

## **Income distribution in a monetary economy**

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### **1. Introduction**

Income is distributed through the price system and there are basically two broad approaches to price determination. The Neoclassical model determines prices as the solution to market clearing equilibrium conditions, and the distribution of income is just a by-product of this determination. The Classical tradition, on the other hand, starts with a given distribution of income (the subsistence real wage rate in Ricardo) and solves for the price structure that distributes income according to the stipulated distribution in all lines of production. Post-Keynesian approaches to income distribution are in the Classical tradition, though they differ according to how the rate of profit is determined. Lavoie (1995) provides a useful summary of various post-Keynesian approaches. The Kaleckian ‘monopoly power’ theory, for example, introduces an exogenous mark-up rate implying in effect an exogenously determined profit rate.

Sraffa was the first to recognise the need to determine the distribution of the surplus, “through the same mechanism and the same time as the prices of commodities” (Sraffa, 1960, p. 6). The focus of his analysis in single product industries was the relationship between relative price structure and the profit rate. From his analysis we see that given the money wage rate, one needs to supply another variable (the price of a commodity, the value of a price index or the rate of profit) in order to determine the nominal price structure. The neo-Ricardian approach associated with the work of Pivetti (1985) is motivated by this need and provides a closing equation for the Sraffian system by setting a direct link between the real rate of interest and the profit rate, based on a suggestion to that effect by Sraffa himself.

Of particular interest to us is the Kaldorian approach, which is based

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on the Ricardian model employing “Keynesian apparatus of thought” (Kaldor, 1956).<sup>1</sup> In the Ricardian model given the rate of profit, investment (= total profit) and the corresponding growth rate is determined (Pasinetti, 1960). The Kaldorian approach reverses the direction of determination so that given the rate of growth (via the assumed investment/income ratio), the rate of profit is determined so as to maintain the goods market equilibrium in the long-run.

“Whatever the ratio of net investment to the value of the stock capital may be, the level of prices must be such as to make the distribution of income such that net saving per unit of value of capital is equal to it. Thus, given the propensity to save from each type of income (the thriftiness conditions) the rate of profit is determined by the rate of accumulation of capital” (Robinson, 1962, p. 11).

That is to say income is distributed so as to generate just enough savings to match investment. This idea is basic to any post-Keynesian theory of income distribution. The present paper is based on the same idea. However, in a monetary economy the idea has to be placed in proper context. Investment involves the purchase of capital assets against the prospective flow of future returns, in the form of net cash flows from selling the output that can be produced with them. An investment is worthwhile when the present value of net cash flows that it generates is just equal to the initial cost of it. Clearly the net cash flow that accrues to the investor from the sale depends on the price of the output relative to the cost of the sale. The aim of this paper is to argue that prices must be determined so as to generate the necessary net cash flow that makes the initial investment worthwhile.

While the post-Keynesians have fully integrated the monetary nature

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<sup>1</sup> The monetary circuit tradition of post-Keynesian Economics also subscribes to the theory of Kaldor–Robinson: “followers of the circulation approach [...] follow the so-called Keynes–Kalecki formulation, a formulation corresponding closely to the post-Keynesian theory of Kaldor and Robinson” (Graziani, 2003, p. 98). “The price level depends [...] on the propensities to save and to invest and on the level of money costs (money wages and the interest rate paid on securities)” (*ibid.*, p. 102). The significant difference with the usual Kaldor–Robinson pricing is the inclusion of ‘interest rate paid on securities’ in money costs, an innovation introduced by the circuit approach. Nevertheless, the fact remains that the price level is solved from the equilibrium condition in the goods market.

of capitalist economies in their analysis of effective demand and capitalist dynamics, the same cannot be said for the theories of income distribution.<sup>2</sup> Keynesian theory is firmly established around a theory of money and monetary production. A monetary economy is a contractual economy that uses money as the means of contractual settlement (Davidson, 1980, p. 297). A non-trivial implication of this is that a monetary economy is a nominal economy. All dealings are in money and parties only observe nominal magnitudes so that income is distributed through a nominal price system. Keynes believed and showed that an essential property of a monetary economy is that of the stickiness of the two fundamental nominal contracts, namely wage and financial contracts, in the sense that they are prior to and independent of income determination, as clearly explained in Lerner (1952, pp. 188 ff.) and also Brenner (1980). Moreover, in a monetary economy capital must be understood as money:

“Monetary production means producing and realizing money values. [...] The task of monetary theory of production is to conceptualise a process that begins with money capital, which is used to purchase materials, capital equipment, and labour; these factors are converted into a product, which is offered for sale [...] the theory’s] concern is with money as capital and not with money as a medium of exchange” (Dillard, 1987, pp. 1624-1625).

This statement has its roots in Marx’s famous  $M - C \dots [P] \dots C' - M'$  circuit.<sup>3</sup> Money as capital comprehended within the circuit framework is essential for the argument of this paper. A circuit of capital is closed when the amount of money that initiates the circuit is recovered together with an appropriate rate of return. The purchase of newly invested capital initiates a circuit that generates a stream of net cash flow from selling its

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<sup>2</sup> As far as the post-Keynesian monetary theory and post-Keynesian theories of distribution are concerned, there is an obvious lack of integration between the two, other than bringing in an exogenously determined interest rate as in various models explored by Lavoie (1995). Panico (1997) shows how the Kaldorian and the monetary theories of distribution associated with Pivetti (1985) and Panico (1985) may be reconciled “in the presence of a government operating with a unbalanced budget”.

