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Defending liquidity preference and Keynesian notions of fundamental uncertainty

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1. Introduction

This paper argues for the continuing theoretical and policy relevance of the (inter-related) notions of liquidity preference and fundamental uncertainty for the analysis of monetary production economies, *including* those operating with a fiat currency issued by the national government under a floating exchange rate regime. The following section of the paper examines the role played by the notions of liquidity preference and fundamental uncertainty in *The General Theory*. This is followed by a discussion of Hyman Minsky's analysis of uncertainty and liquidity preference in his 1975 book on Keynes. The subsequent section examines Chartalist views on the nature of a monetary production economy characterized by a fiat currency. The long-standing debate between *horizontalists* and *verticalists* is reviewed to examine why some horizontalists have questioned relevance of liquidity preference as core aspect of Post Keynesian economic analysis. The next section of the paper responds to these concerns by demonstrating the effects that would flow from an increase in liquidity preference in a simple economy with three financial assets: money, bonds and equities. The conventional Tobin-style asset demand system is modified to accommodate interest rate targeting, and generalizations of this analysis are briefly foreshadowed. The following section of the paper, examines the effects of fundamental uncertainty on non-financial investment by extending real options theory to account for uncertainty aversion. The paper concludes with a discussion of current developments in financial economics and econophysics, which have the potential to transform ways that fundamental uncertainty is formally modelled in macroeconomics and finance.

2. The Role of Liquidity Preference in the *General Theory*

In *The General Theory* the issue of liquidity preference played a role of paramount importance in the narrative about involuntary employment and effective demand for the following reasons:

1. Along with the multiplier and the analysis of income-related demand for transactions balances, it underpinned Keynes's asset-theoretic replacement for the loanable funds theory of interest rate determination;
2. As such, it served to link together the notions of covered and uncovered interest rate parity and, at a more general level, to explain how variations in liquidity preference lead to changes in the relationship between the spot prices and future prices of all assets—financial and non-financial—including the demand price and supply price of non-financial capital;
3. Alongside discussions about how variations in liquidity preference resulted in the volatility of both the speculative and precautionary demand for money balances Keynes drew upon the complementary notion of fundamental uncertainty, to explain instability in the marginal efficiency of capital schedule;
4. In Books I-IV of the *General Theory*, Keynes conducted a short-run analysis, in which he described various influences over the point of effective demand. The underlying assumption was that wages and prices were exogenously determined and were thus held constant over the course of the analysis. This assumption was relaxed in Book V, where Keynes developed his dynamic analysis (Keynes, 1973). Nevertheless, Keynes argued that the (purportedly beneficial) direct wealth effects (i.e. the so called 'Pigou effects') and indirect interest rate effects (i.e. the so called 'Keynes effects'), that could conceivably have been attributed to

> downward flexibility of both wages and prices, would be totally overwhelmed by adverse shifts in liquidity preference, and adverse movements in both the marginal efficiency of capital schedule and the marginal propensity to consume (the latter induced by debt-deflation through shifts in income from high spending borrowers to low spending lenders).

Of critical importance for the asset-theoretic approach adopted by Keynes in the *General Theory* were the three essential properties of money that he introduced in Chapter 17, namely: 1) a small elasticity of production, which implies that an increase in liquidity preference does not lead to diversion of labour into money production; 2) a small elasticity of substitution between highly liquid and illiquid assets; and, 3) a high and positive liquidity premium, which is reflected in the fact that the return on money does not fall quickly as the money supply is increased, due primarily to its negligible carrying costs.

3. The role of Liquidity Preference in Minsky's Work

Keynes argues that fluctuations in investment are the primary influence over the trade cycle - acting through the multiplier to influence aggregate expenditure[2]. In turn, these fluctuations are seen to arise from difficulties associated with decision-making in an uncertain economic environment. On this point Hyman Minsky has emphatically stated:

> To understand Keynes it is necessary to understand his sophisticated view about uncertainty, and the importance of uncertainty in his vision of the economic process. Keynes without uncertainty is something like *Hamlet* without the Prince." (Minsky, 1975, p. 57).

However, while Keynes emphasised the general role of *conventions* as a method for making decisions in the face of uncertainty, Minsky specifically focuses on conventions relating to the financial positions of banks, investors and consumers:

> ...in a capitalist economy the aspect which is least bound by technology or by fundamental psychological properties, which is most clearly a convention or even a fashion, subject to moods of optimism and pessimism and responsive to the visions of soothsayers, is the liability structure of both operating and financial organisations (p. 128).

