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Money in representative agent models

What is money? This seems an odd question to ask. Clearly it is the physical item — dollar bill, beads, gold coins — used to pay for goods in order to avoid the 'double coincidence of wants' required in barter exchange. The classic theory of its emergence without social 'invention' is due to Menger (1892) who develops an evolutionary model. In this a good with appropriate characteristics (transportability, wide use etc.) is requested in exchange for goods by sellers secure in the knowledge that someone else will want it in exchange for the goods they may wish to buy — see White (1999). In fulfilling this function money will not pay interest because of the inconvenience involved; money holdings would have to be dated on their face to pay interest, like bearer bonds. But given the frequency with which money changes hands, for each bearer to get interest due of a few pennies would involve obviously bigger transactions costs. (Mrs. Grocer has to give you interest on your pound note when you pay for your bread, after allowing for when you acquired it — an unhappy lady.)

Other theories of how it emerged are of interest but appear in the end not to dominate Menger's insight. We discuss Wallace's (1980) overlapping-generation, OLG, model below; in it money has a store-of-value role in the absence of bonds. As a store of value money has the serious problem that it does not pay explicit interest. Even in primitive societies without paper bonds there are ways of storing value that yield expected return — cattle, inventories, crop credit arrangements etc.. There is an analogous problem with money as a store of value in the Bewley–Townsend turnpike model.

The search-theoretic models of Kiyotaki and Wright (1989, 1991, 1993) are of great interest and essentially a contribution to Mengerian theory. They derive the optimal search strategy of a representative agent within an environment where there are a variety of goods which may function as money, fiat currency being one but with no intrinsic value, the others (commodity moneys) having intrinsic value. They look for Nash equilibria with different moneys. Of course the problem with these equilibria is how one rather than another is selected. Menger's evolutionary model implicitly assumes in addition some sort of adaptiveness; people 'gravitate' towards the initially most promising commodity money and later as the attractions of fiat money become evident (or the interests of a monopoly currency provider, more likely, become dominant) they 'jump' to a fiat currency equilibrium. In their 1993 paper Kiyotaki and Wright show formally that fiat currency adoption is on a knife-edge; if most people decide to adopt it everyone will, but if few think of doing so, noone will. Selgin (1997) shows that a spontaneous move to fiat currency is unlikely if there is adaptive learning; rather, people are likely to adopt commodity money first as the closest alternative to barter and then stay with it. These models can be thought of as the beginnings of a formalization of Menger's ideas.

Suppose we accept the evolutionary theory of money's emergence. Then by the same evolutionary principles we would expect money's functions in time to be performed by new means. Means of payment emerge that use money as a unit of account but for most of the time avoid using money as a means of payment — clearing systems, bank accounts, deposit accounts with nonbank intermediaries, e–money vouchers and so on. The original physical money is the 'base' of this system of 'credit payment' (so-called because you pay with an interest-bearing balance) besides defining the unit (see White (1999) again for a compact history of intermediation along these lines).

As this evolution proceeds we should observe that competition between intermediaries drives the rewards to these functions of money down to the cost of provision for each. So effecting payment via a clearing system will command a competitive fee, while holding a deposit will command the rate of interest: there is 'unbundling' whereby we can consider deposits as held for their returns as stores of value and payment as a separate service done for a fee. Cash alone, being provided by a monopoly supplier (the government typically), will not be subject to competition by assumption within its 'domain'; however, even here evolution may be producing competition as it becomes easier (via the internet for example) to use alternative units of account with general acceptability.

Hence to introduce 'money' into representative agent models we must ask what our purpose is: to model a particular earlier stage of monetary evolution or to attempt to model 'modern times' (or indeed the possible future)? In what follows we introduce several examples of money in the economy, starting with models which we view as historical in intention and going on to models of the here-and-now. Finally we discuss where some tendencies in monetary policy and in potential competition between monetary authorities might lead in macroeconomic behaviour.

We begin with models which treat money as a store of value (it may also be a means of payment but so is any other asset or any good). Representative agent models face a fundamental difficulty in this case: money, defined as a non-interest bearing asset, has no role to play unless one is created for it by an artificial constraint. Consider the models of chapter 11. In models like Lucas', with infinitely-lived agents, there is nothing to stop trades in fruit (different sorts presumably) being paid for by an interest-bearing claim on fruit-in-general. In the Bewley-Townsend model, with parallel communities, government bonds can be used in payment. In the OLG models, again government bonds can be used. So money is inferior to interest-bearing claims and will have no value.