<sup>3</sup> Keynes made explicit use of Marx’s circuit. See Bertocco (2005), Dillard (1984), Dillard (1987) and Aoki (2001) for accounts of Keynes’ views on Marx, and the common threads in their analysis of the monetary nature of capitalist production.

output. The stream of net cash flow must be sufficient to close the circuit, and this is the sense in which investment is worthwhile. On the other hand, to any circuit of capital as money there corresponds a direct circuit of money. The corresponding direct circuit of money is a pure monetary contract over the same period(s) with the same cash flow as the circuit of capital. In a frictionless world, the two corresponding circuits must be equivalent, as the condition for monetary equilibrium in the sense of Keynes. From the equivalence of the two corresponding circuits of money it is possible to determine what the net cash flow in the circuit of capital assets must be. The next section develops these ideas. In Section 3 a simplified one-sector model in a frictionless environment is used to illustrate how price and income distribution is determined from the equivalence of the corresponding circuits of money. Section 4 extends the approach to a simplified two-sector model, and the nature of equilibrium implied by the model becomes clearer. A final section concludes.

## 2. Money as capital

In a characteristically clear paper, Sir John Hicks distinguishes between what he calls “fundist” and “materialist” conceptions of capital. Accordingly, Classical economists were fundists.

“Classical economics was three-factor economics, and we can now see that the triad had deeper roots than is commonly supposed. Labour is a flow, land is a stock (as stock and flow are used in modern economics); but capital is neither stock nor flow – it is a Fund. Each of the three factors has its own attribute, applicable to itself but to neither of the others. Labour works on land through capital, not on capital nor with capital. The place of each of the factors in the productive process is sharply distinguished” (Hicks, 1974, p. 311).

It is this ‘fund’ nature of capital that the circuits of capital capture. It is an inherent property of a fund that it must be maintained to be available over and again. Any circuit of capital must be closed in the sense that the ‘fund’ that initiates it must be recovered together with sufficient income for capital.

In the basic  $M - C \dots [P] \dots C' - M'$  circuit, production starts with

money ( $M$ ) to obtain commodities ( $C$ ) that go through the production process [ $P$ ] to become a different set of commodities ( $C'$ ), which are then sold for more money ( $M'$ ), and that is how the capitalist sees it, i.e.  $M \rightarrow M'$ . With proper reckoning of what constitutes cost, the difference ( $M' - M$ ) is the gross profit (non-wage value added) that the capitalists derive from the circuit. In careful analysis of Marx's account, 'constant capital' ( $C$ ) is understood to include, "[...] depreciation on fixed capital [and] raw materials and other rapidly used inputs to production" (Foley, 1986, p. 45) and so should not be confused with long-lived plant and equipment, namely fixed capital. The implied rate of 'profit' in this circuit is simply  $r = M'/M - 1$ . In other words, the basic circuit is closed when the initial amount advanced returns (the fund is maintained) together with a profit.

In a monetary economy there is always a direct circuit of money, in the form of a pure monetary contract of money today against payments of money over a number of periods. The one-period direct circuit of money is of the form:

$$M \dots (1 + i)M$$

$i$  being the one-period interest rate. In this circuit, a dollar must earn  $(1 + i)$  so that the fund can be maintained together with the appropriate rate of return. Thus money can either go through the circuit of money as capital, the  $M \dots [P] \dots M'$  circuit, or the direct  $M \dots (1 + i)M$  circuit. If there is no uncertainty associated with realising  $M'$  at the end of the production cycle, the two circuits must be equivalent.<sup>4</sup> Thus a dollar must earn the same rate of return in both circuits and we have

$$i = M'/M - 1 = r$$

With this rate of return, the price of output is  $p = (1 + i)M/X$ ,  $X$  being

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<sup>4</sup> This idea can be traced back to Marx, who considered it as the secondary distribution of the surplus between money-capitalists and the industrial capitalists. See Panico (1980, pp. 365-366).

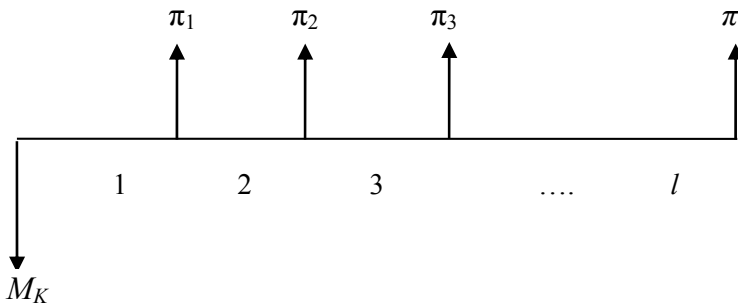
total output so that  $M' = pX$ . This is the same equation that Pivetti (1985)<sup>5</sup> suggested by way of closing the Sraffian system. In the present case, the result follows necessarily from the equivalence of the two corresponding circuits of money.