He goes on to suggest a formal way of unpacking Keynes's arguments about the influence of uncertainty over investment:

> Since investment fluctuates, and since one of the basic ingredients in the analysis of investment - the supply schedule of investment goods - is a stable function, the observed fluctuations must be due to variations in (1) some combination of the prospective yields, as determined by both the production of income and views about the future; (2) the interest rate as determined in financial markets, or (3) the linkage between the capitalisation factor for prospective yields on real-capital assets and the interest rate on money loans. The linkage reflects the uncertainty felt by entrepreneurs, households and bankers. In fact, Keynes uses all three of these to explain the fluctuations of investment (p. 95-96).

He suggests that the use by Keynes of the downward sloping marginal efficiency of capital schedule to discuss the influence of liquidity preference and interest rates on levels of investment helped to obscure the sophistication of his analysis and encouraged later misinterpretations and distortions on the part of his neoclassical reviewers. Minsky favours an alternative representation of Keynes's views on investment, on the grounds that:

> (t)he capitalization of the prospective yields to generate a demand price for capital assets is a more natural way to approach the problems of fluctuating investment than the marginal-efficiency-of-capital schedule; a direct approach through the Q's (quasi-rents)3 and specific capitalisation factors is more precise than an approach by way of relative marginal efficiencies. First of all, the Q's are not submerged, as in the alternative approach; second, the capitalization factor, which can have a varying ratio to the market rate of interest on secure loans because of the different values placed upon liquidity, is explicitly considered. Furthermore, two market-determined prices are dimensionally equivalent to the capitalized value of the Q's: the market price for items in the stock of capital assets and the price of equities, of shares" (p. 100-101).

In Minksy's 1975 book, both Keynesian uncertainty and liquidity preference, featured notably:

- The former in explaining the sensitivity of fluctuations in borrowers and lenders risk to changes in the degree of diversification of investment activity and the reliance on external relative to internal sources of finance;
- The latter in explaining why the capitalization ratio schedule shifts to some extent independently of, and more severely, than the rate of interest on fixed income securities (i.e. capturing influence of increases in the required return on equity over the user cost of capital);
- The former in explaining why the demand price of capital curve (which converts the capitalization ratio into the demand price per unity of capital) rotated in a clockwise direction reflecting a decline in the 'certainty equivalent' of each unit of capital's cash inflows per period (which, when multiplied by the capitalization ratio, determine the per unit demand price of capital)[4]. At the same time, this down-grading of the certainty equivalent would also change the point at which external finance had to be sought and, thus, the point where borrowers risk begins to be imposed as a margin on the demand price of capital;

In Minsky's later work, notions of uncertainty and liquidity preference remain ubiquitous. For example, in his paper on the financial instability hypothesis liquidity preference explains why interest rates may begin to rise independent of any interventions on the part of monetary authorities in response to increasing financial instability, as households, banks and firms move out of Hedge into more Speculative and Ponzi financial positions. However, this analysis merely elaborates on matters that, in his earlier publication, were primarily discussed in terms of increasing diversification risk for providers of finance, to firms and the adverse consequences of an increased reliance by firms upon external finance rather than on retained earnings. As argued previously, this concern about diversification risk, is influenced more by fundamental uncertainty than by liquidity preference *per se*. In the concluding section of this paper the Minskyian notion of financial instability is related to approaches that

have been taken in modeling asset price determination under conditions of uncertainty aversion.

4. Chartalist Perspectives on Money

This section of the paper introduces Chartalist ideas about the operations of a monetary production economy characterized by the issue of a fiat currency. The focus here is on how the Government, through the Central Bank, determines the overnight cash rate and the overall term structure of interest rates. The institutional setting in Australia is used both for convenience and for illustrative purposes. The objective of this overview is to set the scene for later questions abouts the on-going relevance liquidity preference as a notion for understanding macroeconomic dynamics and appropriate policy interventions.

Orthodox or mainstream macro-economists usually confuse the whole issue of government spending by treating the government like a household that must first raise funds before it can spend. This view is usually called the government budget constraint framework (GBC). According to this framework, government must first raise funds before spending can occur. Supposedly, the necessary funds can be raised in three ways:

1. Raising taxes
2. Selling interest-bearing government debt (bonds) to the private sector
3. Issuing non-interest bearing money (money creation)

Chartalists suggest that treating an ex-post accounting identity such as the GBC as a causal model (or ex-ante identity) is underpinned by various erroneous conceptions which contribute to the dominant prejudice that Government deficit spending is ultimately a dangerous and *damaging*, rather than a *necessary* instrument for achieving full employment.