Accordingly, these models have a problem. To resolve it, the Bewley-Townsend model assumes away government bonds, leaving money as the only asset (possibly a government liability). We are presumably to assume that this is a very primitive economy in which there is no legal or other infrastructure to support lending and borrowing.

OLG models attempt an optimizing-agent explanation in the presence of a full menu of assets. They accept that money must offer a yield equal to that of bonds, or it cannot be held (will become valueless, with the 'price level' in terms of it becoming infinite). Then equilibria must involve a rate of inflation (or equivalent money creation and distribution to existing holders) equal to the rate of interest.

It is not obvious what application these models have. The OLG assumption (with no bequests) breaks up inter-generational links and opens up a role for government as an inter-generational intermediary, as we saw in chapter 11 with government bonds. It is frankly difficult to see why a government would print money in such a world when bonds can be issued. (A competitive banking system paying interest on money would be a different matter.) However, a number of these models have grafted on to the OLG constraint additional constraints: that only money (no bond) exists, and that there are regulatory requirements to use it (e.g. to pay taxes). (Incidentally, this regulatory theory of money, presumably motivated by the government's desire for revenue, is the nearest any of these models gets to an optimizing theory of why money exists.) These constraints place such OLG models alongside the Bewley-Townsend one as examinations of economies at a rather early stage of monetary evolution.

INTRODUCING MONEY INTO BEWLEY–TOWNSEND AND OLG MODELS

In chapter 11 we showed that both the Bewley-Townsend and OLG models gave government bonds a role in intermediating between groups which would not lend to each other. However, government bonds are a relatively sophisticated instrument, coming late in economic evolution. Money came first, as a government-backed medium of exchange and store of value. It is interesting to ask how these economies would behave if there were only money to perform this intermediary function.

If money is the only available store of value, then to achieve the optimal consumption-smoothing (that is, intermediation) that bonds achieved (in chapter 11) we require prices to be falling at the rate of time preference.

Consider now the Bewley-Townsend model. Consumers with T-period lives maximize

$$J = \sum_{t=0}^{T} \beta' u(c_t) - \mu_t^h (p_t c_t + m_t^h - p_t y_t - m_{t-1}^h) \tag{1}$$

with $m_{-1}^A = 0$, $m_{-1}^B = m$ given; A agents receive $y^A = \varepsilon$ (odd periods), $y - \varepsilon$ (even); B agents receive $y^B = y - \varepsilon$ (odd), ε (even). The first-order conditions are:

$$0 = \frac{\delta J}{\delta c_t} = \beta' u'(c_t) - h_t p_t \tag{2}$$

$$\frac{\delta J}{\delta m_t^h} = -\mu_t^h + \mu_{t+1}^h = 0 \text{ for } m_t^h > 0$$

$$\leq 0 \text{ for } m_t^h = 0 \tag{3}$$

$$0 = \frac{\delta J}{\delta m_t^h} = -\mu_t^h = 0 \text{ for } m_T^h > 0$$

$$\leq 0 \text{ for } m_T^h = 0 \tag{4}$$

The last, terminal, condition implies that for money to be held in T (as it must be for market clearing, i.e. $N_A m_T^A + N_B m_T^B = M$), then $-\beta^T u'(c_T)/p_T = 0$. But with $\beta^T u'(c_T) > 0$ (since $c_T < \infty$, there can be no saturation of wants), p_T must be infinite: money will all be spent in the last period until it is worthless. Working back to $T-1$, since $\mu_T^h = 0$, so will $\mu^h_{T-1} = 0$, and money will become worthless throughout. So to have a monetary economy we have to let $T \to \infty$. Agents live forever (a parable for the household which treats the interests of its descendants as its own, subject to the constant rate of time preference, β).