Investment in fixed capital has its own peculiar circuit. A capital asset gives the purchaser

“[...] the right to the series of prospective returns, which he expects to obtain from selling its output, after deducting the running expenses of obtaining that output, during the life of the asset” (Keynes, 1973, p. 135).

The implied circuit of fixed capital is illustrated in figure 1 as a net cash flow diagram. A monetary outlay of  $M_K$  is made to purchase a capital asset, and the asset yields a net cash flow of  $\pi_t$  in each period over the expected life of the asset ( $l$  periods). In each period the net cash flow is generated through the relevant basic circuit, so that  $\pi_t = M_t' - M_t$ . In other words, the circuit of fixed capital consists of a number of basic circuits, where  $M$  is simply the ‘running expenses of obtaining’ its output.

Figure 1 – *The circuit of fixed capital,  $\pi_t = M_t' - M_t$*



The circuit of fixed capital is closed and the fund is maintained when

<sup>5</sup> In his case  $r = i + npe$ , where  $npe$  is the normal profit of enterprise for the ‘risk and trouble’ of productively employing capital. The same allowance can be made in the present case.

the initial sum invested is amortised, in the sense that the present value of the net cash flow obtained from selling its output is just equal to its supply price. The equation that closes the circuit of newly invested capital will thus be called the amortisation equation. The length of the amortisation period, denoted  $\tau$  in what follows, may or may not be equal to the expected life of the asset, as will be considered below. The amortisation equation is Keynes's marginal efficiency of capital (MEC) equation turned on its head. The MEC equation is used to determine the (internal) rate of return of a given net cash flow so as to close the circuit of newly invested capital. The amortisation equation will be used, in complete contrast, to determine what the net cash flow must be so as to close the circuit of newly invested capital given the interest rate structure. This requires the determination of the price of output since the net cash flow from employing capital depends on the price of output that can be produced with it. Thus, solving the amortisation equation is to ask what the price of output must be, so that newly invested capital generates just enough net cash flow to amortise itself.

The direct circuit of money comparable to the circuit of fixed capital involves lending out the sum  $M_K$  against  $\tau$  equal payments so that the present value of the payment series, at an appropriate discount rate ( $\delta$ ), is equal to the initial sum. As is well known, this gives rise to the annuity factor

$$A(\delta, \tau) = \frac{1}{\sum_{j=1}^{\tau} \frac{1}{(1+\delta)^j}} = \frac{\delta(1+\delta)^{\tau}}{(1+\delta)^{\tau} - 1}, \tau \geq 1 \quad (1)$$

The annuity factor is the capital recovery cost, or the equal payment per period that closes the direct circuit, with  $M_K = 1$ . In the absence of any uncertainty associated with the realisation of the circuit of fixed capital, the two circuits must again be identical. Thus the imputation for fixed capital must be the capital recovery cost  $A(\delta, \tau)M_K$ . In the next section, we show how prices can be determined from the knowledge of this annuity factor. We also demonstrate that solving the amortisation equation gives the same result as the annuity approach.

As far as the length of the amortisation period,  $\tau$ , is concerned, we must recognise that it is a property of the circuit of money like the interest rate, and it is best conceived as "a highly conventional [...] phenomenon" (Keynes, 1973, p. 203) and "must be ascertained from some other source", as Keynes suggested the interest rate must be (Keynes, 1973, p. 137). It is

thus the existence of money that gives rise to a period of amortisation  $\tau$ , which may or may not be equal to the useful life of a capital asset.

To highlight the significance of the idea of amortisation and its implications for price formation, suppose that  $\tau = 0$ , and (1) has no meaning. In this case, the fund tied up in investment is recovered within the same period in the form of profits, as implied by the quotation from Joan Robinson referred to in the introduction. This would be a coherent view in a non-monetary economy, where  $\tau = 0$  makes sense. But in a monetary economy there is a  $\tau > 1$  period circuit of money, and this gives rise to an opportunity cost consideration as expressed by (1). This cost has to be taken into account in any theory of income distribution as the approach being suggested does. Recognition of this cost is also the condition for monetary equilibrium in the Keynesian sense. Monetary equilibrium as implicitly defined by Keynes in chapter 17 of the *General Theory* is a state in which asset prices and own-rates of return must be “[...] such that there is nothing to choose in the way of advantage between the alternatives” (Keynes, 1936, pp. 227-228; see also Panico, 1985, pp. 39-42 on this issue). Moreover, the money rate of interest “sets the pace” in that it “plays a peculiar part [...] since it sets a standard to which the marginal efficiency of a capital-asset must attain” (Keynes, 1936, p. 222). The significance of money derives from it being the ‘standard’ in this sense, and when marginal efficiencies are equated to that of money, nothing in the way of advantage can be obtained by changing the composition of asset portfolios. It follows that imposing the equivalence of the two corresponding circuits of money is in fact a requirement of monetary equilibrium, and the Kaldorian approach will in general fail to satisfy the Keynesian conditions for monetary equilibrium.