Printing money (money creation) is seen to be a bad thing because it supposedly leads to inflation. Typically, the existence of unemployed resources is entirely ignored and some version of the *quantity theory of money* is expounded to justify these concerns. Under the received wisdom that the real forces of productivity and thrift determine growth in output, while the velocity of circulation is governed by slow improvements in transactions technologies, growth in the money supply is seen to flow directly into price inflation[5].

Under a fiat currency, the *unit of account* (common standard according to which value of goods and services are measures) is only convertible into itself and not into gold (as was the case under a commodity-based form of money) or any other real good or service (Mitchell and Mosler, 2003; Mitchell and Wray, 2004).

This is directly equivalent to a *floating* exchange rate. Under *fixed* exchange rates, each currency is first valued according to its convertibility with a particular commodity such as gold or silver (e.g. number of US dollars per ounce of gold). The rate of conversion then determines the rate at which various currencies can be converted from one to another (e.g. US dollars to Australian dollars).

The *government of issue* (the government actually issuing the currency) is the sole supplier of the currency units that it demands for payment of taxes. The purpose of State money (fiat currency issued by the government in payment for goods and services provided to government by the private sector and required for payment of tax

obligations levied on the private sector by the government) is to move real resources from the private sector into the public domain of government. To obtain the funds needed to net save and to pay taxes the private sector must sell real goods and services to the government in exchange for the units of currency they require (for payment of taxes or purchase of government-issued securities). Although the private sector can sell non-government securities and financial assets (such as shares) to itself, these assets are always matched by an offsetting liability on the part of the issuer and, therefore, do not allow for any *net* saving.

The introduction of State Money in previously non-monetary economies opens the door for unemployment. Unemployment occurs when net government spending is too low to accommodate the needs of the private sector either to pay taxes or to net save. In aggregate, total spending must equal the sum of all incomes (irrespective of whether actual incomes received are fully spent by the recipients of that income). The government deficit (surplus) equals the non-government (resident and non-resident) surplus (deficit).

In aggregate, there can be no (cumulative) net saving of financial assets by the non-government sector without (cumulative) government deficit spending. Involuntary unemployment arises when (1) the private sector, in aggregate, desires to earn the unit of account but doesn't want to spend all that it earns; (2) the government does not deficit spend at a sufficient rate to provide all the financial assets required by the non-government sector (Nugent, 2003)[6].

If the government, as the issuer of fiat currency, must spend first (credit private sector bank accounts) before it can demand payment of tax obligations from the private sector (debit private sector bank accounts) that raises the question of why governments feel the need to issue debt at all. The answer is that government debt functions as a support for the interest rate rather than as a source of funds.

In reality, the money that is used to buy bonds from the government is the same money that has already been created through government spending over and above taxation. In other words, it is deficit spending that creates the funds the private sector requires for the purchase of any government securities that have been issued (if some agents in the private sector sell bonds to others this just transfers money from one private agent to another, which can be ignored from the perspective of the economy as a whole).

Net deficit spending by government will eventually be reflected in the build up of excess reserves (cash supplies) in the exchange settlement accounts which the commercial banks hold at the Reserve Bank of Australia (RBA). Government spending and the purchase of Commonwealth Government Securities (CGS) by the RBA add liquidity to the exchange settlement accounts, while taxation and sales of CGS by the RBA drain liquidity from the exchange settlement accounts of the commercial banks. These transactions influence the cash position of the system on a day-to-day basis and could result in a system-wide surplus (as more cash flows into than out of the exchange settlement accounts) or a system-wide deficit (as less cash flows into than out of the system). This daily balance in the system has obvious implications for the RBA in its efforts to set stable targets for interest rates.

The RBA pays a default return equal to 25 basis points less than the overnight cash rate that commercial banks could earn on the cash in their surplus exchange settlement accounts. If a surplus builds up in the system, therefore, it will put downward pressure

on the overnight cash rate as banks attempt to transfer their funds seeking a higher return than they can gain from keeping the money in their accounts with the RBA. If the RBA wants to maintain the current cash rate of interest from one day to the next it will have to 'drain' any surplus liquidity from the exchange settlement accounts. It does this by selling CGS. Otherwise, the interest rate would fall to zero.