In this case, the terminal condition becomes for $m^h_T > 0$,

$$lim_{T\to\infty}(-\mu^h_T) = 0$$

If prices are falling at the rate $1 - \beta$, we know that all agents will smooth their consumption optimally (as in chapter 11); consumption will be constant. Whichever agents are holding money at time t have

$$\frac{u'(c_t)}{p_t} = \frac{\beta u'(c_{t+1})}{p_{t+1}} \tag{5}$$

But A and B agents hold money in alternate periods (as we saw with bonds in chapter 11). Hence (5) holds in alternate periods for A and B agents: so it always holds for one set of agents. Therefore since c_t and u' are constant, $\frac{p_{t+1}}{p_t} = \beta$. Unfortunately, this violates the terminal condition, since $\mu^h_t = \frac{\beta^t u\prime}{p_0\beta^t}$ and therefore $lim_{T\to\infty}(-\mu^h_T) = \frac{-u\prime(c_t)}{p_0} \neq 0$ (unless $p_0 = \infty$).

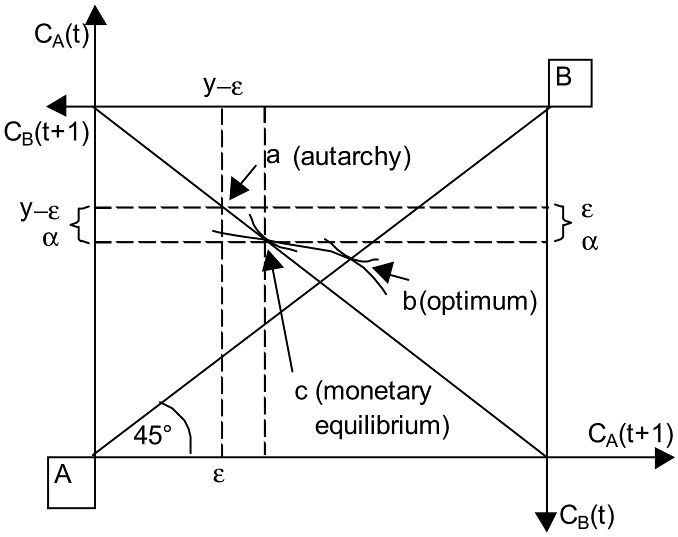
What this means is that as time goes on the present value of money holdings (discounted by the rate of time preference) does not diminish: so people find they have surplus money and spend it. This raises p_T and the path before it, and p does not fall by $(1-\beta)$ each period. This solution is therefore not an equilibrium. It follows that the Pareto-optimal solution in this model is impossible if only money, not bonds, exists.

Only equilibria where prices fall more slowly than $(1-\beta)$ are possible. One such equilibrium is a constant price one: this is obviously interesting as one of the features encouraging the evolution of money would be its stability in purchasing power. Figure 12.1 illustrates how price stability (offering a zero rate of return) achieves less than perfect consumption smoothing.

Let p be constant at $\overline{p} = 1$. Then A agents for example who get ε in odd periods will consume c^{**} in odd periods, c^* in even ($c^{**} \prec c^*$), so that

$$\frac{u'(c**)}{u'(c*)} = 1/\beta \tag{6}$$

B agents consume c^{**} in even periods, c^* in odd (with (6) holding as for A agents). $c^{**} + c^* = y$ for both sets of agents, so that $c^* = y - c^{**}$. Since there are the same numbers ($N = N_A = N_B$) of each, this also satisfies market clearing.



A agents move to an internal equilibrium at c, given zero interest rate: 'lend' α by acquiring money. B agents fail to reach an internal optimum.

Figure 12.1: Monetary equilibrium with a static price level in the Bewley–Townsend model

B agents will hold enough money at the end of odd periods to buy c^{**}in the even periods, but will run this money balances down totally in the even period. The reason is that in the even period $u'(c^{**}) > \beta u'(c^{*})$, so that they would rather spend then than wait and will exhaust their money holdings in the attempt: in terms of the first order conditions, they are at a corner solution with $m_t^h = 0$ (t even). A agents follow the same pattern in the alternate period. The result is that the money supply is passed from A to B each period.

It is possible to get to Pareto-optimal equilibrium if some way can be found to pay interest on money while still satisfying the terminal condition. For example, if prices fall at $1 - \beta$ per period and the money supply is reduced at this rate also by lump sum taxes, then this condition will be satisfied. But it is of course a highly artificial scenario, hardly suited to the idea that this is a primitive economy.

