implicitly assumes that a permanent change in the interest rate has no effect on the levels of employment and production in the economy. My point is that, if the interest rate does indeed affect the levels of employment and production (as suggested, for instance, by expressions (3) and (4) in this paper), then Pivetti's theory cannot be used to predict the real wage's effect of a permanent change in the rate of interest.

This consideration, in my view, suggests the necessity of relying on a theory that is able to say something about income distribution and employment/production at the same time. An advantage of the approach developed in my 2020 article, and enhanced in this paper, is exactly the provision of a *simultaneous* determination of income distribution and employment/production, which is an alternative to the simultaneous determination suggested, despite its shortcomings, by the neoclassical theory (see the Cambridge controversy on capital).

The second assumption that I find questionable is the stability of the rate of profit of enterprise and its independence to changes in the interest rate. This implies no class conflict between bankers and entrepreneurs. A permanent change in the interest rate causes, in each industry in Pivetti's system, a permanent change in the industry's rate of profit in the same direction and of the same size. That is, a given increase in the economy's average interest rate causes the same increase in the average rate of profit, with the average rate of profit of enterprise being unaffected.

The theory proposed in this paper suggests that, in response to an increase in the average interest rate, the industrial capitalists increase the average mark-up – and thus the average rate of profit – by less than the increase in the average interest rate. They accept a reduction in the average rate of profit of enterprise to avoid a fall in the average level of real profits. As shown in Figure 2 and in line

with observational reality, capitalism involves a class conflict not only between workers and capitalists but also among capitalists. If the interest rate increases, the rate of profit of enterprise decreases. This is what expression (10), in general, suggests (see Appendix B for details).

What industrial capitalists can do, to avoid an increased transfer of their income to bankers, is to act in opposition to an increase in the interest rate. They have some power to do so because, in absence of an initial-finance loan at an *agreed* interest rate, industrial production does not take place at all and nobody gets an income, including financial capitalists. If industrial capitalists are so strong and able to push the interest rate down towards zero, then the rate of profit of enterprise is maximized. In general, however, bankers are able to obtain an interest rate larger than zero, which implies a lower rate of profit of enterprise.

The third assumption that I call into question is that Pivetti's monetary theory of distribution is embedded in a Sraffian system where real surplus is assumed to be produced, independently of whether there are monetary conditions in place for such an outcome or not. To this assumption, I oppose the Smithin's view that *"the system as a whole must surely be able to first generate positive aggregate profits, in money terms,* before *any 'real' profit or surplus can even come into existence"* (Smithin 2016, p. 1264). This means that monetary issues play a key role. Yet, in the Sraffian system as modified by Pivetti, even though the interest rate plays a role, it is not clear who is indebted to whom, what is the role of banks, where money comes from, and so on. Instead, the approach developed here and in my earlier work is fully consistent with the Smithin's view, as it explains how positive monetary profits are generated in a long-period position.[22]

9.2 Graziani's theory

Of course, I am also very sympathetic with the monetary theory of production put forward by Graziani, which is the main source of inspiration for the framework that I have proposed in this paper's model. Yet, when compared with Graziani's theory, I believe that this paper's model uses the principle of effective demand more coherently. The reason is as follows.

In Graziani's theory, the price level P solves the equation $PaL = c_w(wL + i_B B) + bPaL$ where B is the nominal value of the securities that workers buy from firms, i_B is the interest rate paid by firms on their issued securities, and b is the share of production that firms decide to buy for their own use. This leads to a price level $P = [(1 - s_w)/(1 - b)][(wL + i_B B)/(aL)]$ (see Graziani 2003, p. 101; I am partly using my notation here). In my view (and this of course may be criticized), a better use of the principle of effective demand would suggest an equation such as $PaL = c_w(wL + i_B B) + b_{\pi(i)}(PaL - wL - i_B B)$,

[22] A book chapter by Rochon (2005) offers very interesting insights on monetary profits' issues in the circuit approach. It also provides an original solution to the so-called "paradox of monetary profits".

where $b_{\pi(i)}$ is the propensity to spend of industrial capitalists, as in this paper's model.

