"Overlapping-Generations Model and Monetary Economics," (with B.D. Smith), in the *New Palgrave Dictionary of Money and Finance* (J. Eatwell, M. Milgate, and P. Newman, Eds.), Macmillan: London, 1992.

[illegible] gilt sales. *Treasury Bulletin* 2(2), Summer: 40–42.

overissue of currency. The concept of an overissue of currency is of mainly historical interest. The quantity theory of money was already well developed by the mid-18th century and held that, other things equal, too rapid an increase in the quantity of money would cause prices to rise. Subsequent developments in banking saw commodity (usually gold or silver) money supplemented and eventually replaced in circulation by bank liabilities. During the early phases of this development, the liabilities in question were mainly bank notes rather than deposits. The question naturally arose as to whether, and under what circumstances, banks could overissue paper currency in the well defined sense of putting enough notes into circulation to cause prices to rise relative to the value they would have taken under a purely commodity money.

Adam Smith addressed this question in the *Wealth of Nations* (1776). He argued, implicitly on the basis of 18th-century Scottish experience, that, so long as banks confined themselves to lending short on the security of good commercial paper ('real bills'), and so long as they were legally compelled to redeem their notes on demand at a fixed price in terms of gold, overissue was impossible. However, Smith left it unclear as to which of these conditions provided the effective constraint. During the period 1797–1821, when the Bank of England's obligation to redeem its notes in gold was suspended, the advocates of what has come to be called the 'real bills doctrine' often cited him in defence of their view that adherence to the above-mentioned lending policies alone would prevent overissue and hence inflation. The analysis of such economists as Henry Thornton (1802) and David Ricardo (1811), not to mention contemporary experience, established the fallaciousness of this doctrine. Inconvertible bank currency could be, and was, overissued during the suspension period.

By the late 1830s an influential group of economists, the Currency School, were arguing that, though effective in the long run, convertibility into gold on demand was an inadequate check against short-term overissue of currency. In their view, the ability of banks to vary their reserve ratios enabled them to overissue notes for long enough to affect domestic prices and the balance of payments. Such an overissue, again in their view, set the scene for a subsequent financial crisis which would occur when a drain of reserves abroad forced a contraction of the note issue. The Currency School were successful in enacting the 1844 Bank Charter Act which secured a national monopoly of note issue to the Bank of England on the security of a hundred percent marginal specie reserve. However the Act fell far short of its defenders' hopes as a device for creating monetary stability and mitigating financial crises. The Currency School had failed to appreciate that, by the 1840s, deposit banking had become sufficiently important that the concept of an overissue of currency no longer provided an adequate basis for analysing the effects of bank activities on the price level. The relevant variable for implementing the quantity theory of money, and hence for dealing with the more general of overissue and inflation, was by then a monetary [illegible] defined broadly enough to encompass chequeable bank deposits. Their opponents, the Banking School, had some insight into this point, but it was not until 1873 that its implications for monetary policy were fully articulated by Walter Bagehot in his celebrated *Lombard Street*.

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See also BANK CHARTER ACT OF 1844; BANKING SCHOOL, CURRENCY SCHOOL, FREE BANKING SCHOOL; CHEQUE; CURRENCY PRINCIPLE; GOLD STANDARD: THEORY; LENDER OF LAST RESORT; LOMBARD STREET; QUANTITY THEORY OF MONEY; REAL BILLS DOCTRINE IN CLASSICAL ECONOMICS; SCOTTISH FREE BANKING.

BIBLIOGRAPHY

Bagehot, W. 1873. *Lombard Street: a Description of the Money Market*. London: P.S. King.

Ricardo, D. 1811. The high price of gold bullion, a proof of the depreciation of bank notes. In *Works and Correspondence of David Ricardo*, ed. P. Sraffa, Vol. III, Cambridge: Cambridge University Press, 1951.

Smith, A. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. Ed. R.H. Campbell, A.S. Skinner and W.B. Todd, in two vols., Oxford: Clarendon Press, 1976.

Thornton, H. 1802. *An Enquiry into the Nature and Effects of the Paper Credit of Great Britain*. Ed. F.A. von Hayek, London: George Allen & Unwin 1939.

overlapping-generations model and monetary economics. The overlapping-generations (OG) model is a leading alternative to the Arrow–Debreu (AD) model. The two models differ in their demographic assumptions. In the OG model, individuals live finite lifetimes, but the economy goes on forever. Hence the OG model is doubly infinite: there are an infinite number of individuals and an infinite number of dated commodities. The OG model is inherently sequential: the present generations cannot trade directly with future generations. This is not to say that the generations are isolated or that they are merely successive. They overlap. Because of this, the decisions of current generations potentially affect through forward induction the actions of all future generations, and the anticipated decisions of future generations affect through backward induction the actions of the current generation. Hence the OG model is – like the AD model – a general-equilibrium model, but one that is especially designed for dynamic analysis.