MONEY IN THE OLG MODEL

In the OLG example of chapter 11, we found that, if the government borrowed to finance a transfer to the initial old generation, and chose this transfer well, it could perfectly smooth each generation's consumption pattern across its youth and old age. By failing ever to pay off the loan it maintains this perfect smoothing for ever. The real interest rate is zero; because the economy is not growing, this is in this example the Pareto-optimal outcome. In this model if the economy were growing at the rate n, the Pareto-optimum would be where $r = n$.

This is illustrated in figure 12.2, which shows the zero-saving equilibrium (consumption is $y - \varepsilon$ in youth and ε in old age) with $r = r_o$ and the feasible reallocation along the line $-(1 + n)$, achieved when $r = n$. This reallocation is feasible because the next generation is $(1 + n)$ times the current; so if δ consumption is transferred by each of the young to the old each period, then each of the old, being less in number, will enjoy $\delta(1 + n)$. By giving up consumption to the old today then the young guarantee an old age in which they will enjoy $\delta(1 + n)$. (To achieve this equilibrium, the government must increase its debt and spending each period at the rate n).

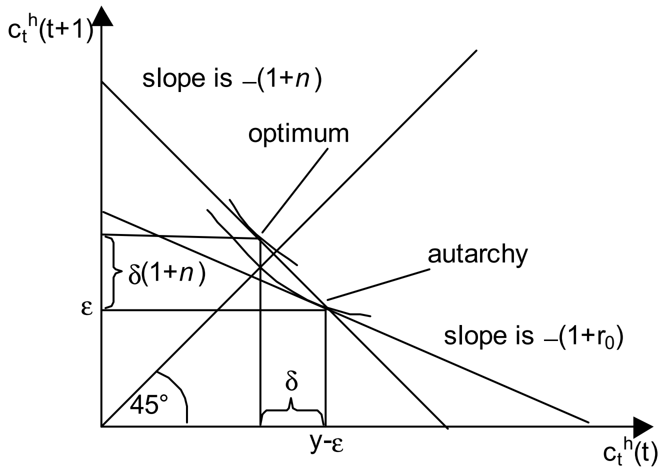


Figure 12.2: Feasible reallocation of consumption from zero savings (autarchy) to optimal intergenerational lending in government bonds — the overlapping generations model with growth, π.

In the example of chapter 11, where $n = 0$, and bonds paid zero interest, we could easily think of money performing exactly the same function as bonds. Let the government issue currency, $H(t)$, instead of bonds and let the price level be $p(t)$. Then we can treat $\frac{H(t)}{p(t)} = -L^g(t)$ as equivalent to the previous bonds, and the equilibrium would be the same. If currency issue were to be kept constant at H_0, $p(t)$ would then be constant at p_0: $\frac{p(t+1)}{p(t)} = 1$, implying a zero interest rate on money, the Pareto-optimal equilibrium as before.

So in this case, money could perform the same consumption-smoothing function as bonds, justifying its role in early societies with no growth and an unsophisticated financial market. It would also be possible for any government to swap bonds for money with no effect on anything (prices, consumption, interest rates) in the economy: there is no need for the new mix of bonds and money $H'(t) + L^{g\prime}(t)$ to change $p(t)$ since $\frac{H'(t)}{p(t)} + L^{g\prime}(t) = \frac{H(t)}{p(t)} + L^g(t)$ and, given that government liabiliies are the same overall, nothing else changes either. This is the 'real bills' doctrine, that open market operations altering the supply of money have no effect.

Matters become more complicated in growing economies, where the optimal $r = n > 0$. Here it will often be the case that a monetary equilibrium cannot be optimal. Essentially, this is because in a monetary equilibrium prices would have to be falling at the rate n. Yet the government must run a deficit in order to permit intermediation between generations. To finance this it must issue more and more currency, which will be inconsistent with falling prices.

However, there will usually exist suboptimal monetary equilibria. A large literature exists exploring the properties of such equilibria: for an introduction to it see Sargent (1987).

The main difficulty with using OLG models for the study of monetary economies is their emphasis on money as a store of value: this and the arbitrage between money and other financial assets produces somewhat strange results. For primitive static economies without alternatives to money, however, OLG monetary models offer interesting insights.