For sake of comparison between Graziani's approach and my own approach, four things are worth noting at the current stage. First, besides entrepreneurs' expenditures funded through bank credit, this paper looks at the spending behaviour of industrial capitalists as a function of their net income and propensity to spend. As stressed in the previous paragraph, this approach looks more in line with the principle of effective demand than the approach suggested by Graziani ($bPaL$). Moreover, this paper's framework can be easily modified to account for a transfer of income in the form of interest payments from industrial capitalists to workers ($i_B B$), in line with Graziani's approach.

Second, Graziani's the unit cost of production is equal to $(wL + i_B B)/(aL)$ and the rate of profit of enterprise is given by $r^e = (b - s_w)/(1 - b)$. In his framework (Graziani 2003, p. 103), the interest rate on bank loans i is not included in the unit cost of production. And, an increase in the interest rate paid by firms on their issued securities i_B does not affect the rate of profit of enterprise.

Third, the endogenous determination of the rate of profit of enterprise, provided by expression (10) in combination with expression (6), appears to be a reasonable alternative to Graziani's approach, which does not seem to recognize a profit-maximizing behaviour of firms (see Section 4).

Fourth, my theory of the rate of profit of enterprise is not consistent with Graziani's own theory, although both theories are embedded in the circuit approach. Indeed, in my theory, an increase in the propensity to save of workers s_w "forces" the firms to set a higher mark-up in order to keep the amount of real profits at the maximum level in a long-period position. Hence, the rate of profit of enterprise r^e, given the interest rate on bank loans i, increases. Instead, in Graziani's theory, an increase in the propensity to save of workers s_w implies a reduction in the rate of profit of enterprise r^e.

9.3 Other theories and respective authors

Notwithstanding my focus on Graziani and Pivetti's theories, I am aware of the existence of other heterodox monetary theories of production and distribution. For instance, Alan Parguez has proposed his own views on the functioning of a monetary production economy (see Parguez and Seccareccia 2000, for a good summary). Similarly, Carlo Panico and Giuseppe Ciccarone have proposed their own views on the link between money and income distribution (see Panico 1988; Ciccarone 1998).

While the differences between the theory of Parguez and the theory of Graziani can be disregarded, at least for the scope of this paper, the differences between the theory of Pivetti and those of Panico and Ciccarone cannot. What these three monetary theories of distribution have in common is the Sraffian separation between the analysis of distribution and the analysis of employment/production. However, unlike Pivetti's theory, Panico and Ciccarone's theories look at the banks as an additional

industry in the Sraffian system. That is, banks are seen as an additional industry that, using workers and non-labour inputs (Panico 1988, p. 94) or workers only (Ciccarone 1998, p. 407), is ultimately involved in producing new goods and services.[23]

Of course, a banking industry does exist in the real world. It undoubtedly contributes to the world production. However, from a theoretical point of view, one needs to distinguish between two types of bank activities: i) the basic bank activity (i.e., creating deposits through loans and charging an interest rate) where incomes are pure rents deriving from the "status of bankers" and are called "interest proceeds"; and ii) the non-basic bank activities (e.g., creating and selling new financial goods and services) where incomes are the result of manufacturing and should be seen as "profits".

When the owners of banks do perform the basic bank activity, I see them as bankers or financial capitalists, and I model their incomes as interest proceeds. When the owners of banks perform non-basic bank activities, I see them as entrepreneurs or industrial capitalists, and I model their incomes as profits. Given this distinction, I see Pivetti's theory as closer to my own theory for the simple reason that Pivetti does not look at interest proceeds as generated by an industrial activity that uses workers and non-labour inputs or workers only. However, my theoretical framework borrows much more from Graziani's theory than from Pivetti's one. In part, I owe to Pivetti the idea of the interest rate on bank loans as a component of the unit cost of production, which is absent in Graziani's theory.