The term 'OG' (or 'OLG') is very broadly applied. The economy is usually assumed to go on forever (as in most of our discussion) or at least not to collapse with probability one at any given date, but there are even finite-horizon OG models. The non-demographic assumptions are completely open, including assumptions about the degree of individual rationality, the flow of information, the formation of expectations, the structure of markets (including the timing of transactions), the behaviour of government agencies, and the nature of the overall equilibrium mechanism (including the degree to which individuals' plans are coordinated). Thus the term '*the* OG model' is sometimes used somewhat misleadingly for 'the OG framework' in describing this *family* of models with common – or, at least, similar –

demographic structures.

From the start, the primary motivation for OG analysis came from monetary economics and macroeconomics (see Samuelson 1958; see also Allais 1947). The basic problems in money/macro – such as how the price level is determined and what causes economic fluctuations – are inherently dynamic issues. The OG framework permits a role for money and other outside assets, and is flexible enough to permit consideration of a wide range of assumptions about government policy and private behaviour.

MONEY AND THE PRICE LEVEL. The OG model provides a mechanism which permits fiat money to serve as a store of value. Consider the finite-horizon AD model. In the last period, money is useless. Unless the entire outstanding stock of money is withdrawn by taxation, the market price of money in terms of goods is necessarily zero in the last period. If money is worthless in the last period, then no one wants to hold it. Hence its market price must also be zero in the penultimate period, and so on. Individuals with foresight – not wanting to be stuck with the hot potato – depress the price of fiat money to zero in every period. Samuelson (1958) exploits the fact that OG models have no last period, and hence the hot-potato argument does not apply. Each consumer in Samuelson's pure-exchange economy is endowed with some commodity in each period of his life. Members of the first generation are also endowed with fiat money: in effect, they receive transfers of money from the government. There are no subsequent taxes or transfers and hence the nominal money supply is constant (the public debt is never retired). In the example, the steady-state price level is also constant. Samuelson, by providing a store-of-value role for money, delivers on his ambitious promise to explain the determination of interest rates *with* the social contrivance of money.

If Samuelson's example is altered so that the money supply is zero, or if money's market price is identically zero – always a possibility in any reasonable model of fiat money! – then the competitive equilibrium allocation is not Pareto optimal, even though for every finite set of periods it is. This non-monetary, competitive equilibrium allocation exhibits *oversaving* in the sense that it can be improved upon by making an infinite sequence of commodity transfers from young individuals to old ones. Since money can be used to decentralize such backward sequences of commodity transfers, it can also be used to attenuate the effects of oversaving. The 'double infinity' (Shell 1971) of consumers and dated commodities in the OG model does two things. (1) It allows money to be a private store of value. (2) It is the *sole* source of the potential inoptimality of perfect-foresight competitive equilibrium.

The influential paper by David Gale (1973) considers dynamical equilibria of a simple *stationary* OG economy. Gale's individuals live for two periods – youth and old age. The population growth rate is constant, and all individuals are identical. Fiat money is transferred to members of the first generation. There are no other taxes or transfers. There are two possible types of economies: 'classical' and 'Samuelson'. The types differ according to the representative individual's pre-trade marginal rate of intertemporal substitution. If the individual would prefer a small increase in consumption when young to the same increase multiplied by one plus the rate of population growth when old, then the economy is 'classical'. Otherwise, it is 'Samuelson'. In the classical case, there is only one competitive equilibrium. In it, fiat money is worthless and the allocation is the no-trade allocation, which is Pareto optimal. In the Samuelson case, the no-trade allocation is not Pareto optimal. Moreover, there is a continuum of monetary equilibria parametrized by the first-period price level. One (and only one) of these, the one with the lowest initial price level, is Pareto optimal.

A fiat-money denominated tax-transfer policy is *bonafide* for a given economy if it permits a perfect-foresight competitive equilibrium in which money has value (see Balasko and Shell 1981). (If the government follows a policy in which money is surely worthless, then it is not acting in *good faith*: its policy is not *bonafide*.) A fiat-money denominated tax-transfer policy is *potent* for a given economy if it permits a perfect-foresight competitive equilibrium which is Pareto optimal. In Gale's Samuelson case, the simple passive tax-transfer policy is potent and bonafide, and there is a continuum of monetary equilibria. In his classical case, the passive policy is (trivially) potent but *not* bonafide. How do these results on bonafidelity, potency and multiplicity extend to more complicated economies with heterogeneous consumers, more commodities per period, more consumers per generation, and active taxes and transfers? Cass, Okuno and Zilcha (1979) present interesting examples which establish that, for non-stationary economies or ones with heterogeneity, passive tax-transfer policies are not always potent. Except for its original prominence in the literature, there is no reason to restrict attention to the simple passive policy. If no restrictions are placed on taxes and transfers, one has the obvious result: every Pareto optimal allocation is a competitive equilibrium for some fiat-money denominated tax-transfer policy (see Balasko and Shell 1981).