THE CASH-IN-ADVANCE MODEL

To resolve the problem of money's value in a model of a modern economy, it is simply assumed that money is needed for transactions. Money here is the physical unit of cash; all other assets and liabilities are bonds, physical assets, or claims to them (e.g. equities). It is assumed that to make transactions cash is required. In one such model, Lucas', there is a 'cash-in-advance' constraint (following Clower, 1965), whereby it is assumed that spending can only be carried out with money, which must therefore be accumulated in advance (Lucas, 1980).

Similar to this, and used in other models of the same general type, is the assumption that money 'has utility' and is an argument of the consumer's utility function. Effectively, this is being justified by the Clower constraint, and is merely an alternative way of expressing it, implying a degree of substitutability of money in transactions, whereas the cash-in-advance model assumes none.

If money has no use, it becomes valueless. This is obvious enough. Consider some cowrie shells which are stated by some village chieftain to be currency: if no one needs them in order to exchange goods (and they are useless for any other purpose), then there are two possibilities. One is that they have a value in exchange: but if so, they will be spent in order to obtain that value from the goods for which they can be exchanged. Since everyone will get rid of them in this way, they fall in value until they are worthless — the other possibility.

This is worth briefly demonstrating. Suppose the chieftain (government) issues currency of M per capita and will spend $\frac{M}{p_0} = g_0$ where $p_t=$ the price level, g_0 = government spending in period 0: the government spends no more, $g_t = 0$ $(t \geq 1)$. If there exist other assets with a gross return R_t, then for currency to be held it must have an equal return so that

$$\frac{p_t}{p_{t+1}} = R_t = \frac{q_{t+1} + d_{t+1}}{q_t} \tag{7}$$

where q_t is the price of the assets (trees) and d_t their dividend (fruit). Now consider the consumer's budget constraint when the market equilibrium holds:

$$q_t\overline{s} + \frac{M}{p_t} + d_t = c_t + q_t\overline{s} + \frac{m_{t+1}}{p_t} \ (t \geq 1) \tag{8}$$

where $\overline{s}$ = the number of trees per capita and $m_{t+1}=$ the number of currency units held for period $t+1$.

Since $c_t = d_t$ by goods market equilibrium, it follows that $\frac{M}{p_t} = \frac{m_{t+1}}{p_t}$; that is, $\frac{M}{p_t}$ is never spent, but it grows at the rate $(R_t - 1)$ each period, so that its present discounted value is $\frac{M}{p_t}$ of course.

It follows that if there is market equilibrium the consumer can only spend d_t in every period; and yet if $\frac{M}{p_t} > 0$, he will fail to spend all his wealth over his infinite lifetime; that is, he will spend all except $\frac{M}{p_t}$ (in present value). This is sub-optimal. The consumer will therefore attempt to spend more than d_t, which will drive the price level to infinity. Since $1/p_1 = 0$, money will not be held in period 0, so that $1/p_0 = 0$, and the government will be unable to spend anything ($g_0 = 0$).

In order to give money value, it must be given a source of usefulness. As we have seen, one way to point to this is through the Clower constraint, revived by Lucas (1980).

In Lucas' model each household has to acquire money *before* going to buy goods for consumption. Then while one member is shopping for consumption, the other householder is selling the household product for money, which is taken into the next period. Then that part of it not needed for shopping is exchanged for income-yielding assets; and the whole sequence is repeated, starting again with shopping/selling later in that period.

Begin at the start of a period, where the houshold has money, $\frac{M_t}{p_t}$, and assets: one tree, $s_{t-1} = 1$ whose price is $r_t(x_t)$, and government nominal debt $\frac{l_t^h(x_t)}{p_t}$, where x_t is the state of the economy (the vector of current endogenous and exogenous variables). All quantities are measured per capita: everyone now goes into a securities-trading session where assets are acquired and taxes are paid. The market-clearing conditions for this are:

$$m_t^p + m_t^g = M_{t+1} \tag{9}$$

$$s_t = 1 \tag{10}$$

$$l_{t+1}^h(x_{t+1}) = l_{t+1}(x_{t+1}) \tag{11}$$

where M_{t+1} and $l_{t+1}(x_{t+1})$ are respectively the money supply and government claims issued by the government and m_t^p, $l_{t+1}^p(x_{t+1})$ the private sector's demand for these; m_t^g is the government's demand for money.