Finally, I am aware of the existence of other theories that look at the rate of interest as influenced by the rate of profit, rather than the converse. An example is a theory put forward by Anwar Shaikh (see Shaikh, 2016). On this specific matter, I fully agree with the direction of causality − from interest to profit − that is suggested by Pivetti, Panico and Ciccarone, all following an initial intuition by Sraffa (1960). These authors have written wonderful pages to explain the reason why the interest rate should be seen as a *primum movens*, using Pivetti's words, and my research adds nothing to earlier studies on this specific point.

10 Conclusions

In one of his recent books, John Smithin refers to my earlier work as an example of *"a useful, relevant, and teachable model of the operations of an economy whose nature is that of the method of enterprise."* (Smithin 2022, p. 55). This paper is an attempt of improvement. It proposes a theory of the mark-up that is embedded in a circuit model of the capitalist mode of production.

This paper's model and theory are built on Keynes's principle of effective demand, Graziani's monetary theory of production and Pivetti's monetary theory of distribution. The price-setting mechanism

[23] Unlike Panico's system, the solution proposed by Ciccarone leaves the Sraffa's original equations unaffected.

is conceived as driven by a Kaleckian rule. The rate of interest on bank loans and the propensities to save of different macro-players are shown to affect the level of the mark-up, thus contributing to explain "labour exploitation" as measured by the average gap between worker's pay and productivity. In other words, this paper suggests that "labour exploitation" is in part originated by monetary phenomena, though its primary source should still be linked to the real (i.e. non-monetary) phenomenon of the workers' separation from the ownership of both the means of production and the output itself.

To summarize, adapting Keynes's analysis of effective demand to a Marxian framework with classes, this paper argues that − for given levels of "final finance", labour productivity and nominal wage − two key monetary factors affect the functioning of a modern capitalist economy: the interest rate on bank loans and the liquidity preference of workers and capitalists. These two monetary factors, when evaluated at their long-period average levels, are seen as playing an important role in determining the long-period average levels of employment and production, both directly and indirectly.

The direct channel is described in my 2020 article (see expressions (3) and (4) in Section 3). The indirect channel, which is the focus of this paper, consists in affecting the price-setting mechanism through the level of the mark-up (see expression (6) in Section 4). For this reason, the interest rate on bank loans and the liquidity preference of different macro-players can be viewed as "the monetary roots of exploitation" in a basic circuit model with Kaleckian pricing, thus also playing a fundamental role in the determination of income distribution.

Appendix A

The long-period average amount of real profits is $\Pi/P = Y - (w/P)L$. Using expressions (1), (3) and (4), one gets:

$$\frac{\Pi}{P} = \frac{a}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w}\frac{B_F}{w} - \left(\frac{a}{1+\mu}\right)\frac{1}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w}\frac{B_F}{w} \tag{A.1}$$

which simplifies to:

$$\frac{\Pi}{P} = \left(a - \frac{a}{1+\mu}\right)\frac{1}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w}\frac{B_F}{w} \tag{A.2}$$

or alternatively to:

$$\frac{\Pi}{P} = \frac{a(1+\mu) - a}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w}\frac{B_F}{w(1+\mu)} \tag{A.3}$$

or finally to:

$$\frac{\Pi}{P} = \frac{\mu}{\mu s_{\pi(i)} + i\left(s_{\pi(f)} - s_{\pi(i)}\right) + s_w}\frac{B_F}{(w/a)(1+\mu)} \tag{A.4}$$

To obtain the profit-maximizing mark-up in Section 4, note that the first-order condition $\partial(\Pi/P)/\partial\mu = 0$ implies:

$$\frac{B_F\left\{[\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w][(w/a)(1+\mu)]\right\} - \left\{s_{\pi(i)}[(w/a)(1+\mu)] + (w/a)[\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w]\right\}\mu B_F}{\left\{[\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w][(w/a)(1+\mu)]\right\}^2} = 0 \tag{A.5}$$

