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An important inconsistency at the heart of the standard macroeconomic model

Abstract: *The neoclassical macroeconomic dichotomy between real and nominal variables is shown to be generally false, even within the standard structure of the model. The model implicitly assumes that disbursements via interest payments on bonds somehow ensure that all profits are disbursed. But the two are generally different. Forcing them to match renders the model mathematically inconsistent. Alternately, distinguishing the two rectifies the inconsistency but destroys the dichotomy between real and nominal variables and dramatically alter the model's outcomes. One striking consequence is that a rise in the money supply can lead to a fall in prices.*

Keywords: *flow of funds, macroeconomic models, monetarism, neoclassical economics.*

The problem stated

The standard neoclassical model is the foundation of most mainstream macroeconomics. Its basic structure dominates the analysis of macroeconomic phenomena, the teaching of the subject, and even the formation of economic policy. And, of course, the modern quantity theory of money and its attendant monetarist prescriptions are grounded in the model's strict separation between real and nominal variables.

It is quite curious, therefore, to discover that this model contains an inconsistency in its treatment of the distribution of income. And when this seemingly small discrepancy is corrected, without any change in all of the other assumptions, many of the model's characteristic results disappear. Two instances are of particular interest. First, the strict dichotomy

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between real variables and nominal variables breaks down, so that, for example, an increase in the exogenously given money supply changes real variables such as household income, consumption, investment, the interest rate, and hence real money demand. Second, since the price level depends on the interaction of real money demand and the nominal money supply, and since the former is now affected by the latter, price changes are no longer proportional to changes in the money supply. Indeed, we will demonstrate that prices can even *fall* when the money supply rises. The link to the quantity theory of money, and to monetarism, is severed.

In its most basic form, the model encompasses four "markets": commodities, labor, private bonds, and money.[1] These arenas are bound together by the (implicit) household and business sectors' budget constraints, which link what agents plan to spend with what they expect to receive. When cast in Walrasian terms, these budget constraints aggregate into the familiar expression known as Walras's Law, which states that the sum of the planned demands for the four items must equal the sum of their expected supplies—that is, that excess demands in the four arenas must sum to zero (Buiter, 1980; Clower, 1979). This latter result is then used to justify the dropping of any one market from the formal description of the model, on the grounds that equilibria (or even particular disequilibria) in any three determine the state of the fourth. In the standard form depicted in Equations (1) through (11) of the next section, it is the bond market that drops out of view (McCafferty, 1990, p. 46).

As is well-known, the standard model exhibits a block recursive structure beginning from equilibrium in the labor market and moving to real output demand and its components, including the real demand for money, and ending finally in nominal wages and prices. The price level in particular is determined by the conjunction of the real demand for money and a given nominal money supply. Since the former is a function of real variables such as output and the interest rate, and since the block recursive structure implies that real variables are unaffected by the money supply (because they are analytically upstream of nominal relations), it follows that doubling the money supply must double prices so as to keep the real money supply equal to an unchanged real money demand. This is acknowledged to be an absolutely central result of the model (McCafferty, 1990, p. 53). Yet it turns out to be very generally false.

[1] The desired holdings of money are counterposed to an exogenous supply of money, which is not really a market.

The source of the problem lies in the apparently innocuous assumption that all of the real net income of the business sector (the real value of the net product) is somehow distributed to households. In the case of wage income, this is straightforward, since firms pay workers for their labor services. But when we ask how profits are to be distributed, we find that within the logic of the model they can only be distributed in the form of interest payments on the bonds issued by firms, *for there is no other instrument available in the model.* Firms borrow money from households by issuing bonds, and are then obliged to pay interest on them at the rate determined by the model. The difficulty is that these aggregate real interest payments will generally differ from aggregate real profits. This in turn implies that household income (wage and interest income) must generally differ from business income (wages and profits).

It is a simple matter to correct the model by explicitly writing real household income as the sum of real wage and interest income (the latter being the interest rate times the real value of bonds). On the side of businesses, this implies that the value of new bonds issued by firms (their new borrowing) in a given period can differ from the value of the investment expenditures they plan to make, precisely because their total out payments to households can differ from their own net income. Budget constraints, after all, only require that the overall sum of inflows equal overall outflows. With these minor changes, the model becomes consistent.