Having acquired money, government and private agents go into a goods trading session in which household products are sold for money to government and household consumers:

$$p_t d_t = m_t^p + m_t^g \tag{12}$$

is the household income carried into the next period in the form of a money holding. d_t is the harvest per tree.

$$p_t g_t = m_t^g \tag{13}$$

$$p_t c_t = m_t^p \tag{14}$$

are the government's and household's consumption respectively. (We will assume that the nominal rate of interest is positive so dominating the zero return on money — so that consumers never hold more money than they plan to spend. Hence (14) is an equality.)

Equations (12)-(14) imply that the goods market clears:

$$p_t c_t + p_t g_t = p_t d_t \tag{15}$$

and money-market clearing (9) then implies the Quantity Theory:

$$M_{t+1} = p_t d_t \tag{16}$$

Now consider the household's consumption decision in this framework.

It maximizes $E_{t=0} \sum_{t=0}^{\infty} \beta' u(c_t)$ subject to

$$\begin{aligned} \theta_t(x_t) &\geq \frac{m_t^p}{p_t} + \tau_t + r_t(x_t)s_t + \frac{1}{p_t}\int l_{t+1}^p(x_{t+1})n(x_{t+1}, x_t)dx_{t+1} \\ m_t^p &= p_t c_t \end{aligned}$$

$$\theta_{t+1}(x_{t+1}) = \frac{p_t d_t s_t}{p_{t+1}} + r_{t+1}(x_{t+1})s_t + \frac{l_{t+1}^p(x_{t+1})}{p_{t+1}} + \frac{m_t^p - p_t c_t}{p_{t+1}} \tag{17}$$

Equation (17) states that the household's beginning period real wealth, $\theta_t(x_t)$, must be spent on money, taxes (τ_t), and government claims (at current price $n(x_{t+1},\ x_t)$ for contingency x_{t+1}); that consumption can only be carried out by money; and that next period's beginning wealth will be produced by this period's income (in the form of money $=p_t d_t s_t$) deflated by next period's prices, next period's value of the trees and government claims acquired this period, and the value of any money acquired by the household before the goods trading session but not used for consumption then. However our assumption that the nominal return on bonds is positive implies that there will be no such surplus money balance, because money is only useful for buying consumption goods, and the cash-in-advance constraint is binding: $m_t^p = p_t c_t$.

The consumer's Lagrangean is then:

$$L = E_{t=0} \sum_{t=0}^{\infty} \beta^t u(c_t) - \mu_t\{(c_t + T_t + r_t(x_t)s_t \tag{18}$$

$$+\frac{1}{p_t}\int l^p t_{+1}(x_{t+1})n(x_{t+1}, x_t)dx_{t+1} - \frac{d_{t-1}f_{t-1}s_{t-1}}{p_t} \tag{19}$$

$$-r(x_t)s_{t-1} - \frac{l_t^p(x_t)}{p_t}\} \tag{20}$$

The first order conditions yield:

$$n(x_{t+1}, x_t) = \frac{\beta u'(d_{t+1} - g_{t+1})M_{t+1}d_{t+1}}{u'(d_t - g_t)M_{t+2}d_t} f(x_{t+1}, x_1) \tag{21}$$

$$r_t(x_t) = \int \left\{ \frac{\beta u'(d_{t+1} - g_{t+1})}{u'(d_t - g_t)} \right\}. \tag{22}$$

$$\left\{ r_{t+1}(x_{t+1}) + \frac{M_{t+1} d_{t+1}}{M_{t+2}} \right\} f(x_{t+1}, x_t) dx_{t+1} \tag{23}$$

Equation (19) is the price of a nominal bond which pays out when x_{t+1} occurs and it is set just as it was earlier, as the expected domestic marginal utility of consumption in that event relative to its current marginal utility; except that in this case it is the marginal utility of consumption of a nominal rather than a real unit that is assessed, so that it is deflated by the price level when x_{t+1} occurs. (Of course $c_t = d_t - g_t$ by the market-clearing condition.)