It follows that the mark-up in expression (6) solves the following equation:

$$B_F\left\{[\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w][(w/a)(1+\mu)]\right\} - \left\{s_{\pi(i)}[(w/a)(1+\mu)] + (w/a)[\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w]\right\}\mu B_F = 0 \tag{A.6}$$

The following sequence of equations leads to the solution:

$$B_F(w/a)\left\{[\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w](1+\mu)\right\} - \left\{s_{\pi(i)}(1+\mu) + [\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w]\right\}(w/a)\mu B_F = 0 \tag{A.7}$$

$$\left\{[\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w](1+\mu)\right\} - \left\{s_{\pi(i)}(1+\mu) + [\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w]\right\}\mu = 0 \tag{A.8}$$

$$\mu s_{\pi(i)} + i(s_{\pi(f)} - s_{\pi(i)}) + s_w - s_{\pi(i)}(1+\mu)\mu = 0 \tag{A.9}$$

$$i(s_{\pi(f)} - s_{\pi(i)}) + s_w - \mu^2 s_{\pi(i)} = 0 \tag{A.10}$$

$$i(s_{\pi(f)} - s_{\pi(i)}) + s_w = \mu^2 s_{\pi(i)} \tag{A.11}$$

$$\mu = \sqrt{\frac{i(s_{\pi(f)} - s_{\pi(i)}) + s_w}{s_{\pi(i)}}} \tag{A.12}$$

Appendix B

To understand the relation between i and r^e in Section 5, note that the first derivative of interest implies:

$$\frac{\partial r^e}{\partial i} = \frac{(\partial \mu / \partial i - 1)(1+i) - (1)(\mu - i)}{(1+i)^2} \tag{B.1}$$

For every $i \geq 0$ and $\mu > i$, the above derivative is negative if $\partial \mu / \partial i \leq 1$. It is easy to see that:

$$\frac{\partial \mu}{\partial i} = \frac{1}{2}\left(\frac{s_{\pi(f)}}{s_{\pi(i)}} - 1\right)\left[\frac{i(s_{\pi(f)} - s_{\pi(i)}) + s_w}{s_{\pi(i)}}\right]^{-1/2} \tag{B.2}$$

which can be written as:

$$\frac{\partial \mu}{\partial i} = \frac{1}{2}\left(\frac{s_{\pi(f)}}{s_{\pi(i)}} - 1\right)\left(\mu^2\right)^{-1/2} = \frac{1}{2}\left(\frac{s_{\pi(f)}}{s_{\pi(i)}} - 1\right)\mu^{-1} \tag{B.3}$$

It follows that, for every $\mu > 0$ and $s_{\pi(f)} > s_{\pi(i)}$, there is a positive association between i and μ because:

$$\frac{1}{2}\left(\frac{s_{\pi(f)}}{s_{\pi(i)}} - 1\right)\mu^{-1} > 0 \tag{B.4}$$

It also follows that the inequality $\partial \mu / \partial i \leq 1$ holds when:

$$\frac{1}{2}\left(\frac{s_{\pi(f)}}{s_{\pi(i)}} - 1\right)\mu^{-1} \leq 1 \tag{B.5}$$

which simplifies to:

$$\mu \geq \frac{1}{2}\left(\frac{s_{\pi(f)}}{s_{\pi(i)}} - 1\right) \tag{B.6}$$

For instance, with the propensities to save used in Section 6 ($s_{\pi(f)} = 0.40$ and $s_{\pi(i)} = 0.30$), the above condition becomes:

$$\mu \geq 0.166 \tag{B.7}$$

which is consistent with the mark-up observed in available data in Figure 5.

The exact condition for an inverse relation between i and r^e is the following:

$$\frac{\partial \mu}{\partial i} < \frac{1+\mu}{1+i} \tag{B.8}$$

which means that $\partial \mu / \partial i$ can be even larger than one, provided that μ is sufficiently larger than i.