Finally, it is interesting to note that the circuit approach produces a result similar to that of Sraffa, who showed that the annual charge for a machine is  $A(r, t)p_m$ , where  $t$  is the life of the machine,  $r$  is the rate of profit and  $p_m$  is the price of a new machine (Sraffa, 1961, paragraphs 75-77, pp. 64-66). The present fundist perspective is straightforward and derives the annuity result from the equivalence of the two comparable circuits of money. The joint production approach of Sraffa treats fixed capital not as a fund, but as a collection of distinct objects distinguished in terms of age, and falls squarely within the ‘materialist’ approach as defined by Hicks (1974). The joint production approach is thus not suitable for comprehending the wider nature of capital as money. Because of this, it cannot distinguish between the length of the amortisation period as a



property of money and the lifetime of capital assets as a technical parameter, while the difference has novel implications that will be developed below.

### 3. A one-sector model

The economy produces a malleable good using labour ( $L$ ) and capital ( $K$ ) according to

$$Q = K/\sigma = L/\lambda, \quad \sigma, \lambda > 0 \quad (2)$$

it being understood that  $L = \lambda K/\sigma$ .<sup>6</sup> The economy is in a steady growth equilibrium with investment ( $I$ ) being a constant fraction ( $\alpha$ ) of output,  $I = \alpha Q$ .<sup>7</sup> In addition, perfect foresight is assumed so that all future prices are expected to remain equal to current prices. All future quantities are also known along the growth path, and there is no uncertainty in this respect. As a result ‘prospective returns’ from investment are known and are realised as expected. Investment has a gestation period of one year, and it takes  $\tau$  years to amortise newly acquired capital assets. Finally, the money wage rate ( $w$ ) and short and long term nominal interest rates are all assumed to be given. These assumptions are consistent with the Keynesian notion of money as explained in Lerner (1952) and Brenner (1980).

Capitalists invest an amount of money  $M_k = pI$  ( $p$  being the current and expected future prices of output) in newly produced capital goods in exchange for a net cash flow of

$$\pi_t = \pi = M' - (1 + i)M = pI/\sigma - (1 + i)w\lambda I/\sigma \quad (3)$$

in each period for  $\tau$  periods, which they expect to obtain from selling its output ( $M' = pI/\sigma$ ), after deducting the running expenses ( $M = w\lambda I/\sigma$ ) of obtaining that output. Here  $i$  is the period interest rate, and running expenses (variable capital) consist of the wage cost, so that  $(1 + i)w\lambda$  is the cost of labour per unit of output as required by the equivalence of the

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<sup>6</sup> To assume such a ‘production function’ is perfectly consistent with the fundist perspective: “[...] the rethinking of capital theory and of growth theory, which followed from Keynes [...] led to a revival of Fundism. If the Production Function is a hallmark of Materialism, the capital-output ratio is a hallmark of modern Fundism” (Hicks, 1974, p. 309).

<sup>7</sup> This means that the economy is growing at the rate  $g = \alpha\sigma - d$ ,  $d$  being the rate of depreciation of the capital stock; and that  $\alpha$  happens to be equal to the propensity to save.

basic circuits of money, as explained in the previous section. We assume that the average productivity of newly installed equipment remains constant during the amortisation period.

With this information, the price of output may be readily determined from the equivalence of the circuit of fixed capital and the corresponding direct circuit of money. Here we define, from equation (1), the capital recovery cost of a dollar as

$$r = A(i^*, \tau) = 1/PV(i^*, \tau) \quad (4)$$

where

$$PV(i^*, \tau) = \sum_{j=1}^{\tau} \frac{1}{(1+i^*)^j} \quad (5)$$

is the present value of a (real) dollar invested for  $\tau$  periods, and  $i^*$  is the long-run real rate of interest (discount), again assumed to be a given.<sup>8</sup> It follows that the required annuity to amortise the invested amount  $M_K = pI$  is simply  $A(i^*, \tau)M_K = rpI$ . Thus, the amount  $M_K$  receives  $\pi_t$  per period, as defined in (3), in the circuit of newly produced fixed capital, while in the corresponding direct circuit of money it must receive  $rpI$  per period. For the two circuits to be equivalent, the net cash flow from (3) must be equal to  $rpI$  and we get:

$$rpI = pI/\sigma - (1+i)w\lambda I/\sigma \quad (6)$$

or after rearranging,

$$p = (1+i)w\lambda + rp\sigma \quad (7)$$

Appendix 1 shows the amortisation equation method of obtaining (7).<sup>9</sup> This equation says that the price of a unit of output produced by newly installed capital assets must cover the cost of capital per unit of output. The cost of capital has two components. That of variable capital, which in the present setting is  $[(1+i)w\lambda]$  and that of fixed capital, which is  $rp\sigma$ . To put

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<sup>8</sup> Here the discount factor has to be in real terms, because in (3) it is implicitly assumed that the net cash flow is in constant dollars. If there is a steady rate of inflation,  $inf$ , equation (3) becomes  $\pi_t = M^t - (1+i)M = p(1+inf)^t I/\sigma - (1+i)w(1+inf)^t \lambda I/\sigma$ , where  $p$  and  $w$  are initial period prices. We would then have  $\pi_t = \pi(1+inf)^t$ , and discounting this nominal flow by nominal interest rates is equivalent to discounting the corresponding real flow by the corresponding real rate. This is because  $\pi_t/(1+i_n^*)^t = \pi(1+inf)^t/(1+i_n^*)^t = \pi/(1+i^*)^t$ , given that  $1+i^* = (1+i_n^*)/(1+inf)$ .