But, although the correction appears minor, its consequences are not. The full employment core of the original model is preserved, so that real wages, employment, and output continue to be the same. This means that real profits are also unaffected. But now a change in the price level (due, say, to a change in the money supply) changes the real value of bonds outstanding, and hence changes the level of real interest flows.[2] Since real interest flows enter into household income, this affects real consumption demand, real investment demand (which is the difference between the unchanged real output and changed consumption demand), and the interest rate (which must adjust to make real investment demand come out right). Because real money demand is affected in opposite ways by real household income[3] and the interest rate, both of which

[2] Real interest payments $r \bullet Pb \bullet b/P = b/P$ = the real value of bonds outstanding, where r = the rate of interest, Pb = the price of bonds = $1/r$, b = the number of bonds, and P = the price level.

[3] In the standard model, only households hold money. But this is not essential to our results.

change in the same direction, its overall direction of change is ambiguous. It can rise or fall in the face of an increase in the money supply so that prices can change less or more than the money supply. This property alone is sufficient to sever any simple linkage between the two. As noted earlier, we can show that even under perfectly plausible parameter values, prices can actually fall when the money supply increases.

The problem that we have identified is noted in passing in Patinkin's (1965) seminal text, but is then buried in footnotes. In an effort to maintain a forced equality between aggregate household income and aggregate value added, he is driven to make a series of ad hoc behavioral assumptions. He does not remark on the contradictions to which these give rise. We comment on his proposed solutions in the section "Patinkin's attempts to grapple with the issue."

One implication of our results is that the bond market can no longer be "dropped" out of the story. This is because real interest payments depend on the number of bonds, which requires us to deal explicitly with the determinants of this quantity. It is true, of course, that Walras' Law still allows us to infer the state of excess demand in the bond market from that in the other three arenas. But this implicit relation between the supply and demand for bonds does not in itself allow us to determine their respective levels. For that, and hence for the determination of real interest flows, the bond market becomes a structurally necessary part of the model. This is possible because a description of the bond market actually requires *two* conditions: Walras's Law, which in this model reduces to the requirement that the bond market be in equilibrium; and an investment finance constraint for the firm, which provides us necessary additional equation. We will see that these two conditions derive from the implicit budget constraints of the household and business sectors (Buiter, 1980).

A formal exposition

The standard neoclassical macroeconomic model

We start with the standard exposition of the model, elaborated to as to make explicit its underlying assumption that household income is identical to value added—that is, that profits are always completely distributed. Thus, we explicitly express consumption and money demand functions in terms of household income (Equations (4) and (6)), and then add the condition that household income equals value added (Equation (11)). This has no effect on the results at this stage in the argument, but it does prepare us for what follows. In general, lowercase refers to real and uppercase to nominal variables.

Theory of the firm

$$ys = f(k, nd) \quad \text{[aggregate production function, with given real capital stock } k\text{]} \tag{1}$$

$$nd = nd(W/P) \quad [P = MC, \text{ where } MC = W/MPL, \; MPL = f(nd) \text{ from short-run profit-maximizing}] \tag{2}$$

$$id = id(r) \quad [id(r) = \text{investment demand}] \tag{3}$$

Theory of the household

$$cd = cd(yh) \quad \text{[consumption function, from utility-maximizing behavior]} \tag{4}$$

$$ns = ns(W/P) \quad \text{[labor supply of households, from utility-maximizing behavior]} \tag{5}$$

$$Md/P = md(yh, r) \quad \text{[money demand function of households, from optimal portfolio formation]} \tag{6}$$

Definitions and equilibrium conditions

$$yd = cd + id \quad \text{[definition of aggregate demand]} \tag{7}$$

$$yd = ys \quad \text{[commodity market equilibrium]} \tag{8}$$

$$nd = ns \quad \text{[labor market equilibrium]} \tag{9}$$

$$Md = M \quad \text{[money market equilibrium, the money stock } M \text{ being taken as given]} \tag{10}$$

Distribution condition

$$yh = ys \quad \text{[household income assumed to equal value added, that is, all profits are distributed]} \tag{11}$$

where, respectively, yd and ys are real commodity demand and supply, nd and ns are labor demand and supply, yh is real household income, cd and id are real consumption and investment demand, Md is nominal money demand, r is the real (and nominal) interest rate, W and P are nominal wages and profits, and M is the exogenously given money supply.

Note that we have 11 endogenous variables defined above (M being exogenous), and 11 independent equations.