Appendix C

In Pivetti's monetary theory of distribution, each industry in the economy produces one product. It does so by using labour and non-labour inputs. The technical conditions of production are taken as given, and so are the output quantities.

More specifically, the nominal wage (w), the interest rate (i), the rates of profit of enterprise in each industry ($r_a^e, r_b^e, ..., r_k^e$), the non-labour inputs in each industry ($A_a, B_a, ..., K_a, A_b, B_b, ..., K_b, ..., A_k, B_k, ..., K_k$), the labour inputs in each industry ($L_a, L_b, ..., L_k$) and the output quantities in each industry ($A, B, ..., K$) are all taken as given in Pivetti's theory.

Under the above assumptions, Pivetti determines the prices of the products ($P_a, P_b, ..., P_k$), the rates of profit in each industry ($r_a, r_b, ..., r_k$) and the price of one unit of the bundle of products that the workers buy with their nominal wage ($P_w = A_w P_a + B_w P_b + ... + K_w P_k$, where A_w is a given quantity of the product a in one unit of the bundle w, and similar definitions apply to the other quantities from B_w to K_w). As a consequence, the real wage (w/P_w) is also determined.

In industry a, the equation $r_a = r_a^e + i$ holds by assumption, and so is for all the other industries from b to k. Moreover, in industry a again, the equation $(A_a P_a + B_a P_b + ... + K_a P_k)(1 + r_a) + wL_a = AP_a$ holds by assumption, and so is for all the other industries from b to k.

A way of summarizing Pivetti's key argument is that an increase in the interest rate (i) causes an increase in the rate of profit in each industry ($r_a, r_b, ..., r_k$), thus increasing the prices of the products in the workers' bundle ($P_a, P_b, ..., P_k$). So, the price of the workers' bundle (P_w) increases and the real wage (w/P_w) decreases.

Note that, by averaging the rates of profit across industries, Pivetti's theory implies $r = r^e + i$, where r is the average rate of profit in the economy and r^e is the average rate of profit of enterprise. This equation approximately holds in this paper's model (see footnote (16)) only if r^e and i are small enough.

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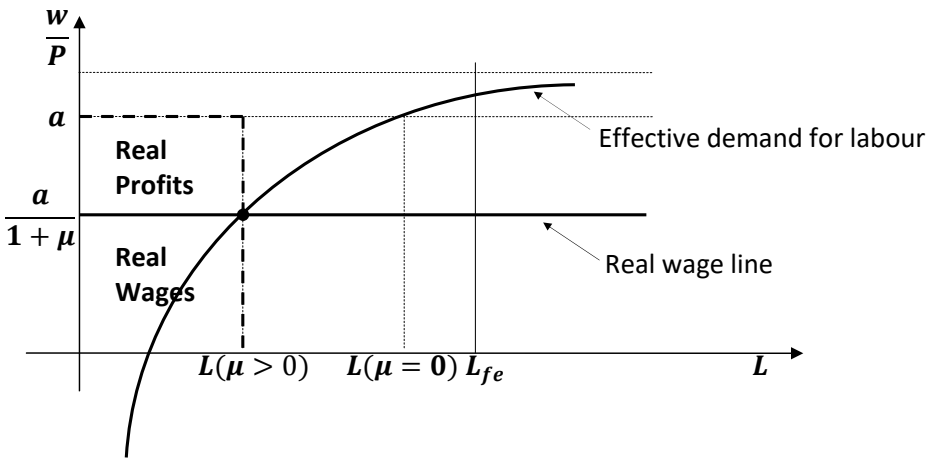
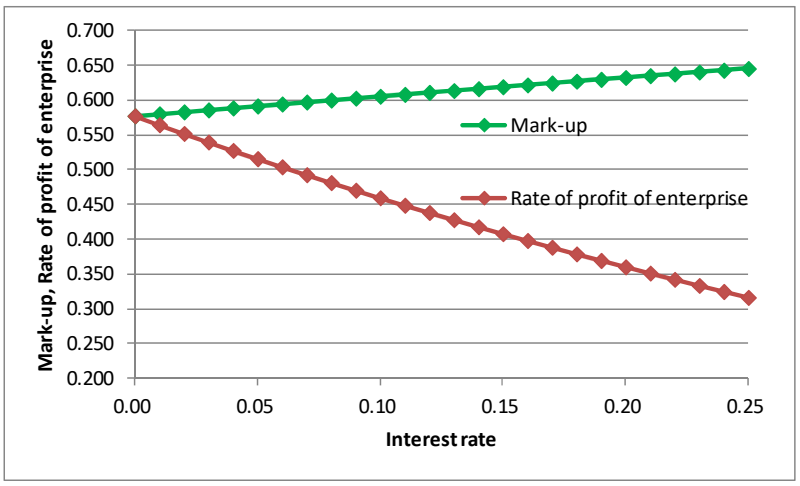
Figure 1. Simple model of modern capitalism