<sup>9</sup> Note that for (7) to yield a positive solution for the price, we must have  $1-r\sigma > 0$ . This is equivalent to the requirement that  $PV(i^*, \tau) > \sigma$  in view of (4).

it differently, the unit cost is the sum of capital recovery costs in the circuits of variable and fixed capital. It follows that the amount  $pI$ , whether lent as money or used to purchase a newly produced capital asset, is earning just  $i^*pI$  in each period, sufficient provision having been made for the normal profit of enterprise. This is also true for capital assets of an older age. A newly produced asset has a supply price, and output that can be produced with it is so priced as to amortise the asset leading to a definite income distribution. An older asset has no supply price, and the price of output that can be produced with it having been determined in the circuit of newly invested capital, its (demand) price reflects its earning potential.<sup>10</sup> In this way, in equilibrium a dollar invested in a fixed asset of any age has the same rate of return  $i^*$ , so that monetary equilibrium in the sense of Keynes holds. Finally, it must be noted that capital has an intrinsic monopoly power, in that the pricing rule in (7) incorporates a capital recovery cost inclusive of interest. Suppose that there is no interest and the amortisation period is just equal to the life ( $t$ ) of the investment goods. Then,  $r = A(0, t) = 1/t$  and let  $p(0, t) = w\lambda + p\sigma/t$  be the price corresponding to this non-monetary world without interest. To the extent that  $A(i^*, \tau) > A(0, t)$  and  $i > 0$ , we have  $p(i^*, \tau) > p(0, t)$  and the difference between the two may be considered a measure of the intrinsic monopoly power of capital.

Since  $rp\sigma$  is non-wage value added, or per unit profit in this two-factor setting, and  $p\sigma$  is the value of per unit capital, it is tempting to refer to  $r$  as the rate of profit. This is potentially misleading as will become clear below. The rate  $r$  is the capital recovery cost and is distinct from the real rate of interest. In particular, a positive capital recovery cost rate does not require a positive interest rate structure, since with  $i^* = i = 0$ , we have  $PV(0, \tau) = \tau$  and  $r = 1/\tau$ , i.e. with interest rates set at zero,  $r$  recovers the capital invested in equal instalments without any rate of return. Further, the rate  $r$  is readily seen to be independent of the short-term interest rate, increasing in the real rate  $i^*$  and decreasing in  $\tau$ . Thus, the higher must be the capital recovery cost, the shorter the amortisation period is and the higher the real discount rate.

The price of output is increasing in  $w$ ,  $i$  and  $i^*$  and is decreasing in  $\tau$ . While these are valid inferences in the strictest sense of comparative statics, it is altogether a different matter to set out clearly the transitional

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<sup>10</sup> This follows from the fact that the demand price of a capital asset is simply the present value of earnings over its remaining lifetime.

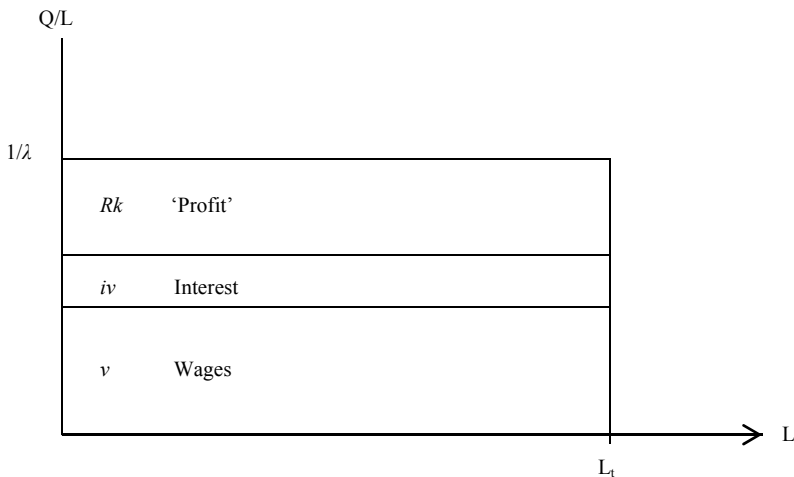
dynamics of how an economy may settle in the final equilibrium after a change. Under plausible scenarios, the actual outcome may be quite different from the *ceteris paribus* comparative static results. Pursuing these issues any further is beyond the scope of this paper, except to point out that the course of nominal wage contracts in response to increases in interest rates, or the possible interaction between short and long term interest rates, may render the *ceteris paribus* results practically meaningless.