Equation (20) is the price of a real asset (the tree). Again the pricing method is the same as before but now the asset's dividend is in monetary form ($p_t d_t$) as it can only be exchanged for money. So apart from the expected future real price, $\int r_{t+1}(x_{t+1}) f(x_{t+1}, \ x_t) dx_{t+1}$, its value depends on the expected value of the dividend received this period but spent next, $\int \frac{d_t p_t}{p_{t+1}} f(x_{t+1}, \ x_t) dx_{t+1}$.

What effects does government policy have on this economy?

The government's budget constraint is:

$$g_t = \tau_t + \frac{1}{p_t} \int l_{t+1}(x_{t+1}) n(x_{t+1}, x_t) dx_{t+1} - \frac{l_t(x_t)}{p_t} + \frac{M_{t+1} - M_t}{p_t} \tag{24}$$

Government policy consists of choosing sequences for g_t, τ_t and M_t, conditional on x_t, and consistently with (21). Now because in this economy the output must be shared between government and private consumption, it is impossible for consumption to be affected by the pattern of taxation or money supply, given the government consumption sequence. However, the money supply sequence (and so also the taxation sequence if it is altered as a result) does affect the real value of real assets (trees). Hence there are real effects of monetary policy and taxation, because the returns from real assets can only be enjoyed by being exchanged for money and then spent. It follows that if there was investment in this economy, but the returns from investment could only be enjoyed by exchange for money, then private consumption would be affected by taxation and monetary policy: the mix between private investment and consumption would be changed. Only if there were an investment vehicle (such as an indexed bond) offering consumption possibilities quite independent of the price level would this cease to be the case. But such a vehicle may be ruled out in this cash-in-advance world (even on an indexed bond the indexed dividend has to be paid at a particular time to be exchanged later for goods in monetary exchange).

UNPLEASANT MONETARIST ARITHMETIC REVISITED

Let us return to the question addressed in chapter 7: whether tighter money today will reduce inflation permanently in the absence of changes in government spending and tax sequences. We can rewrite the government budget constraint:

$$K = \frac{M_1 - M_0}{p_0} + \sum_{j=1} \int q(x_{t+j}, x_t) \frac{(M_{t+j+1} - M_{t+j})}{p_{t+j}} dx_{t+j} \qquad (25)$$

where K is the present value of the $(g_t - \tau_t)$ sequence and $q(x_{t+j},\ x_t) = \frac{\beta' u'(c_{T+j})}{u'(c_t)} f(x_{t+j},\ x_t)$ is the present (t-period) real discounted value of a unit of consumption if x_{t+j} occurs (that is, it is a contingent real discount rate).

Using the quantity theory, we can rewrite this:

$$K = d_0 - \frac{M_0}{p_0} + \sum_{j=1} \int q(x_{t+j}, x_t)(d_{t+j} - p_{t+j-1} d_{t+j-1}/p_{t+j}) dx_{t+j} \qquad (26)$$

If M_1 is lowered, p_0 falls (M_0 is given), so $\frac{M_0}{p_0}$ rises and there is a lower current inflation tax which must be offset by a higher future inflation tax (p_{t+j}/p_{t+j-1}): but because $q(x_{t+j},\ x_t)$ is of the order $\beta^{\ j}$ (c_{t+j} being random and stationary), future inflation has to be higher by the order β^{-j}.

POSSIBLE MODERN EVOLUTIONS OF MONEY AND MONETARY POLICY: THE REEMERGENCE OF COMMODITY MONEY?

In chapter 6 we considered the evidence on optimal monetary (interest rate) feedback policy. We saw that rules in which monetary conditions reacted to deviations of inflation and output from their respective targets (of 'low' inflation and the natural rate) gave good results in conditions where people signed overlapping wage (or price) contracts of some given structure. However, the question arises whether these rules remain optimal when this structure is endogenous; we suggested there that this was not so but rather one found that rules offering price stability (that is, where any excess over the inflation target — which need not be zero — is clawed back in subsequent periods) produced a gain in macro stability because people lengthened the period for which nominal contracts would be signed. A formal rule of this sort would be one with a price-level target in which there was, for example, full clawback of a quarterly inflation error in the following quarter. This is examined in Minford et al. (2001) where the details can be found. The rule is analogous to a commodity standard in which if prices rise, implying that the relative price of the commodity, say gold, has fallen, then less gold is produced, driving the price up again and the general price level down again. With fiat money being targeted on the general price level in terms of money, the supply of money would react more rapidly than gold production under the gold standard; for example, suppose that productivity rose, raising the supply of goods and so driving down the price level, then the money supply would rise in the following period to accommodate this productivity increase, pushing prices back up again.