The interest rate on short-term government bills moves closely in line with the overnight cash rate. The required return on longer-term government bonds is determined in the bond markets largely through expectations about future RBA targets for the cash rate. For example, if market participants believe the RBA will be steadily raising cash rates over coming months this will be reflected in higher interest rates on longer-term securities.

5. The Horizontalist Critique of Liquidity Preference

Some Chartalists have questioned the relevance of liquidity preference for a nation, issuing a fiat currency under a floating exchange rate. The conviction is that liquidity preference only applies to portfolio choices under conditions of convertability (i.e. where a commodity-based currency or gold itself functions as the international unit of account. The analysis of interest rate determination in the previous section carries the implication that government's can choose to set low and stable interest rates across the term structure based on the composition of government securities that are sold to drain excess reserves (or purchased to maintain system-wide liquidity). Accordingly, the liquidity premium on long-duration assets would become an instrument of government policy.

For example, defenders of horizontalism or the endogenous money supply tradition such as Marc Lavoie (1985) and Basil Moore (1988) have rejected the *General Theory*'s Chapter 17 arguments that liquidity preference influences short-run asset market equilibrium across the span between physical or material assets such as commodities and plant and equipment, on one hand and financial assets such as bonds and equities, on the other hand[7]. Moore further contends that Keynes' theory is based on a circular argument because the demand for money and the level of interest rates vary with income, so that each change of income would change interest rates and therefore affect investment, thereby leading to further changes in income and interest rates (Wray, 1990, p.155)[8]. Moore favours replacing *The General Theory's* multiplier analysis and its "flawed" notion of liquidity preference with an endogenous money approach. Similarly, Lavoie criticizes Keynesian notions of the finance motive, suggesting that a rise in the demand for finance cannot put pressure on interest rates in a world where the money supply responds endogenously to money demand[9].

In his comprehensive 1990 study of money and credit, Wray has attacked the horizontalist conceptions of Moore and Lavoie, arguing that liquidity preference theory is still applicable in a financial system with lender-of-last-resort facilities, sophisticated asset and liability management mechanisms, and the wide-spread predominance of underutilised lines of credit. Wray turns to Jan Kregel's work for support, endorsing Kregel's argument that liquidity preference theory and the expenditure multiplier are 'two sides of the same coin':

> A decline in liquidity preference will lower the interest rate, which raises the demand price of capital assets and causes investment to rise until the marginal efficiencies of all assets fall to equality with the lower interest rate. This is equivalent to arguing that income rises through the multiplier until savings

rises to equality with the new higher level of investment[10]. (Kregel 1988, cited in Wray, p. 157)

While doubts may be raised about the lowering of interest rates, on the basis of the previous section's Chartalist arguments, it would be much harder to claim that the cost of funds to support corporate investment would not fall with a decline in liquidity preference. The following two sections of this paper defend this thesis.

6. Modelling Liquidity Preference with Endogenous Money

Influenced by Kregel's comments about the multiplier that were quoted above this section of the paper sets out a simple model of asset demand, for an economy characterized by an endogenous money supply, to examine how the required return on equities would be influenced an increase in liquidity preference. Modifications are made to a conventional Tobin-style model of asset-market equilibrium to account for endogeneity of the money supply. This geometrical model is then manipulated to determine how asset market equilibrium shifts in response to a change in the preference for liquidity.

The Figure 1 provides this geometric representation of equilibrium in a market for three financial assets: M, money paying a zero rate of interest; B, bonds paying a required return r_b; and V, equity paying a required return r_k (Tobin, 1958). The equations for asset demand equilibrium are derived from optimizing conditions for a portfolio of assets under the appropriate adding up constraints. A complete IS-LM model could then be derived through the addition of government spending, an investment equation (as a function of the weighted average cost of capital), and a straightforward consumption equation to represent the other component of aggregate demand (see Stevenson et al, 1988, Chapter 5, for a conventional treatment and Panico, 1993 for a post-Keynesian approach along Kaldorian lines)[11].

In the more conventional left-hand graph, which assumes an exogenous money supply, the required return on equity appears on the vertical axis and the required return on bonds appearing on the horizontal axis, while equilibrium in the money market can be represented by a downward sloping MM curve. For a given supply of money balances the MM curve would slope downwards because a drop in money demand occasioned by a rise in the return to equity would have to be offset by a drop in the return on bond holdings. The KK and BB curves, showing equilibrium conditions in the equity market and bonds markets respectively, would be upward sloping for a given supply of each financial asset. For the KK curve this is because an increase in the return on equity that might otherwise raise demand for this asset, would have to be matched by a rise in the rate of return on bonds. Moreover, the KK curve would be flatter than the BB curve because demand for a specific asset would more sensitive to the own rate of return than it is to cross-rates of return. For equity demand, the effect of a rise in the return to equity would have to be offset by a larger increase in the return on bonds than it would for bond demand.