For finite economies, bonafide tax-transfer policies are essentially equivalent to balanced fiscal policies: a tax-transfer policy is bonafide in an irreducible AD economy if and only if the public debt is exactly retired on the final date (see Shell and Balasko, forthcoming). Bonafidelity in the OG model is more complicated. If the debt is retired in finite time, then the tax-transfer policy is bonafide, as are some constant-debt policies. Some policies in which the debt is asymptotically retired are not bonafide (see Balasko and Shell 1981, 1986). Balasko and Shell (1981) provide a complete characterization of bonafide policies for the OG economy. This result is very deep; but it is far less simple than for the finite-horizon AD economy. In the AD model, only nominal tax quantities matter: bonafide policies and balanced policies are essentially equivalent. On the other hand, in the OG model, the tax-transfer quantities interact with the equilibrium prices and equilibrium allocations in the system of inequalities that is the basis of this characterization of bonafidelity. In OG economies, bonafidelity does not necessarily require balancedness, nor does balancedness ensure bonafidelity.

The multiplicity of competitive equilibria in Gale (1973) (see also Calvo 1978) is even more pronounced in more general OG models. As in Gale, there is multiplicity of initial price levels, but (unlike in Gale) there are also likely to be high-dimensional sets of equilibria for any fixed equilibrium price of money (including zero) (see Kehoe and Levine 1984a, 1984b; Geanakoplos and Polemarchakis 1984; Santos and Bona 1989). If the tax-transfer policy is bonafide in a smooth economy, then the set of equilibrium money prices usually contains an interval (see Balasko and Shell 1981), although Peck (1988) shows that this set is not always connected. (As the goods price of money is increased, some taxed individual is eventually bankrupt, which destroys the possibility of equilibrium. It is possible that through income effects the taxed individual is restored to solvency at a higher real tax, permitting the existence of monetary equilibrium.) Garratt (1992) shows that the connectedness property is sensitive to the choice of *numéraire* good. In a simple note, Michael Kelly (1991) shows that restrictions on the path of taxes and transfers place no restrictions on the government's ability to affect the *set* of perfect-foresight monetary equilibria in economies with perfect capital markets, but that the path of deficits could possibly play a role as a coordinating device in selecting perfect-foresight equilibria.

What is to be made of this vast indeterminacy of monetary (and non-monetary) perfect-foresight competitive equilibria? The indeterminacy reminds us that the so-called Quantity Theory is only one of a vast multiplicity of perfect-foresight models of price-level determination. It also makes one sceptical of the perfect-foresight concept itself. How do individuals pick one perfect-foresight solution over another? How do individuals from different generations coordinate their plans on a perfect-foresight solution? This leaves open the possibility of other solution concepts, including the sunspot-equilibrium concept. The histories of the OG model and the sunspot-equilibrium model are intertwined. The two defining features of the OG model, the double infinity and the natural restrictions on market participation, *are separate sources* of sunspot equilibria (see Shell 1977; Cass and Shell 1983, 1989; Azariadis 1981; Azariadis and Guesnerie 1986; Shell 1987; Guesnerie and Woodford 1991; Chiappori and Guesnerie 1991).

MONEY AND BONDS. Our discussion thus far could be regarded as applying not just to money, but to any kind of paper asset created by the government. This public debt includes both money and bonds, and serves as a store of value, a medium of exchange and a vehicle for paying taxes (and receiving transfers). Obviously these roles are interdependent, and also depend on existing institutions and conventions. However, if an asset is not a store of value, then it cannot perform the other functions mentioned (see Wallace 1980 and Cass and Shell 1980). The store of value function may or may not be the most interesting role of a paper asset, but it is a necessary one, and one the OG model permits money and bonds to play.