Turning to income distribution implications of equation (7), we can write (after dividing both sides of (7) by  $p\lambda$ ):

$$1/\lambda = v(1 + i) + rk = v + iv + rk \quad (8)$$

Here  $v = w/p$  is the real wage rate and  $k = \sigma/\lambda$  is capital per worker. The  $rk$  component is the capital recovery cost, or amortisation payment per worker employed. This equation shows the distribution between wages, interest and ‘profit’ of output per worker produced using newly invested capital goods. Assuming that  $\tau$  is the same as the useful life of the capital good ( $l$ ), and that labour is equally productive on new and old machines, the distribution of income corresponding to a given level of employment is shown in figure 2.

Figure 2 – *Distribution of income, with  $\tau = l$*



In figure 2 the area ‘Profit’ is the total capital recovery cost (or total amortisation payment) and is proportional to investment. In any period, investment undertaken in the previous  $\tau$  periods is being amortised, and the capital recovery cost per each ‘shot’ of investment is  $\pi_j = rpI_j$  ( $j = 1, 2, \dots, \tau$ ).<sup>11</sup> But because  $I_j = \alpha Q_j$ , and since output is growing at the constant rate  $g$ , we can write

$$\pi_j = rp\alpha Q_j = \frac{rp\alpha Q_t}{(1+g)^j} \quad (9)$$

So that the area “Profit” of figure 2 is given by:

$$\Pi_t = \sum_1^{\tau} \pi_{-j} = rp\alpha Q_t \sum_1^{\tau} \frac{1}{(1+g)^j} = \psi(\tau) p\alpha Q_t = \psi(\tau) pI_t \quad (10)$$

where  $\psi(\tau) = r \sum_1^{\tau} \frac{1}{(1+g)^j} = \frac{A(i^*, \tau)}{A(g, \tau)}$ , in view of (4).

This says that total (nominal) profits are proportional to current (nominal) investment ( $p\alpha Q_t$ ), the factor of proportionality ( $\psi$ ) being the ratio of the two annuity factors. We thus have a modified version of the usual maxim that what capitalists earn as profit is proportional to what they spend as investment. Within the current framework, this result follows from the pricing rule, by definition. Moreover, in the Kaleckian ‘macroeconomic’ theory of distribution (Asimakopulos, 1975, pp. 321 ff.), profits refer to total non-wage income, while here it may be only part of it, if the period of amortisation is shorter than the useful life of capital assets ( $I$ ).<sup>12</sup> To see this, note that total non-wage income ( $NWI$ ) is obtained by summing capital recovery costs over all surviving assets, and is given by:

<sup>11</sup> Since  $\pi_j = pI_j/\sigma - (1+i)w\lambda I_j/\sigma = I_j/\sigma(p - (1+i)w\lambda) = (I_j/\sigma)rp\sigma$ , in view of (7).

<sup>12</sup> Since investments that have a shorter life than a viable amortisation period would never be undertaken, the amortisation period can either be equal to or shorter than the useful life of a capital asset. According to Godden (2001) the simple payback period is common as an investment appraisal method in British industry, especially among smaller firms, at least as one of the methods that firms use in conjunction with discount methods. The average payback period turned out to be 2.7 years in 1994 and 3.6 years in 2001 for the firms included in the sample of surveys conducted by the Confederation of British Industry. A small number of firms (less than 5% of the sample in 2001) reported a payback period of 10-11 years. Thus, the payback period seems to depend on the type of industry. If payback period is a rough guide to the parameter  $\tau$ , then the amortisation period is not very long.

$$NWI_t = \sum_j \pi_{-j} = \psi(l)pI_t \quad (10a)$$

Clearly,  $NWI_t = \Pi_t$  would hold whenever  $l = \tau$ , but if  $1 \leq \tau < l$ , then  $NWI_t > \Pi_t$  and the difference we call gross rent (GR). The difference arises because output produced with capital goods that survive beyond the amortisation period must be valued at the same price as that produced by newly invested capital, as determined by (7). Thus, an amortised capital asset keeps on earning  $rk$ , the capital recovery cost per unit of worker employed, while for the asset there is no capital cost to be recovered. Therefore, for amortised assets the  $(rk)$  component yields pure rent, and the difference  $NWI_t - \Pi_t$  is the sum of all such payments.

This is shown in figure 3. As before, the productivity of labour is assumed to be the same on both new and old capital assets. The area denoted by Gross Rent =  $NWI_t - \Pi_t$  is rent proper, unless all of it can be assigned to production related costs other than those covered in the present simplified framework.<sup>13</sup> The existence of rent means “an asset offers a prospect of yielding during its life services having an aggregate value greater than its initial supply price” (Keynes, 1973, p. 213). In the same passage, Keynes suggests that “the only reason” for this is “[...] because it [capital] is scarce”. Our analysis, on the other hand, suggests that whether or not it is scarce, the aggregate value of capital will always exceed the supply price, so long as output is priced to amortise investment and the amortisation period is shorter than the useful life of capital goods.