In this diagram the real wealth constraint $W/P = (M + B + V)/P$ ensures that all three curves intersect at one common point both before and after any policy change. An increase in the money supply would shift the MM curve to the left (i.e. the rates of return on bonds and equity would both fall to ensure that investors were happy to hold the now larger quantity of money balances. However, real wealth will have increased thereby raising demand for other financial assets as well. Thus, the BB curve would shift to the left raising r_k and reducing r_b all other things being equal; while the KK

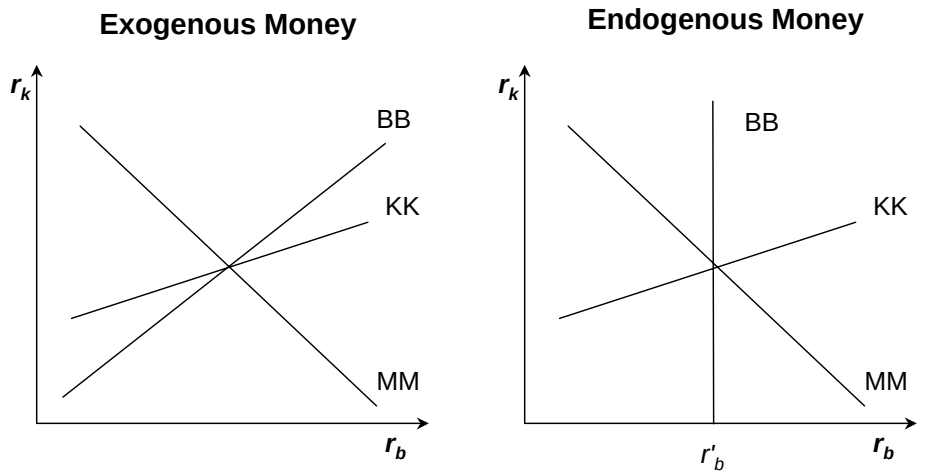
curve would shift to the right lowering r_k and raising r_b, all other things being equal. The final outcome would be for both r_k and r_b to fall.

An increase in the supply of bonds would have to be offset by a rise in the return on bonds to ensure a match between demand and supply (the BB curve shifts to the right). Once again, wealth has increased raising demand for equity and money, whose supplies have not changed. Thus, for equity demand to remain constant the return on equity must fall (KK shifts to the right) while for money demand, the return on both equity and bonds must rise (the MM curve shifts to the right). Now, r_b would rise while the effect on r_k would be ambiguous. The case of a fall in r_k is shown below, but it is conceivable that a larger shift in the MM curve could lead to a rise in r_k.

In the case of an open market operation, however, where the central bank purchases bonds in exchange for money, the money supply would rise, but the effect of this on real wealth would be entirely offset by a decline in the supply of bonds. Because wealth does not change, while bond supply falls and money supply increases, the MM curve would shift left, the BB curve would also shift left, whereas the KK curve would not shift at all. Thus, r_b and r_k would fall unambiguously.

In the case where liquidity preference increased across-the-board, the MM curve would shift upwards and outwards, the BB curve downwards and outwards, and the KK inwards and upwards, unambiguously raising the required rates of return on both money and bonds.

Figure 1 Asset market equilibrium



Money supply is determined by setting the bond rate of interest at the rate of target r'_b so that the BB curve becomes vertical. Now an increase in liquidity preference would be shown as an upward movement in KK and MM curves raising the required return on equity, thus increasing the weighted average cost of capital required for the funding of investment.

The same diagrammatic approach can be applied in the case where the money supply is endogenous. The only change would be to make the BB curve vertical at the chosen target rate of return on bonds, say, r'_k. Now, as stated under the diagram, an increase in liquidity preference would be reflected in an upward movement in both the MM and KK curves, once again raising the required return on equity, and thus the weighted average cost of capital. To sum up these results, despite holding the bond

rate of interest constant in this elementary textbook model, an increase in liquidity preference would raise the required return on equity and the weighted average cost of capital, with adverse consequences for investment activity.