For some purposes, one may wish to draw a sharper distinction than this between 'money' and 'bonds', based on the observation that 'bonds' earn higher nominal interest than 'money'. As has been widely noted (see, e.g., Tobin 1980 and Wallace 1983), OG models with only the features we have considered up to this point will not permit the coexistence of positively priced fiat money with an asset that dominates it in rate of return. Several routes can be taken that allow money and interest-bearing bonds to coexist in an OG model. One, pursued by Grandmont and Laroque (1975), imposes liquidity constraints that limit borrowing and hence force the use of money to purchase commodities. Grandmont and Laroque motivate liquidity constraints by appealing to problems associated with enforceability, informational frictions, and transactions costs (similar to those analysed by Foley 1970; Hahn 1971, 1973; Starrett 1973; and Heller and Starr 1976). The OG framework permits a tractable introduction of both informational asymmetries (see Brock (1990) for a discussion of pure-exchange OG economies with transaction costs or Bencivenga, Smith and Starr (1992) for a discussion of transactions costs in an OG model with production) and transactions costs (Bencivenga, Smith and Starr 1992), as well as an analysis of how these factors create additional roles for money.

Another method for allowing money and interest-bearing bonds to coexist is for the government to impose restrictions that limit competition between money and assets that dominate it in rate of return. Such approaches, termed 'legal-restrictions theories' (Wallace 1983), proceed from the observation that governments often use reserve requirements or restrictions on the issue of small-denomination circulating liabilities to 'separate' money from 'credit instruments'. Moreover, Bryant and Wallace (1984) (see also Villamil 1988 or Cooley and Smith 1991) have shown how such restrictions may reduce welfare losses from inflationary taxation, while Smith (1988) has illustrated how they may reduce potential indeterminacies.

Finally, we note that there is an OG literature which bases a medium-of-exchange (as well as the store-of-value) role of money on spatial separation and limited communication. Such work is in the spirit of Townsend (1980, 1987a, 1987b), and represents an attempt to be concrete about potential sources of informational frictions or transactions costs. Examples of such work include Peled (1982), Freeman (1989), and Champ, Smith and Williamson (1991).

MONETARY AND FISCAL POLICY. One of the first applications of the OG framework to a conventional macroeconomic problem was that of Diamond (1965). Diamond adds production – undertaken with labour and physical capital – to the OG framework. Diamond avoids issues of price-level determination by denominating the government debt in real terms. Competitive equilibria without debt can be non-optimal. In particular, the steady-state capital–labour ratio can exceed its golden-rule level. Diamond also re-examined the burden-of-the-public-debt question posed by Modigliani (1961): how much private capital is displaced by public debt (comparing steady states)? He shows that the crowding out of capital is not typically of the one-for-one variety conjectured by Modigliani. Diamond's analysis, which considers only constant per capita deficits, was subsequently extended by Phelps and Shell (1969), who show that, for high-interest-rate regimes, increased debt would even lead to increased capital–labour ratios across steady states.

Another seminal contribution using the OG framework to analyse macroeconomic policy issues was that of Lucas (1972). Following Phelps (1970), Friedman (1968) and others, Lucas produces theoretical underpinnings for a 'Phillips-curve' relation by confronting agents with an information-processing problem. In particular, Lucas considers an OG model with production in which money is injected via proportional transfers, with the quantity of money injected being a random variable. The economy is also subject to an additional source of randomness. The types of randomness Lucas considers would seem to be innocuous (but consider sunspots!) if the realization of each random disturbance were separately observed. However, some individuals in the model observe only one signal about the two disturbances, and hence face a signal-extraction problem. By focusing on a particular class of equilibria, Lucas is able to show that the presence of this problem allows monetary shocks (that would have been neutral under full information) to have real effects. More specifically, within the class of equilibria (the Quantity-Theory class) which Lucas examines, high money-growth rates lead on average to both high inflation and high output, thus providing a rationalization for the 'Phillips-curve'. Subsequent research has established the sensitivity of Lucas's particular results to his restrictive assumptions about price-level expectations. Quantity-theory beliefs are not the only rational-expectations beliefs.

Lucas's seminal article also stimulated research on other methods for generating 'business-cycle' behaviour in rational-expectations OG models. Shell (1977), Azariadis (1981) and Cass and Shell (1983) demonstrate that equilibria can arise in which extrinsic uncertainty matters: the observed cyclical fluctuations are then due to rational self-fulfilling beliefs. These equilibria, the sunspot equilibria, allow random fluctuations in economic outcomes, despite the absence of randomness in economic fundamentals. This line of research has generated a large subsequent literature, which is reviewed by Chiappori and Guesnerie (1991), Guesnerie and Woodford (forthcoming) and Shell (1987). In a different vein, Benhabib and Day (1982), Grandmont (1985), Benhabib and Laroque (1988), and others have shown how complex perfect-foresight dynamics can arise in OG models. Such equilibria can be regarded as displaying endogenous fluctuations (see also the collection of essays in Grandmont 1987, or, for a survey, Boldrin and Woodford 1990).