A fundamental characteristic of the model is that it is block recursive. Thus, Equations (2), (5), and (9) determine the equilibrium real wage $(W/P)^*$ and real employment n^*, and through Equations (1) and (8) the latter determines real output and real demand y^*. The preceding variables then determine equilibrium household income yh^*, consumption c^*, investment i^*, the interest rate r^*, and real money demand $(Md/P)^* = md^* = md(y^*, r^*)$, by means of Equations (3), (4), (6), (7), and (11). This last variable, in conjunction with the given money supply M and Equations (6) and (10) allows us to determine nominal money demand $Md = M$, the nominal price level $P = Md/md(yh^*, r^*)$, and the nominal wage $W = P \bullet (W/P)^*$. The significance of block recursion is that equilibrium values of downstream variables have no effect on those of upstream ones. Therefore, a change in the supply of money M must change the equilibrium price level P in the same proportion and direction, because $P = M/md^*$, and the equilibrium real output y^* and interest rate r^*, which determine equilibrium real money demand md^* are upstream of P (and independent of M). *It is this particular property that is the foundation for the monetarist aspect of the model. And it is precisely this property that does not survive.*

Finding the bond market

Although interest *rates* play an important role in the operations of the model, there is no representation of interest *payments.* Where the subject is mentioned at all, it is generally dismissed on the grounds that Walras's Law allows us to drop the bond market out of explicit consideration (Barro, 1990, p. 108; McCafferty, 1990, p. 46; Modigliani, 1963, p. 81; Patinkin, 1954, p. 125; 1965, p. 230). But Walras's Law only permits us to deduce that there will be equilibrium in the bond market if the other three markets are in equilibrium. It does not tell us what the equilibrium quantity of bonds, and hence what the equilibrium level of interest payments, will be. Most important, it does not permit us to drop the flow of interest payments out of sight.

The issues involved can be brought into focus by considering the ex ante budget constraints that underlie the whole model, because then we are forced to explicitly account for the planned uses and expected sources of funds (including borrowing) for each sector. In Table 1, each column represents a particular sector's uses (negative signs) and sources (posi-

Table 1
The *ex ante* flow of real funds

	Households	Firms	Totals
Consumption and investment	$-cd$	$-id$	$-yd = -(cd + id)$
Sales		ys	ys
Wages	$(W/P) \bullet ns$	$-(W/P) \bullet nd$	$-(W/P) \bullet (nd - ns)$
Financial payments	f^e	$-f^p$	$(f^e - f^p)$
Changes in bonds	$-(Pb/P) \bullet (bd - b0)$	$(Pb/P) \bullet (bs - b0)$	$-(Pb/P) \bullet (bd - bs)$
Changes in money	$-(Md - M)/P$		$-(Md - M)/P$
Totals	0	0	0

tive signs). If sectors' are consistent in making their plans,[4] each column, and hence the overall sum of columns, must sum to zero.

The row sums of the matrix are another matter, since they represent the discrepancy between ex ante expenditures planned on a particular activity by a given sector and the ex ante receipts expected from the same activity by another sector. There is no reason here for individual rows to sum to zero, since plans by one sector need not match anticipated receipts by another. All that is required is that the overall sum of the rows be zero,[5] since this is merely the overall column sum. The latter requirement implies that ex ante discrepancies must add up to zero, which in this context is simply Walras's Law.

In Table 1, flows are presented in real terms, and the initial number of bonds is denoted by $b0$ (so that $bd - b0$ represents the change in bond holdings desired by households, and $bs - b0$ represents the change in bond issue expected by firms). Of crucial significance are the *yet undefined* flows of real financial payments f^e expected by households and f^p planned by firms. The flow of funds matrix implies that in addition to the equations of the model there are two further equations implicit in the model. We can derive these equations from any two of the three column sums in the model (since the third is just the sum of the first two). Taking the firms' and totals columns give us the most familiar results.

[4] Clower (1979, p. 297) calls this assumption "a fundamental convention of economic science."

[5] Sectoral budget constraints imply that individual columns, and hence both the sum of column sums and the sum of row sums, equal zero.