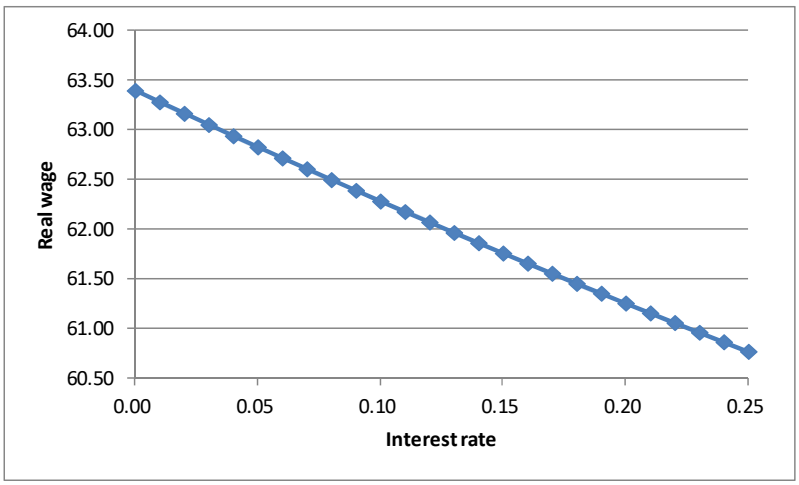
Source: Author's own elaboration from Figure 1 in Andini (2020, p. 418)