In much of this work that considers variations in the money supply (for instance that of Lucas or Grandmont), these variations could as well be regarded as the consequence of fiscal as of monetary policy. In particular, these analyses have monetary changes accomplished via taxes and transfers; hence monetary changes are also fiscal policy changes. If we regard monetary policy as being solely about changing the composition of the central bank's balance sheet, then the earliest analyses of pure monetary policy in the OG model are those of Bryant and Wallace (1979, 1980) and Wallace (1981). Of these, Wallace (1981) presents a particularly striking result, which he terms a Modigliani–Miller Theorem for open-market operations. Based on the same reasoning as the Modigliani–Miller Theorem for corporate finance (Modigliani and Miller 1958), this theorem asserts that open-market operations (which hold fiscal policy constant in a precise sense) are irrelevant for the entire set of equilibria in a monetary OG economy. More specifically, not only do open-market operations not affect allocations, they do not affect the price level. Interestingly, there is some empirical support for this implication of the OG model, which does not arise in most other money models. Along similar lines, Bryant and Wallace (1979) consider open-market operations when bonds dominate money in rate of return because of certain kinds of transactions costs. They find that open-market expansions of the money supply *reduce* the price level, because such expansions reduce economy-wide bondholdings and the transactions costs associated with them. The associated resource saving is then a deflationary force. This is an important point, because most standard money demand functions are based on the notion of transactions costs associated with converting interest-earning into non-interest-earning assets of the type that Bryant and Wallace consider.

Another area of discussion in which OG models have proven useful is the regulation of financial markets. Ever since Adam Smith (1776), debate has raged over the appropriate degree of government regulation of banking and financial markets. Some, such as Simons (1948) and Friedman (1960), have advocated extensive regulation, including but not limited to 100 percent reserve requirements for banks. These proposals are based on the notion that a failure to prevent economic actors from issuing close money substitutes would lead to 'excessive' price-level fluctuations, and possibly to price-level indeterminacy. Such reasoning has been formalized in an OG context by Sargent and Wallace (1982) and Smith (1988), who provide models in which unfettered financial intermediation does lead to price-level fluctuations, and in the latter case, sunspot indeterminacies. These authors also show how the Simons–Friedman proposals can lead to price stability. Nevertheless, such proposals often result in poor welfare performance. This illustrates the point, most often made in OG models, that it is not necessarily correct to evaluate policy proposals based solely on their implications for price-level behaviour.

We have only scratched the surface of the actual and potential usefulness of the OG framework in the analysis of monetary policy issues. For example, the OG model is a natural means for analysing exchange-rate determination (Kareken and Wallace 1981; Manuelli and Peck 1990) and the consequences of foreign-exchange operations (Sargent and Smith 1987). This literature draws the parallel between the dollar/yen exchange rate in the international economy and the blue-money/red-money exchange rate in the domestic economy. The OG framework is also proving to be congenial to the analysis of government policy in the face of financial intermediation (Bencivenga and Smith 1991; Champ, Smith and Williamson 1991; Azariadis and Smith 1991b). Finally there are several monetary policy areas in which OG analysis has yet to be applied, but could be applied fruitfully. An example is the analysis by Lucas and Stokey (1983) of credibility, commitment, and time-consistency of government policy. Their model is based on infinite-lived consumers who face cash-in-advance constraints. In their model, the presence of money is incompatible with time consistency. In an OG environment, this incompatibility would be closely related to the possibility that the core of an economy is empty, and in particular, that it might be desirable for the young to avoid resource transfers to old agents. Thus we conjecture that the literature on the core of the OG economy (see, e.g., Hendricks, Judd and Kovenock 1980; Esteban 1986, 1991; Chae 1987; Chae and

Esteban 1989; and Esteban and Millan 1990) will be of assistance in analysing credibility and commitment in terms of various 'bounded core' concepts. The bounded core might also allow us to replace the infinite set of inequalities which characterize bonafide government policies (see Balasko and Shell 1981) with a finite subset of the inequalities.

BIBLIOGRAPHY. Our references are incomplete, since we do not wish to duplicate the excellent bibliographies in some recent reviews. The lists of references in the surveys of OG models by Brock (1990), Geanakoplos and Polemarchakis (1991), and Esteban (1991) are excellent. See also the surveys of sunspot equilibrium by Shell (1987) and Chiappori and Guesnerie (1991). The survey by Guesnerie and Woodford (forthcoming) of economic fluctuations is also a source of references.

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See also ARROW–DEBREU MODEL OF GENERAL EQUILIBRIUM; BUSINESS CYCLES; MONEY IN GENERAL EQUILIBRIUM THEORY; NEW MONETARY ECONOMICS; RATIONAL EXPECTATION BUSINESS CYCLE MODELS; SUNSPOT EQUILIBRIUM.