Of course, a more realistic though more complicated story could be told by introducing more asset classes into the model, accounting for term structure effects on fixed income securities of varying duration and quality (junk bonds come to mind), but it is the equity premium, which is more pertinent to this paper's arguments. Needless to say, the effects of changes in liquidity preference would also be felt in derivatives markets. As such, it would also carry over to real investment to the extent that the latter shared certain essential characteristics in common with financial options. This possibility, which relates back to Minsky's arguments about the effects of liquidity preference on the demand price of capital, is discussed in the following section of the paper. In any event, the phenomenon of liquidity preference has obvious and continuing relevance in this context to the extent that it can explain fluctuations in private sector investment: in the absence of counter-cyclical deficit spending on the part of government the latter would ultimately lead to unemployment.

7. Uncertainty Aversion, Real Options Theory, and Implied Volatility

One important example of fundamental uncertainty at work is the phenomenon whereby 'out-of-the-money' put options increase dramatically in value after major financial crises (Rubinstein, 1994). An alternative interpretation of this phenomenon would be to claim that this is merely an example of 'implied volatility'[12]. The prevalent nature of this phenomenon demands a more detailed investigation into possible determinants of implied volatility, which is evidenced by the volatility 'smile' or 'smirk' observed in option markets (typically seen when implied volatility is graphed as a function of a range of strike price of a chosen option: both in-the-money and out-of-the-money).

Essentially, implied volatility is effectively an expression of our ignorance about the root causes of fluctuations in option prices. It is calculated by comparing the market price of a chosen option with the Black and Scholes price calculated using an estimate of the actual volatility of the underlying asset. Taking actual market prices for an option at each strike price, the Black and Scholes equation is inverted to calculate the volatility that would have to obtain for that market price to issue from the option price formula and compared with the empirical volatility. As such, implied volatility can reflect a variety of departures from the Black and Scholes assumptions, namely those due to:

- Non-normality of the stochastic process for the log-price relative of the underlying asset;
- Incomplete markets due in turn to stochastic volatility or missing markets for certain risk factors (this latter case, for example, would arise as a matter of course in the real options case where the underlying asset is the entitlement to a series of cash inflows emanating from an investment project). In incomplete markets it is necessary to estimate the market price of risk to calculate asset prices (i.e. in more formal terms, an equivalent martingale measure must be derived using either a utility function or, alternatively, a dual operator such as a minimum variance hedge or minimum relative entropy); and,
- Uncertainty aversion (which can also be granted a utility-theoretic foundation, and that can be interpreted as equivalent to liquidity preference, insofar as it is

reflected in the presence of uncertainty premia in asset markets, in addition to more conventional risk premia).

Under a real options framework, corporate investment projects are treated as possessing characteristics that are analogous to those of financial options: the strike price would represent the initial investment expenditure, while the underlying stock price would represent the demand price of the investment project calculated using standard martingale techniques for option pricing, as in Trigeorgis (1996) and Copeland and Antikaro (2001). The volatility of these returns is then equated to the volatility of the underlying stcok in conventional option pricing theory[13].

The prospect of incorporating uncertainty aversion into the pricing of real options opens the door for different kinds of investment behavior to be modeled mathematically as a form of decision-making under uncertainty[14]. This approach would effectively accommodate some of Minsky's concerns about the formal modeling of investor uncertainty about the quasi-rents derived from corporate investment activity.

8. New Theoretical Developments

A number of theoretical developments now in train have the potential to reverse the current dominance of the neoclassical conception of macroeconomics. First, a number of researchers have developed a renewed understanding of multisectoral growth dynamics that (1) escapes the inadequacies of the neoclassical aggregate production function; (2) links neo-Ricardian concerns about long-period growth paths in a multi-sectoral economy with those of those researchers working within the New Growth Theory (see contributors to Salvadori, 2003). Within a multi-sectoral setting where capital is a produced good, these researchers have made valuable contribution in demonstrating the formal equivalence between model closures determined by the Cambridge Growth Equation and steady-state outcomes derived from neoclassical, representative-agent models of optimal consumption. This research has helped to clarify the nature of both the Keynesian-Kaldorian (as determined by the Cambridge equation) and Classical *long-run* (see Freni et al, 2001).

Second, another group of authors are applying the framework of statistical mechanics in developing an alternative conception of how markets clear in the absence of a Walrasian auctioneer (Durlauf, 1996; Brock, 1996; Smith & Foley, 2002). This research raises a series of profound and unsettling series of questions for rational expectations approaches to the modeling of equilibrium prices. And perhaps this *ensemble* average approach to aggregative outcomes affords a more robust alternative to Chiarella et al's (2000) Phillips curve-based interpretation of the 'macroeconomic foundations of microeconomics'[15].