Thus, if we take the column sum for firms, recognizing that $ys - (W/P) \bullet nd$ = real profits = π, and that $\pi - f^p$ = undistributed profits, we find that the sectoral budget constraint of firms is equivalent to an *investment finance constraint,* which says that the real value of new bonds issued must equal the *excess* of investment needs over undistributed profits.

$$(Pb/P) \bullet (bs - b0) = id - [ys - (W/P) \bullet nd] - f^p = id - (\pi - f^p) \quad \text{[investment finance constraint]} \tag{12}$$

For the other equation we take the total column sum (and reverse signs), which gives us an expression recognizable as Walras' Law (Equation (13)), except for the presence of the yet undefined financial payments flows. Indeed Equation (13) *is* exactly the form of Walras' Law that Buiter (1980) derives.[6] We will return to that point shortly.

$$\begin{aligned}(yd - ys) + (W/P) \cdot (nd - ns) + (Md - M)/P \\ + (Pb/P) \cdot (bd - bs) - (f^e - f^p) = 0 \\ \text{[Walras's Law]}\end{aligned} \tag{13}$$

Real financial payments appear in both of the preceding relations. But what determines them? The answer lies in the fact that the model assumes that firms issue new bonds, in which case they must also pay interest on these same bonds. *Since bonds are the only instruments for the disbursement of profits, these interest flows are the only financial payments dictated by the logic of the model.* If, in a Walrasian spirit, we assume that borrowing is planned at the beginning of the period and that the corresponding interest rate flows are expected during that same period, and if we note that the price of bonds $Pb = 1/r$, then[7]

[6] Buiter (1980, equation 14, p. 6) actually lists the financial payments as "dividend" payments expected and planned. This is odd because the model contains bonds but no equity (were it the other way around, there would be no rate of interest in the model). In leaving these "dividend" payments unexplained, he sidesteps the inconsistency that we have identified.

[7] An alternate assumption is that interest flows in a given period are on the stock of bonds inherited from the previous period ($b0$). In this case, $f^e = f^p = r \bullet (Pb/P) \bullet b0 = b0/P$ = current real value of the opening stock of bonds. Then Equation (13) takes the familiar form of Walras's Law, since the term $(f^e - f^p)$ drops out. But the dependence of investment finance on interest payments (Equation (12)), and hence on undistributed profits, still remains. And so the basic contradiction in the standard model continues to exist.

$$f^{e} = \text{interest payments expected by household}$$
$$= r \bullet (Pb/P) \bullet bd = bd/P = \text{real value of bonds demanded.}$$
$$f^{p} = \text{interest payments planned by firms}$$
$$= r \bullet (Pb/P) \bullet bs = bs/P = \text{real value of bonds supplied.} \quad (14)$$

Substituting the expressions for real financial payments (Equation (14)) into Walras's Law (Equation (13)) allows us to combine the resulting bond market terms into one expression concerning excess demand in the bond market: $(Pb'/P) \bullet (bd - bs)$, where $Pb' = Pb \bullet (1 - r)$ = the *net* price of bonds. Note that the three equilibrium conditions in Equations (8) through (10), along with Walras's Law in Equation (13), imply the bond market equilibrium condition $bd = bs$. With this elaboration, the model is completely specified.

The trouble is that now the overall model, built around the familiar core in Equations (1) through (11) from which all the standard results derive, *is inconsistent.* This is because the standard form *assumes* that household income yh = the value of net output y = wages + profits. But in actuality, yh = wages + interest payments = $(W/P) \bullet ns + r \bullet (Pb/P) \bullet bd = (W/P) \bullet ns + bs/P$, *so the two expressions for yh are not equivalent because real interest payments will not generally equal real profits.* The former is determined in the bond and money markets, and the latter is determined by a given capital stock and the full employment marginal product of capital. They would be equal only by accident.

Removing the inconsistency is straightforward. One only has to substitute the second, proper, expression for yh into what was formerly Equation (11) of the original model. The consistent model then consists of Equations (1) through (10), the corrected definition of household income (Equation (11')), Equations (12) and (13) modified to reflect the definitions of financial payments in Equation (14) into account, and an explicit definition of bond price *Pb:*

$$yh = \text{wages} + \text{interest payments} = (W/P) \bullet ns + bs/P \quad [\text{household income}] \quad (11')$$

$$(Pb/P) \bullet (bs - b0) = id - \left(\left[ys - (W/P) \bullet nd\right] - r \bullet (Pb/P) \bullet bs\right) \quad [\text{investment finance constraint}] \quad (12')$$

$$(yd - ys) + (W/P) \bullet (nd - ns) + (Md - M)/P + (Pb'/P) \bullet (bd - bs) \quad [\text{Walras' Law}], \tag{13'}$$

where $Pb' = Pb \bullet (1 - r)$ = net price of bonds.