Figure 2. Interest rate, rate of profit of enterprise and mark-up



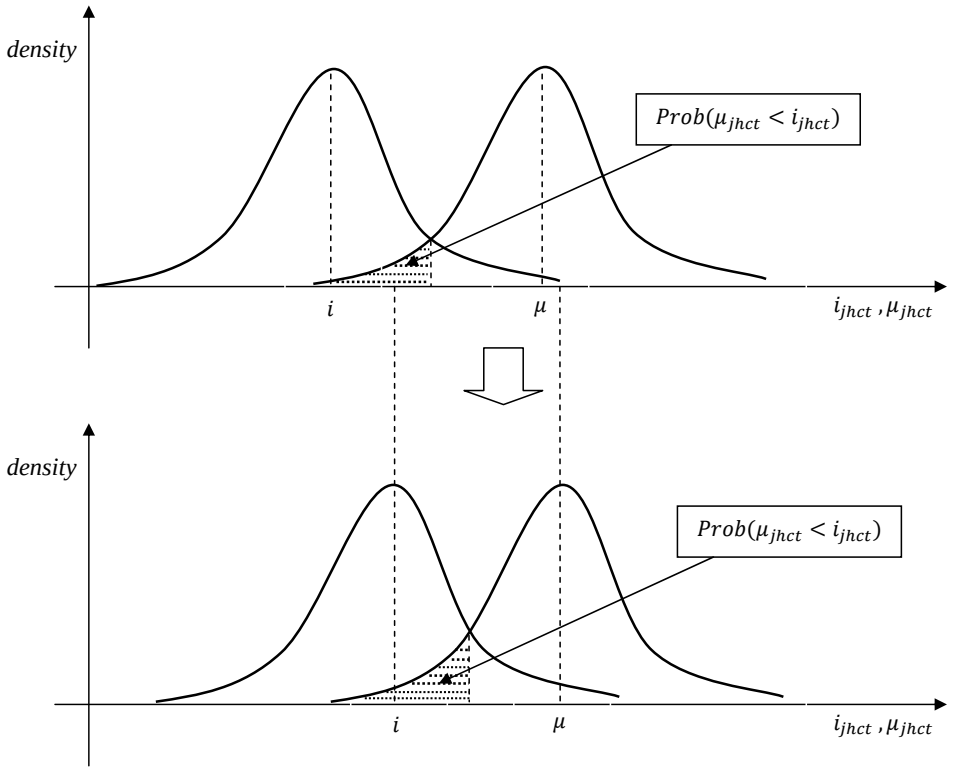
Source: Author's own elaboration

Figure 3. Interest rate and real wage



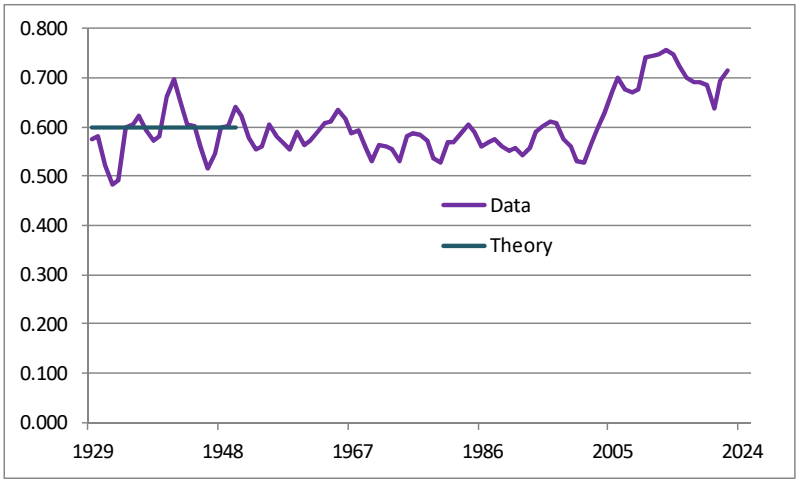
Source: Author's own elaboration

Figure 4. Probability of firm closure



Source: Author's own elaboration

Figure 5. Mark-up in the United States: actual vs. predicted



Source: Author's own elaboration

Table 1. Savings rates at multiples and fractions of average income (1.00)

	0.25	0.50	0.75	1.00	1.50	2.00	3.00	4.00	7.00	10.00	25.00
1929	–30.4	–1.3	8.1	11.6	16.3	19.5	23.6	29.0	37.0	38.5	43.1
1930											
1931											
1932											
1933											
1934											
1935	–32.1	–7.4	–1.5	3.5	9.4	14.1	21.9	27.2	37.5	39.8	49.2
1936											
1937											
1938											
1939											
1940											
1941	–15.6	0.2	5.3	5.0	10.7	13.9	19.3	24.8			
1942	–25.1	–0.1	8.3	10.9	15.9	18.2	22.7	27.1			
1943											
1944											
1945	4.9	7.9	10.7	12.9	15.7	19.6	28.6				
1946	–9.3	1.9	7.0	10.8	15.9	19.7	24.9				
1947	–14.8	1.4	4.6	7.0	10.2	14.0	21.5				
1948	–22.2	–1.3	3.2	6.4	10.8	14.0	18.5				
1949	–31.1	–5.7	–0.6	5.0	11.2	15.6	21.8				
1950	–15.9	–0.8	3.9	7.4	12.1	15.4	20.2				

Source: Author's own elaboration from Table 48 in Kuznets (1953, p. 187)