Third, as argued in Juniper (forthcoming), the insights gained from a critical analysis of Hansen and Sargent's (1999) adoption of risk-sensitive and robust control theory for the modeling economic decision-making under uncertainty or ambiguity aversion, once the underlying principles have been extracted from their neoclassical integument, provide a behavioral justification for the Kaldorian versions of asset-price theoretic macro-models proposed by Carlo Panico (1993) or Godley and Lavioie (2000). This affords the opportunity for developing a more robust (in both sense of the term) and defensible understanding of Keynesian approaches to asset markets than can be afforded by Tobin's conventional risk-based approach.

In a move away from the conventional, neoclassical, representative-agent framework, researchers working in the *Econphysics* tradition have constructed phenomenological models that are related to the literature on uncertainty aversion. For example, Constantino Tsallis, who contrived Tsallis entropy for solving problems in the thermodynamics of anomalous diffusion, has highlighted a number of applications of his method to the analysis of financial markets (see Plerou at al., 2000; Borland, 2002; Gopikrishnan et al., 2000; Gupta and Campanha, 2000, 2002). Here, the connecting element Tsallis identifies is that holding between the sub-additivity parameter appearing in the expression for Tsallis entropy and the degree of sub-additivity featuring in Kahneman and Tversky's cumulative prospect theory (Tsallis et al., 2003; also see van der Hoek and Sherris, 2001, for a discussion of the relevant decision-making axioms and a practical approach to implementation based on distortion functions). This notion of sub-additivity is closely related to the engineering literature on robust, risk-sensitive, and fuzzy control and filtering theory. [16]. Together this research permits the construction of a rigorous modeling, filtering and simulation framework that has the potential to restore liquidity preference to the center of Keynesian macroeconomic research[17].

In the light of these concluding comments, a major task must still be accomplished: that of integrating approaches to modeling decisions about financial and non-financial investment with Minkyian notions of financial instability. In related work Juniper (forthcoming) has argued that economy-wide variations in uncertainty aversion are precipitated by changes in the level of financial instability. In effect, increases in financial instability reflect a heightened sensitivity on the part of the financial system to adverse movements in liquidity preference (due to detrimental changes in the balance sheet exposure of banks, households and firms). This heightened vulnerability is responsible for initiating adverse movements in the sentiment of investors: the whole economy thus becoming exposed to a form of self-fulfilling prophecy, though one that would operate through increases in both fundamental uncertainty and uncertainty aversion[18]. Investment decisions would then be affected across the entire liquidity spectrum from financial assets to non-financial and commodity-specific assets. Of course, further complicating factors would be introduced if uncertainty were directed at concerns about differential inflation rates. In this case, the demand for certain commodities such as gold, wine, or antiques to act as hedges against inflation, could increase at the expense of more strictly financial assets.

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[1] The author is a Lecturer in the School of Policy and Research Associate of the Centre of Full Employment and Equity, University of Newcastle.

[2] Chick (1983) and Vercelli (1991) have emphasised the dynamic rather than the static nature of the multiplier. This dynamic perspective interprets the multiplier as a disequilibrium propagation mechanism.

[3] Following Keynes, Minsky defines quasi-rents as equal to the rentals arising from the difference between price and prime costs (material and labour). In Chapter 17 of *The General Theory*, returns on each asset are defined to equal $q - c + l + a$, where a equals the expected capital appreciation, l is the liquidity premium on the asset, q is the own rate of return (Q in Minsky's notation) and c is the carrying cost. For money, $q - c$ equals zero, but the liquidity premium is the highest of all assets. For equities, q is the dividend, while a is the expected capital gain. For liquid goods, c is the cost of warehousing, insurance and the short-term borrowing rate, while a is the expected capital gain from resale. Finally, for capital goods q is the expected quasi-rents from sale of the product, while c is the interest and dividends to be paid on external debt and equity finance. Production will only take place if the expected quasi-rents net of carrying costs are greater than the user cost (the latter is defined as the cost of putting assets to work productively over the period rather than deferring production).

[4] Here, "certainty equivalent" appears in quotation marks in recognition of the Keynesian distinction between uncertainty and risk.