$$Pb = 1/r \tag{14'}$$

Now the model is consistent. But its behavior is substantially different. This is because household income depends on the real value of interest payments, which means that a rise in the money supply affects both the price level *and* the level of real household income (through the real value of interest flows, in Equation (11')). Complex interactions then become possible (see the Appendix). For instance, it becomes possible for a rise in the money supply to raise real household income. This would in turn raise real consumption and *ceteris paribus,* also raise real money demand (Equations (4) and (6)), both of which depend positively on real household income. Because real output, and hence aggregate demand (Equation (8)) is unaffected, the fact that consumption demand has risen implies that real investment demand must fall and hence the interest rate must rise. *Therefore a rise in the money supply can raise the interest rate and "crowd out" investment.*

Real household income and the interest rate move together but have opposite effects on real money demand (Equation (6)), so the overall effect is ambiguous. But the important point is that real money demand $md(yh, r)$ generally changes when the money supply changes. Since the price level $P = M/md(yh, r)$, this means that neither the magnitude, nor even the direction, of price changes is a simple reflection of changes in the money supply. The Appendix shows that some real effects can be substantial, and that prices can even *fall* when the money supply increases. This latter case is illustrated in Table 2.

Patinkin's attempts to grapple with the issue

The crux of the problem arises from the fact that within the logic of the neoclassical model, profits and real interest payments are differently determined and hence will not generally be equal. The standard form of the model, in which these two flows are simply assumed to be equal, produces a system that is over-determined and hence generally inconsistent. This difficulty can be resolved by making the two flows distinct, which renders the model consistent. But then its standard results, particularly those pertaining to the so-called dichotomy between real and

Table 2
Simulated price and real variable changes in the face of an increase in money supply

M	*y*	*yh*	*b*	*c*	*i*	*r*	*W*	*P*
3.8	0.981	0.981	1.087	0.589	0.393	0.172	3.934	2.768
4.2	0.981	0.965	0.943	0.579	0.402	0.044	3.558	2.504
(+10.5%)	(0%)	(–1.6%)	(–13.2%)	(–1.7%)	(+2.3%)	(–25.56%)	(–9.6%)	(–9.5%)

nominal variables, and to the putative effects of a change in the money supply, no longer hold.

Conversely, the standard results require that real business financial out payments f^p = real profits $mpk \bullet k$ at all times, where financial payments at least encompass real interest flows $r \bullet Pb \bullet bs/P$. Only then will household income yh = net value added y, and the value of newly issued bonds equals the value of investment (from Equation (12)). Since all the relevant variables are either given exogenously or determined within the model, *one must propose an additional mechanism to bring about the desired result.* We will see that this is precisely what Patinkin attempts to do.

Throughout his text, Patinkin (1965) *assumes* that all profits will be automatically distributed. But the problems we have raised also seem to have troubled him, because he does make an attempt, albeit very cursory, to justify this crucial assumption. He notes that the assumption of the full distribution of profits requires the further assumption that any excess of profits over interest payments is "appropriated by entrepreneurs" (Patinkin, 1965, p. 201), which would then ensure that total financial out payments by firms f^p = real profits $mpk \bullet k$. Nowhere does he even mention the fact that the difference between profits and interest payments can be positive or negative, which would require entrepreneurs to always pay themselves bonuses in the first case, and always assess themselves *penalties* in the second. Moreover, he does not note that if entrepreneurs did happen to behave in such a manner, the excess profits they paid themselves would be taken from funds that would otherwise be used for investment, and that then have to be made up by extra borrowing by their firms. They would simply be robbing Peter to pay Paul. The implicit behavioral assumptions become even more strained when one considers the case in which interest flows exceed profits, for then entrepreneurs must be supposed to reduce their own incomes (via a penalty) so as to make up the difference. But most important of all, there is absolutely no motivation within the model's own microfoundations for any such behavior. Given Patinkin's emphasis (and that of neoclassical macroeconomics in general) on the importance of microfoundations, this is very telling indeed.

One implication of the assumed automatic full disbursement of profits is that firms must finance investment entirely through borrowing in the bond market (Equation (12) in the case where undistributed profits $\pi - f^p = 0$). This in turn implies that in both real and nominal terms the total value of bonds equals the value of the stock of capital. Just a few pages later, Patinkin runs headlong into the further problems caused by this assumption. And once again, he is forced to make another set of ad hoc assumptions in order to keep these new difficulties at bay.