Finally, from figure 3 gross rent may be defined residually as:

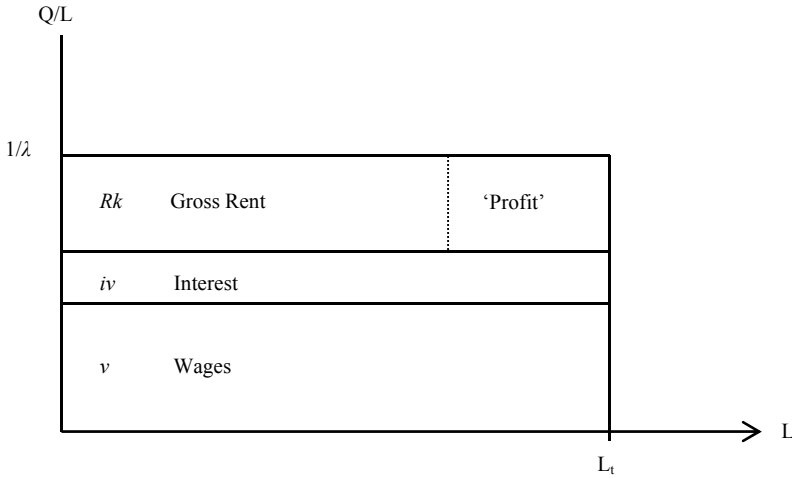
$$GR = rK_t - \psi(\tau)I_t \quad (11)$$

in view of (10), and is therefore well defined. Thus, the share of gross rent in output is  $GR/Q = r\sigma - \alpha\psi(\tau)$ . It is shown in Appendix 2 that for reasonable parameter values the share of gross rent in income would be lower with a higher rate of investment in proportion to output.

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<sup>13</sup> Depreciation in the national income accounting sense and manufacturing overhead costs are obvious candidates for items to be accounted for as costs to be covered in gross rent.

Figure 3 – *Distribution of income with  $\tau < l$*



**4. A two-sector model**

We now briefly consider a two-sector extension of the model, to illustrate how the solution based on closing the circuits of capital may be applied in general. The two sectors produce consumption (*C*) and investment goods (*I*). Outputs are produced according to

$$Q_z = K_z/\sigma_z = L_z/\lambda_z, z = C, I$$

We assume as before that, along the growth path, newly invested capital in each sector is expected to be, and it is, fully utilised, and there is no uncertainty in this respect. Allowing for differences in the amortisation periods in the two industries, the amortisation equations are (see Appendix 1):

$$p_i I_c = \sum_{j=1}^{\infty} \frac{p_c I_c / \sigma_c - (1+i)w\lambda_c I_c / \sigma_c}{(1+i^*)^j}$$

$$p_i I_i = \sum_{j=1}^{\infty} \frac{p_i I_i / \sigma_i - (1+i)w\lambda_i I_i / \sigma_i}{(1+i^*)^j} \tag{12}$$

From these we obtain, in the same way as (7) is derived in Appendix 1, the following price equations in each industry:

$$p_c = (1 + i)w\lambda_c + r_p p \sigma_c \quad (13)$$

$$p_I = (1 + i)w\lambda_I + r_I p_I \sigma_I \quad (14)$$

where  $r_z = 1/PV_z(i^*, \tau_z)$  and  $PV_z(i^*, \tau_z) = \sum_{j=1}^{\tau_z} \frac{1}{(1+i^*)^j}$  = present value factor in

the industry  $z = C, I$ .

These nominal prices, at which newly invested capital assets in their respective industry are amortised, are fully determined for a given constellation of the parameters  $(w, i, i^*, \tau_c, \tau_I)$ . As the focus of the paper is to establish the general nature of the approach, we shall not pursue the solution any more than is provided in Appendix 3.

We now see that if  $r$  is interpreted to be the rate of profit, equations (13) and (14) cannot be equilibrium relations, given that profit rates are not equalised across industries. However, equations (13) and (14) are equilibrium relations in the sense that, if they hold, there is nothing to be gained by shifting capital from one industry to the other, as required by monetary equilibrium. This is because when equations (13) and (14) are satisfied, a dollar invested in either industry is just earning  $i^*$  and it makes no difference if the money invested in one sector is recovered earlier. In equilibrium, a dollar can only earn  $i^*$  whether it is recovered or it is in the process of being recovered, so long as there is no uncertainty associated with the realisation of  $rp\sigma$  in the respective industry, as we are assuming throughout. If uncertainty in this sense becomes an issue, liquidity preference may change in favour of money, pushing the system out of equilibrium as the identity between the direct circuit of money and that of money as capital no longer holds. But that is the concern of a theory of investment and income determination, and not of a theory of long run income distribution, where a state of tranquillity is assumed.

## 5. Summary and conclusions

In a monetary economy, capital is a fund in the form of money, and is best conceived as such within the circuit framework. A circuit must be closed in the sense that the money committed to initiate it must be



recovered together with the appropriate rate of return. To any circuit of capital there corresponds a direct circuit of money, in the form of a pure monetary contract over the same period(s) with the same net cash flow. In a frictionless world, the two corresponding circuits of capital must be equivalent. In other words, in equilibrium there is only one substance in different (liquid or 'solid') states, and there is nothing to choose from in the way of advantage between them. This is also true for the circuit of newly invested capital.

It follows that in equilibrium the imputation for newly invested capital must be the capital recovery cost, as obtained from the corresponding direct circuit of money adjusted for the normal rate of profit. This is the basis of a pricing rule as in (7) above. The income distribution that the pricing rule implies may be neatly summarised by reformulating Robinson (1962): whatever the ratio of net investment to the value of the stock capital may be, the level of prices must be such as to make the distribution of income such that *the present value of the flow of net profits* per unit of *newly invested* capital is equal to *its supply price*. Thus, in a monetary economy income distribution cannot be the long-run mechanism through which equilibrium in the goods market is established along the equilibrium growth path.