BIBLIOGRAPHY

Allais, M. 1947. *Economie et intérêt*. 2 vols, Paris: Imprimerie Nationale.

Azariadis, C. 1981. Self-fulfilling prophecies. *Journal of Economic Theory* 25: 380–96.

Azariadis, C. and Guesnerie, R. 1986. Sunspots and cycles. *Review of Economic Studies* 58: 725–37.

Azariadis, C. and Smith, B. 1991a. Adverse selection in the overlapping generations model: the case of pure exchange. Working paper no. 91-04, Center for Analytic Economics, Cornell University.

Azariadis, C. and Smith, B. 1991b. Adverse selection in a neoclassical growth model. Manuscript, Cornell University.

Balasko, Y and Shell, K. Forthcoming. Lump-sum taxation: the static economy. In *General Equilibrium and Growth: The Legacy of Lionel McKenzie*, ed. R. Becker, M. Boldrin, R. Jones and W. Thomson, New York: Academic Press.

Balasko, Y. and Shell, K. 1980. The overlapping generations model I: the case of pure exchange without money. *Journal of Economic Theory* 23: 281–306.

Balasko, Y. and Shell, K. 1981. The overlapping generations model II: the case of pure exchange with money. *Journal of Economic Theory* 24: 112–42.

Balasko, Y. and Shell, K. 1986. Lump-sum taxes and transfers: public debt in the overlapping generations model. *Essays in Honor of Kenneth J. Arrow, Volume II: Equilibrium Analysis*, ed. W. Heller, R. Starr and D. Starrett, Cambridge: Cambridge University Press.

Bencivenga, V. and Smith, B. 1991. Financial intermediation and endogenous growth. *Review of Economic Studies* 58: 195–209.

Bencivenga, V., Smith, B. and Starr, R. 1992. The liquidity of secondary capital markets: allocative efficiency and the maturity composition of the capital stock. Manuscript, Cornell University.

Benhabib, J. and Day, R.H. 1982. A characterization of erratic dynamics in the overlapping generations model. *Journal of Economics Dynamics and Control* 4: 37–55.

Benhabib, J. and Laroque, G. 1988. On competitive cycles in productive economies. *Journal of Economic Theory* 45: 145–70.

Boldrin, M. and Woodford, M. 1990. Equilibrium models displaying endogenous fluctuations and chaos: a survey. *Journal of Monetary Economics* 25: 189–222.

Brock, W.A. 1990. Overlapping generations models with money and transactions costs. In *Handbook of Monetary Economics*, ed. B.M. Friedman and F.H. Hahn: Elsevier Science.

Bryant, J. and Wallace, N. 1979. The inefficiency of interest-bearing national debt. *Journal of Political Economy* 87: 365–81.

Bryant, J. and Wallace, N. 1980. Open market operations in a model of regulated, insured intermediaries. *Journal of Political Economy* 88: 146–73.

Bryant, J. and Wallace, N. 1984. A price discrimination analysis of monetary policy. *Review of Economic Studies* 51: 279–88.

Calvo, G. 1978. On the indeterminacy of interest rates and wages with perfect foresight. *Journal of Economic Theory* 19: 321–37.

Cass, D., Okuno, M. and Zilcha, I. 1979. The role of money in supporting the Pareto optimality of competitive equilibrium in consumption-loan type models. *Journal of Economic Theory* 20: 41–80.

Cass, D. and Shell, K. 1980. In defense of a basic approach. In Kareken and Wallace (1980).

Cass, D. and Shell, K. 1983. Do sunspots matter? *Journal of Political Economy* 91: 193–227.

Cass, D. and Shell, K. 1989. Sunspot equilibrium in an overlapping generations economy with an idealized contingent-commodities market. In *Economic Complexity: Chaos, Sunspots, Bubbles, and Nonlinearity*, ed. W. Barnett, J. Geweke and K. Shell, New York: Cambridge University Press.

Chae, S. 1987. Short run core equivalence in an overlapping generations model. *Journal of Economic Theory* 43: 170–83.

Chae, S. and Esteban, J. 1989. The bounded core of an overlapping generations economy. *International Economic Review* 30: 519–26.

Champ, B., Smith, B. and Williamson, S. 1991. Currency elasticity and banking panics: theory and evidence. Working paper no. 91-14, Center for Analytic Economics, Cornell University.

Chiappori, P. and Guesnerie, R. 1991. Sunspot equilibria in sequential markets models. In *Handbook of Mathematical Economics*, Vol. 4, ed. W. Hildenbrand and H. Sonnenschein, New York: Elsevier.