In the course of a discussion of the effects of a doubling of the money supply, Patinkin derives the familiar result in which nominal variables (W, P) are doubled, but real variables such as output y, the interest r (and hence bond price $Pb = 1/r$), and the real money supply M/P are unchanged. The real *value* of the planned bond supply $Pb \bullet bs/P$ has been *assumed* to be a function of these real variables, so it too must be unchanged. But with Pb unchanged and P doubled, it must then be the case that the *number* of bonds issued by firms bs must somehow double as nominal variables double (Patinkin, 1965, pp. 216–217). So, in a footnote, he says: "There is an implicit assumption here that all the firms' capital equipment must be replaced during the period in question" (ibid., p. 217, footnote 13).

But what can it mean that the firms capital equipment must be "replaced," and how could this resolve the present difficulty? The answer lies in recognizing that with y and r unchanged, real net investment is unchanged. But with P doubled and real investment unchanged, nominal investment is doubled. Thus, firms will have to issue a new quantity of bonds equal to the changed nominal value of new investment. However, with the price level doubled, the nominal value of new capital will also have doubled, so *if firms are to maintain a stock of bonds equal to the value of the capital stock, as required by the distributional assumption,* they must sell a quantity of new bonds equal to the changed nominal value of the capital stock. These two distinct requirements are generally inconsistent.

One step toward rendering the two distinct financial relations consistent is to assume that *all capital turns over in one period,*[8] so that real investment and the real capital stock are always equal. Then, with $i = \Delta k = k$, if firms issue new bonds to finance new investment ($Pb \bullet \Delta bs = \Delta P \bullet i$), then this will also ensure that the change in the nominal value of bonds will match the change in the nominal value of the given capital stock ($Pb \bullet \Delta bs = \Delta P \bullet k$). Then, if the initial value of bonds equaled the initial value of the capital stock, this equality would be maintained throughout as long as the capital stock turned over completely in each

[8] Formally, the number of new bonds issued is given by the investment finance relation $Pb \bullet (bs - b0) = P \bullet \Delta k$. In the standard model, with $r = 1/Pb$ and $i = \Delta k$ unchanged, a change in the money supply implies $Pb \bullet \Delta bs = \Delta P \bullet \Delta k$ in this particular period alone. Hence, only if capital turns over in one period—that is, if there is no fixed capital—does this also imply that the outstanding stock of bonds will have doubled.

period. It should be noted that in this case bonds would also have to be one-period bonds with a price $pb = 1/(1 + r)$, not the consols with a price $pb = 1/r$, which Patinkin assumes throughout.

Understandably uneasy about the previous solution, Patinkin proposes an alternative one.

> Alternatively, we can assume that firms immediately write up their capital equipment in accordance with its increased market value, sell additional bonds to the extent of this increased value, and pass on the explicit capital gains to their respective entrepreneurs. Conversely, in the event of a decrease in prices, entrepreneurs must make good the implicit capital loss, and firms then use these funds to retire bonds. *In this way the nominal amount of bonds outstanding can always be kept equal to the current value of the firms' assets.* (Patinkin, 1965, p. 217, n. 13, emphasis added)

Recall that the crux of the problem is that the assumed automatic distribution of profits requires that the nominal value of bonds remain equal to the nominal value of the capital stock. So now Patinkin abandons the bedrock assumption that firms issue bonds to finance new investment in favor of the assumption that they instead issue or retire bonds to match changes in the nominal value of the existing capital stock: $Pb \bullet \Delta bs = \Delta P \bullet k > \Delta P \bullet i$, since in general $k > i$.

A simple numerical example illustrates the difficulty facing Patinkin. Suppose that initially $Pb = 5$, $P = 1$, $i = 10$, $k = 100$, and that a change in the money supply produces $\Delta P = 1$. Then if new bonds are issued to finance the changed value of new investment, $Pb \bullet \Delta bs = \Delta P \bullet i = 10$, so $\Delta bs = 2$. Alternatively, if new bonds are issued to realize capital gains on the stock of capital, $Pb \bullet \Delta bs = \Delta P \bullet k = 100$, so $\Delta bs = 20$. The two solutions are inconsistent unless one assumes that all capital turns over in one period ($k = i$ at all times), or one abandons the notion that firms issue bonds to finance nominal new investment in favor of the assumption that bonds are issued to "pass on the explicit capital gains [from the increased value of the capital stock] to entrepreneurs."