[5] For largely strategic reasons, Keynes left the logical kernel of the neoclassical growth theory —the Wicksellian notion of the natural rate of interest—intact in the aftermath of the 'Keynesian revolution'. It would effectively become the 'chink in the armour' accommodating, first the Monetarist, and later

the Rational Expectations counter-revolutions. For instance, it supports Sargent's (1979) demonstration of the block recursive structure of the neoclassical growth model in which all nominal variables are determined independently from the structure of the real economy so that monetary interventions only influence the aggregate price level.

[6] This horizontal leverage of excess reserves created by deficit spending on the part of the government sector can sustain accumulation on an expanding scale (see Keen, 2004). Even though the non-Government sector does not create net financial assets, it can still create money. However, this will only occur so long as financial instability does not lead non-Government to restructure their balance sheets in a conservative mannere.

[7] An alternative "*Structuralist*" position has been propounded by Thomas Palley (1995), which is based on the notion that there are structural barriers to the continuous, endogenous expansion of money supply at unchanged interest rates to meet growth in demand. This paper does not engage in these debates. Here the focus is more on the question of how liquidity preference can influence the process of capital accumulation both through changes in the weighted average cost of funds, and the certainty equivalent of anticipated cash inflows.

[8] On the face of it, this is a simple problem of feedback from expenditure to transactions demand (and the finance motive), which can readily be accommodated analytically through the use of feedback mechanisms, without resorting to the IS-LM model's simultaneous determination of both income and the interest rate (see Vercelli, Chapter 11).

[9] In a lucid paper, Paul Dalziel (1996) has usefully applied a process model of the multiplier, of the kind first developed by James Meade, to clarify a number of post-Keynesian controversies about liquidity preference, the multiplier, endogenous money and the finance motive.

[10] Wray has erroneously substituted the term "income" for "investment" at the end of this quoted sentence. However, the passage only makes sense in the latter case.

[11] Of course, Tobin's approach interprets Keynesian liquidity preference as behavior towards risk: the latter accommodated within a conventional mean-variance framework. Another approach would be to follow Boulding's (1944) analysis of generalized stock-price equilibrium across traders in commodities and financial assets, which has been modified to account for an endogenous money supply in Randall-Wray (1991). Alternatively, as described in the final section of the paper, a non-expected utility perspective on uncertainty aversion could be adopted.

[12] Private conversation with Warren Mosler, December 16, 2004.

[13] There are on-going debates about whether the pricing of real options should be conducted using techniques for incomplete rather than complete markets.

[14] see van der Hoek and Sherris, 2001 for a workable approach to options pricing under uncertainty aversion based on the use of distortion functions, which conform to the axioms of non-expected utility theory.

[15] These researchers have extended the short-run *control theoretic* interpretation of the 'Phillip's curve' from the labour-market to the goods market as well: a generalization which yields Goodwin-style paired-systems of non-linear differential equations. Needless to say, in this manner limit cycle—and ultimately—chaotic dynamics can readily be generated. In my opinion though, this modeling trajectory does not carry us very far from what Joan Robinson dismissed as 'Bastard Keynesianism'!

[16] As Gilboa and Schmeidler (1989) have established the mathematical equivalence between two capacity-based representations of uncertainty aversion: the first of these entailing the use of *sub-additive probabilities*, and the second, involving max-min optimization within a *multiple-priors* setting.

17 See Elliott et al, (1995) and James and Baras, (1995) for material on robust and risk-sensitive control and filtering of Hidden Markov Models and more complex linear and non-linear diffusion processes. These techniques of dynamic programming, which employ operators derived from applications of Girsanov's theorem, can readily be extended to support the estimation and control of non-Gaussian stochastic processes, including Lévy processes and those characterized by multifractional Brownian motion (Helge et al., 1996).

18 Elliott et al., (1995) draw on Dupuis and Ellis's (1997) characterization of the duality between free energy and relative entropy to construct error bounds for risk-sensitive filters. They assume that the true probability model is fixed but unknown, and that the estimation procedure makes use of a fixed nominal model. They show that the resulting error bound for the risk-sensitive filter is the sum of two terms, the first of which coincides with an upper bound on the error one would obtain if one knew exactly the underlying probability model, while the second term is a measure of the distance between the true and design probability models. Under Hansen et al's (1999) interpretation these two components, comprising the stochastic uncertainty constraint, reflect the inability of the controller to discriminate between a range of feasible probability models using the usual, entropy-based information criteria. Thus, as propounded in Juniper (forthcoming), both ontological (i.e. levels of financial instability determining the magnitude of the stochastic uncertainty constraint) and epistemic factors (i.e. behavioral parameters governing risk-sensitivity) interact to determine model outcomes.