Cooley, T. and Smith, B. 1991. A theory of optimal denominations for government liabilities. Working paper no. 251, Rochester Center for Economic Research, University of Rochester.

Diamond, P.A. 1965. National debt in a neoclassical growth model. *American Economic Review* 55: 1126–50.

Esteban, J. 1986. A characterization of the core in overlapping generations economies. *Journal of Economic Theory* 39: 439–56.

Esteban, J. 1991. *The Social Viability of Money: Competitive Equilibria and the Core of Overlapping Generations Economies*. Berlin: Springer-Verlag.

Esteban, J. and Millan, T. 1990. Competitive equilibria and the core of overlapping generations economies. *Journal of Economic Theory* 50: 155–74.

Foley, D.K. 1970. Economic equilibrium with costly marketing. *Journal of Economic Theory* 2: 276–91.

Freeman, S. 1989. Fiat money as a medium of exchange. *International Economic Review* 30: 137–51.

Friedman, M. 1960. *A Program for Monetary Stability*. New York: Fordham University Press.

Friedman, M. 1968. The role of monetary policy. *American Economic Review* 58: 1–17.

Gale, D. 1973. Pure exchange equilibrium of dynamic economic models. *Journal of Economic Theory* 6(1): 12–36.

Garratt, R. 1992. The connectedness of the set of equilibrium money prices depends on the choice of the numeraire. *Journal of Economic Theory* 56: 206–17.

Geanakoplos, J.D. 1987. Overlapping generations models of general equilibrium. In *The New Palgrave: A Dictionary of Economics*, ed. J. Eatwell, M. Milgate and P. Newman, London: Macmillan.

Geanakoplos, J.D. and Polemarchakis, H.M. 1984. Intertemporally separable, overlapping-generations economies. *Journal of Economic Theory* 34: 207–15.

Geanakoplos, J.D. and Polemarchakis, H.M. 1991. Overlapping generations. In *Handbook of Mathematical Economics*, Vol. 4, ed. W. Hildenbrand and H. Sonnenschein, New York: Elsevier.

Grandmont, J.-M. 1985. On endogenous, competitive business cycles. *Econometrica* 53: 995–1046.

Grandmont, J.-M. 1986. Stabilizing competitive business cycles. *Journal of Economic Theory* 40: 57–76.

Grandmont, J.-M. (ed.) 1987. *Non-linear Economic Dynamics*. Orlando: Academic Press.

Grandmont, J.-M. and Laroque, G. 1975. On money and banking. *Review of Economic Studies* 42: 207–36.

Grandmont, J.-M. and Younès, Y. 1972. On the role of money and the existence of a monetary equilibrium. *Review of Economic Studies* 39: 355–72.

Guesnerie, R. and Woodford, M. Endogenous fluctuations, In *Advances in Economic Theory*, ed. J.-J. Laffont, Cambridge: Cambridge University Press, forthcoming.

Hahn, F. 1971. Equilibrium with transaction costs. *Econometrica* 39: 417–39.

Hahn, F. 1973. On transaction costs, inessential sequence economies and money. *Review of Economic Studies* 40: 449–61.

Heller, W. and Starr, R. 1976. Equilibrium with non-convex transactions costs: monetary and non-monetary economies. *Review of Economic Studies* 43: 195–215.

Hendricks, K., Judd, K. and Kovenock, D. 1980. A note on the core of the overlapping generations model. *Economic Letters* 6: 95–7.

Kareken, J. and Wallace, N. (eds) 1980. *Models of Monetary Economics*. Minneapolis: Federal Reserve Bank of Minneapolis.

Kareken, J. and Wallace, N. 1981. On the indeterminacy of equilibrium exchange rates. *Quarterly Journal of Economics* 96: 207–22.

Kehoe, T.J. and Levine, D.K. 1984a. Intertemporal separability in overlapping generations models. *Journal of Economic Theory* 34: 216–26.

Kehoe, T.J. and Levine, D.K. 1984b. Regularity in overlapping generations exchange economies. *Journal of Mathematical Economics* 13: 69–93.

Kelly, M. 1991. Does Gramm–Rudman matter? Working paper no. 91-19, Center for Analytic Economics, Cornell University.

Lucas, R.E., Jr. 1972. Expectations and the neutrality of money. *Journal of Economic Theory* 4: 103–24.

Lucas, R.E. Jr. and Stokey, N.L. 1983. Optimal fiscal and monetary policy in an economy without capital. *Journal of Monetary Economics* 12: 55–93.

Malinvaud, E. 1987. The overlapping generations model in 1947. *Journal of Economic Literature* 25: 103–5.