In all of these instances, Patinkin's strained and behaviorally unmotivated assumptions are driven entirely by the need to avoid the contradictions generated by the a priori assumption that household income always be the same thing as the aggregate net income of firms. This assumption is essential to the derivation of the famed dichotomy between real and nominal variables. But we have seen that any such forced equality between household income and aggregate value added is not sustainable within the logic of the model. Patinkin's discussion only confirms this fact.

Summary and conclusions

Our central finding has been that the famous dichotomy between real and nominal variables, which emerges from the standard neoclassical macroeconomic model, rests on extraordinarily shaky foundations. Writing out the ex ante flow of funds corresponding to the model reveals that its standard form embodies inconsistent assumptions about the treatment of the distribution of non-wage income. Firms are assumed to disburse all of the profits, but the only instrument available is the interest on the bonds they have issued. Contrary to the implicit assumption within the model, the resulting interest flows will not generally equal profits.

The revealed inconsistency is easily rectified by distinguishing between household income (wages and interest payments) and net value added (wages and profits). But then, leaving all other assumptions unchanged, the model's behavior changes dramatically. In particular, real variables such as consumption, investment, the interest rate, and real money demand, become intrinsically linked to nominal variables such as the price level and the money supply. One striking consequence is that a rise in the money supply can actually lead to a fall in prices—even under the standard assumptions about money demand functions. It follows that monetarism cannot be grounded in a consistent neoclassical model.

It should be noted that our main concern here has been to examine internal consistency of the standard neoclassical macroeconomic model. Although we do not advocate this model, it is our hope that our colleagues in the neoclassical tradition will recognize it as a consistent exposition of their own framework and modify their own claims correspondingly.

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Appendix

Numerical simulation of the consistent neoclassical model

The corrected model

$$ys = a \bullet k^{\beta} \bullet nd^{1-\beta} \tag{1}$$

$$MPL \equiv (1-\beta) \bullet nd^{-\beta} = W/P \tag{2}$$

$$id = \gamma_0 - \gamma_1 \bullet r \tag{3}$$

$$cd = \alpha \bullet yh \tag{4}$$

$$ns = \sigma_0 (W/P)^{\sigma_1} \tag{5}$$

$$Md/P = \lambda_0 + \lambda_1 \bullet yh - \lambda_2 \bullet r \tag{6}$$

$$yd = cd + id \tag{7}$$

$$yd = ys \tag{8}$$

$$nd = ns \tag{9}$$

$$Md = M \tag{10}$$

$$yh = (W/P) \bullet ns + (r \bullet Pb \bullet bd)/P \qquad [\text{household income}] \tag{11'}$$

$$(Pb/P) \bullet (bs - b0) = id - (ys - (WP) \bullet nd - r \bullet Pb \bullet bs/P) \qquad [\text{investment finance constraint}] \tag{12'}$$

$$(yd - ys) + (W/P) \bullet (nd - ns) + (Md - M)/P + (Pb'/P) \bullet (bd - bs) = 0 \qquad [\text{Walras' Law}] \tag{13'}$$

where $Pb' = Pb \bullet (1 - r)$ = net price of bonds.

$$Pb = 1/r \tag{14'}$$

We have 14 endogenous variables (*ys, nd, id, cd, ns, yd, yh, Md, r, W, P, Pb, bs,* and *bd*) and 14 independent equations. The three equilibrium conditions and Walras' Law (Equations (8) through (10), and 13) together imply bond market equilibrium *bd* = *bs*.

Parameter values:

$a = 0.97$	$\beta = 0.4$	$k = 3.86$	$\gamma 0 = 0.4054$	$\gamma 1 = 0.75$	$a = 0.6$
$\sigma 0 = 0.4$	$\sigma 1 = 0.1$	$\lambda 0 = 0.20$	$\lambda 1 = 1.65$	$\lambda 2 = 2.6$	$b0 = 0.9$

Initial values (note that initially values have been chosen so that household income is *initially* equal to net value added—that is, all profits are initially distributed):

$M = 3.8$

$ys = yd = 0.981$	$ns = nd = 0.414$	$Md = M = 3.8$
$bd = bs = 1.087$	$cd = 0.589$	$id = 0.393$
$yh = 0.981$ [note that $yh = ys$, initially]		$r = 0.172$
$Pb = 5.81$	$W = 3.934$	$P = 2.768$

Now, when the money supply rises by 10.5 percent to $M = 4.2$, real output and employment are unchanged, household income changes only slightly (from 0.981 to 0.965), and yet there are substantial changes in the interest rate (it drops from 17.2 percent to 4.4 percent), and *the price level actually falls by 9.5 percent.*