If households are using their wage contract structure to help minimize the variance of their consumption pattern, then they should react to this greater certainty in prices by reducing the indexation element (or equivalently lengthening their contract period). This will mean (see figure 12.3) that the aggregate supply curve will be flatter (more nominal rigidity) and the aggregate demand curve will be steeper (less reaction of money demand to rising prices because less effect on wages; and so less monetary tightening caused by rising prices, so less fall in output and employment). This in turn implies that real shocks have less effect on both output and prices. So provided pure monetary shocks are kept low this is a recipe for general macro stability.

CONCLUSIONS

Money is a commodity used as a unit of account and a means of payment. Its evolutionary origin most likely lies in the emergence of a commodity with the right characteristics to avoid the double coincidence of wants implied by barter. Its evolution proceeded towards the modern competitive banking system in which money remains the unit of account, issued by a monopoly government, but its payments function has largely been taken over by clearing systems based on credit, in which people can earn interest on their assets as well. Its evolution continues today, with the monopoly role of government in deciding the unit of account possibly coming under competitive threat from other governments and even perhaps the private sector. The models we focus on in this chapter are intended to understand how money interacts with the economy at different stages of monetary evolution. The Bewley-Townsend model

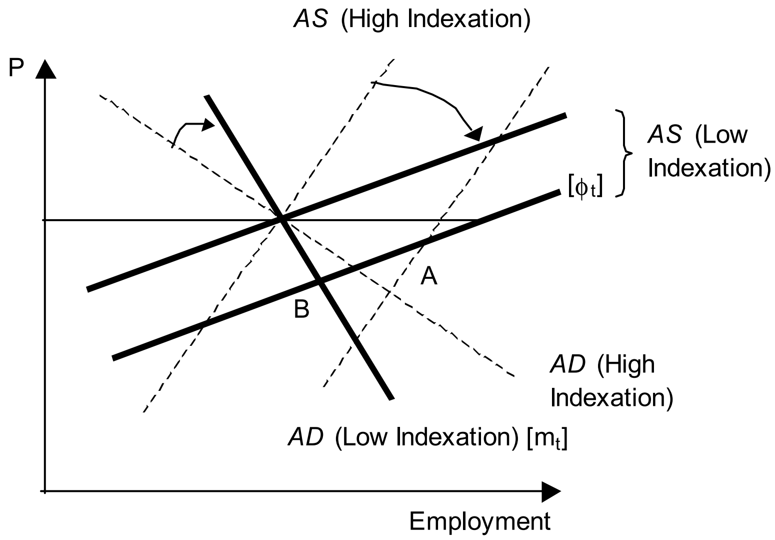


Figure 12.3: The effect of reduced indexation on slopes of AS and AD curves [ϕ_t = productivity shock; m_t = monetary shock]

explains how money permits two parallel (primitive) communities which are too remote from each other to lend directly to each other, to lend indirectly via money holding in the absence of interest-bearing instruments issued by a government or some trusted international intermediary. The OLG model shows how money can be a store of value which permits one generation to lend to the next indirectly again in the absence of bonds: however in a growing economy there are difficulties in achieving a monetary equilibrium which is Pareto optimal. The last model we looked at, Lucas' model of cash-in-advance, simply assumes money is needed for transactions; given that, it models how an economy with its full panoply of other financial instruments would behave. Because returns on other assets have to be turned into money before they can be enjoyed, changes in monetary policy can alter the expected rate of return on these and so have real effects. Finally, we considered how money and monetary policy might develop; currently we observe overlapping wage (and price) contracts which make it optimal to pursue rules of monetary reaction to deviations from inflation and output targets. However, if contracts are endogenous, as surely they are over some time period, then it may well be desirable to pursue price-level stability; this lengthens contracts and creates greater automatic stability in the economy.