Manuelli, R. and Peck, J. 1990. Exchange rate volatility in an equilibrium asset pricing model. *International Economic Review* 31: 559–74.

Manuelli, R. and Peck, P. 1992. Sunspot-like effects of random endowments. *Journal of Economic Dynamics and Control*, forthcoming.

Modigliani, F. 1961. Long-run implications of alternative fiscal policies and the burden of the national debt. *Economic Journal* 71: 730–55.

Modigliani, F. and Miller, M. 1958. The cost of capital, corporation finance, and the theory of investment. *American Economic Review* 48: 261–97.

Okuno, M. and Zilcha, I. 1981. A proof of existence of competitive equilibrium in an overlapping generation exchange economy with money. *International Economic Review* 22: 239–52.

Peck, J. 1987a. Non-connectedness of the set of equilibrium money prices: the static economy. *Journal of Economic Theory* 43: 348–54.

Peck, J. 1987b. Non-connectedness of the set of equilibrium money prices: the overlapping generations economy. *Journal of Economic Theory* 43: 355–63.

Peck, J. 1988. On the existence of sunspot equilibria in an overlapping generations model. *Journal of Economic Theory* 44: 19–42.

Peled, D. 1982. Informational diversity over time and the optimality of monetary equilibria. *Journal of Economic Theory* 28: 255–74.

Phelps, E.S. et al. (eds) 1970. *Microeconomic Foundations of Employment and Inflation Theory*. New York: Norton.

Phelps, E.S. and Shell, K. 1969. Public debt, taxation, and capital intensiveness. *Journal of Economic Theory* 1: 330–46.

Samuelson, P.A. 1958. An exact consumption-loan model of interest with or without the social contrivance of money. *Journal of Political Economy* 66: 467–82.

Santos, M.S. and Bona, J. 1989. On the structure of the equilibrium price set of overlapping generations economies. *Journal of Mathematical Economics* 18: 209–30.

Sargent, T.J. and Wallace, N. 1983. A model of commodity money. *Journal of Monetary Economics* 12: 163–87.

Sargent, T. and Smith, B. 1987. The irrelevance of government foreign exchange operations. In *The Economic Effects of Government Budgets*, ed. E. Helpman, A. Razin and E. Sadka, Cambridge, Mass.: MIT Press.

Sargent, T. and Wallace, N. 1982. The real-bills doctrine versus the quantity theory: a reconsideration. *Journal of Political Economy* 90: 1212–36.

Shell, K. 1971. Notes on the economics of infinity. *Journal of Political Economy* 79: 1002–11.

Shell, K. 1977. Monnaie et allocation intertemporelle. Communication to the Roy–Malinvaud Séminaire d'économetrie. Mimeo, Paris (title and abstract in French, text in English).

Shell, K. 1987. Sunspot equilibrium. In *The New Palgrave: A Dictionary of Economics*, ed. J. Eatwell, M. Milgate and P. Newman, London: Macmillan.

Simons, H.C. 1948. *Economic Policy for a Free Society*. Chicago: University of Chicago Press.

Smith, A. 1776. *The Wealth of Nations*. Chicago: University of Chicago Press, 1976.

Smith, B.D. 1988. Legal restrictions, sunspots, and Peel's bank act: the real bills doctrine versus the quantity theory reconsidered. *Journal of Political Economy* 96: 3–19.

Spear, S.E. 1984. Sufficient conditions for the existence of sunspot equilibria. *Journal of Economic Theory* 34: 360–70.

Starrett, D. 1973. Inefficiency and the demand for 'money' in a sequence economy. *Review of Economic Studies* 40: 437–48.

Tirole, J. 1985. Asset bubbles and overlapping generations. *Econometrica* 53: 1499–528.

Tobin, J. 1980. Comments on Wallace paper. In Kareken and Wallace (1980).

Townsend, R. 1980. Models of money with spatially separated agents. In Kareken and Wallace (1980).

Townsend, R. 1987a. Asset return anomalies in a monetary economy. *Journal of Economic Theory* 41: 219–47.

Townsend, R. 1987b. Economic organization with limited communication. *American Economic Review* 77: 954–71.

Villamil, A. 1988. Price discriminating monetary policy: a non-uniform pricing approach. *Journal of Public Economics* 35: 385–92.

Wallace, N. 1980. The overlapping generations model of fiat money. In Kareken and Wallace (1980).

Wallace, N. 1981. A Modigliani–Miller theorem for open market operations. *American Economic Review* 71: 267–74.

Wallace, N. 1983. A legal restrictions theory of the demand for 'money' and the role of monetary policy. *Federal Reserve Bank of Minneapolis Quarterly Review* 7(1): 1–7.