$M = 4.2$ (+10.5%)

$ys = yd = 0.981$	$ns = nd = 0.414$	$Md = M = 4.2$
$bd = bs = 0.943$	$cd = 0.579$	$id = 0.402$
$yh = 0.965$	$r = 0.044$	$Pb = 22.721$
$W = 3.558$	$P = 2.504$ (– 9.5%)	

Analysis of the consistent model helps us understand how this sort of result can occur. Equilibrium in the labor market together with the aggregate production function (Equations (1), (2), (5), and (9)) yield equilibrium real output y^*, the real wage bill $(W/P)^* \bullet n^*$, and real profits $\pi^* = y^* - (W/P)^* \bullet n^* = mpk^* \bullet k^*$, none of which are affected by nominal changes. Then equilibrium in the commodity market and its associated relations (Equations (3), (4), (7), and (8)) gives us

$$y^* = cd^* + id^* = \alpha \bullet yh + \gamma_0 - \gamma_1 \bullet r. \quad (15)$$

A comparable result can be derived from money market equilibrium and its associated conditions (Equations (6) and (10)).

$$M/P = \lambda_0 + \lambda_1 \bullet yh - \lambda_2 \bullet r. \tag{16}$$

Note that the two derived relations do not reduce to the familiar I-S, L-M pair because real household income *yh* is not generally equal to real (full employment) output y^*. The former depends on the real demand for bonds, and it is precisely this dependence that prevents us from "dropping" the bond market out of sight. From Equations (8) through (10) and (13') we get $bd = bs = b$, so from Equations (12'), (14'), (7), (8), (4), and (11'),

$$(1/r)(b/P - b0/P) = id - ys + (W/P)^* \bullet n^* + b/P =$$
$$-cd + yh = (1-\alpha)yh,$$

so

$$(b/P - b0/P) = r \bullet (1-\alpha)yh. \tag{17}$$

Since $Pb = 1/r$, $r \bullet Pb = 1$, so from Equation (11'), $b/P = yh - (W/P)^* \bullet n^*$. Substituting this into Equation (17) yields

$$\left[yh - (W/P)^* \bullet n^* - b0/P\right] = r \bullet (1-\alpha)yh$$

$$\left[1 - r \bullet (1-\alpha)\right]yh = \left[b0/P + (W/P)^* \bullet n^*\right], \tag{18}$$

where, since the propensity to consume $\alpha < 1$, $yh > 0$ if $r \leq 1$.

Combining Equation (18) with each of Equations (15) and (16) then gives us two nonlinear equations in $1/P$ and r,[9] whose intersection determines the equilibrium values of P^*, r^*. Note that the value of the money stock *M* enters directly into the equilibrium values via Equation B, as does the initial number of bonds *b*0 via both equations.

$$1/P = \left[\left\{(1 - r + r \bullet \alpha)\left(y^* - \gamma_0 + \gamma_1 \bullet r\right)/\alpha\right\} - (W/P)^* \bullet n^*\right]/b0 \tag{A}$$

[9] The first of these is straightforward, and results in Equation (A). For the second, we get $M/P = \lambda_0 + \lambda_1 \bullet yh - \lambda_2 \bullet r = M/P = \lambda_0 + \lambda_1 \bullet [\{b0/P + (W/P)^* \bullet n^*\}/\{1 - r \bullet (1 - \alpha)\}] - \lambda_2 \bullet r$, which, after rearrangement, yields Equation (B).

$$1/P = \left[\left(1 - r + r \bullet \alpha\right)\left(\lambda_0 - \lambda_2 \bullet r\right) + \lambda_1 \bullet \left(W/P\right)^* \bullet n^* \right] / \left[\left(1 - r + r \bullet \alpha\right) \bullet M - \lambda_1 \bullet b0 \right], \quad \text{for } \left(1 - r + r \bullet \alpha\right) \bullet M \neq \lambda_1 \bullet b0. \tag{B}$$

Given the particular linear functional forms used in this appendix, one can impose restrictions on r (such as, $y^* > \gamma_0 - \gamma_1 \bullet r > 0$ since the right-hand side is investment demand *id,* and $1 - r + r \bullet \alpha > 0$ since that is necessary for $yh > 0$, and so on). There are multiple intersections possible for such nonlinear curves, hence, multiple possible equilibria. Plotting these curves and their shifts in the face of changes in the money supply M or in the initial bond stock $b0$ demonstrates that the possible effects are quite complex.