The higher price associated with the recovery cost of fixed capital reflects the monopoly power of capital in general, whereby investment is amortised out of the funds it generates over an amortisation period that is shorter or equal to the useful life of the asset. The length of the amortisation period is a property of money, and like other properties of money it is attributed from outside. Whenever the amortisation period is shorter than the useful life of capital assets, the income accruing to already amortised capital stock is rent proper.

In the aggregate, it turns out that total profit is proportional to investment, and may be approximated by it, so that the total gross rent component of income is well defined as the residual non-wage income. The existence of rent is perfectly compatible with the Keynesian notion of monetary equilibrium, in which "[...] there is nothing to choose in the way of advantage between the alternatives". In equilibrium, any alternative is earning the same rate of return as money. In the case of newly invested assets this is achieved by the pricing rule as explained above. In the case of an older fixed asset, this is achieved by the adjustment of the (demand) price of the asset.

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## Appendix 1

Here we show how the MEC equation for a newly invested asset is turned on its head to become the amortisation equation and can then be solved for the price of output. Given the net cash flow from (3), the MEC equation is:

$$pI = \sum_{j=1}^{\tau} \frac{pI/\sigma - (1+i)w\lambda I/\sigma}{(1+i^*)^j} \quad (\text{A1})$$

The MEC approach takes  $pI$  and the net cash flow to be given, and solves for  $i^*$  as the internal rate of return. In complete contrast, we take the real rate of discount  $i^*$  as given and the only unknown in this equation becomes the price of output. Solving for  $p$  in this equation is tantamount to finding the requisite net cash flow to amortise the initial investment  $pI$ . Rearranging (A1),

$$p\sigma = [p - (1+i)w\lambda]PV(i^*, \tau) \quad (\text{A2})$$

or

$$rp\sigma = p - (1+i)w\lambda \quad (\text{A3})$$

with  $PV(i^*, \tau)$  as in (5) and  $r = 1/PV(i^*, \tau)$  as in (4) above. Equation (7) in the text follows immediately from (A3).

## Appendix 2

The share of profits in income is  $\Pi_i/pQ_i = \alpha\psi = \alpha r \sum_1^{\tau} \frac{1}{(1+g)^j}$ .

It is seen that an increase in  $\alpha$  has conflicting effects on the share of profits, because  $\psi$  falls as the growth rate increases with  $\alpha$ . Differentiating  $\alpha\psi$  with respect to  $\alpha$  we get:

$$\begin{aligned} \frac{d(\alpha\psi)}{d\alpha} &= \psi + \alpha r \sum_1^{\tau} \frac{-j(1+g)^{j-1}g'}{(1+g)^{2j}} = \psi - \alpha r g' \sum_1^{\tau} \frac{j}{(1+g)^{j+1}} = \\ &= r \sum_1^{\tau} \frac{1}{(1+g)^j} - \frac{r(g+d)}{1+g} \sum_1^{\tau} \frac{j}{(1+g)^j} \end{aligned}$$

The last equality follows from observing that  $g = \alpha/\sigma - d$ , so that  $g' = 1/\sigma$  and  $\alpha g' = g + d$ ,  $d$  being the rate of depreciation. Clearly, if  $\tau$  is large enough, this expression can be negative. For example, with  $g = 5\%$  and  $d = 2\%$ , the expression is negative for  $\tau = 44$ . Thus, it is safe to consider the effect to be positive for the range of values of  $\tau$  as suggested in note 10. If the share of profits in income increases with  $\alpha$ , that of gross rent falls, as suggested in the text.

### Appendix 3

From (14) we get

$$p_I = \frac{(1+i)\lambda_I}{1-r_I\sigma_I} w$$

which is meaningful so long as the denominator is positive, as in the one-sector model. Using this in (13) we can solve for  $p_C$  in nominal terms as:

$$p_C = (1+i)w \left( \lambda_C + \frac{r_C\sigma_C}{1-r_I\sigma_I} \lambda_I \right)$$

The real wage rate in terms of the consumption good is:

$$w/p_C = \frac{1}{(1+i) \left( \lambda_C + \frac{r_C\sigma_C}{1-r_I\sigma_I} \lambda_I \right)}$$

This means that the short-term interest rate, the usual tool of monetary policy, has a potential downward pressure on the real wage. Using this, we can solve for the relative price:

$$\frac{p_I}{p_C} = \frac{\lambda_I}{1-r_I\sigma_I} \frac{1}{\left( \lambda_C + \frac{r_C\sigma_C}{1-r_I\sigma_I} \lambda_I \right)} = \frac{1}{\frac{\lambda_C}{\lambda_I} + r_C k_C - r_I k_I}$$

where  $r_C k_C = r_C \sigma_C / \lambda_C$  and  $r_I k_I = r_I \sigma_I / \lambda_I$ . Note that the relative price is independent of the short-term interest rate.