# Why DSGE analysis cannot accurately model financial-real sector interaction

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**Abstract**
How financial-real sector interaction is theoretically modelled depends on something surprisingly simple: the shape of the theory's coordination conditions as consisting of its market clearing conditions and budget equations. The paper demonstrates how resource-constrained, dynamic optimisation requires a set of such conditions which make it impossible for DSGE analysis accurately to capture financial-real sector interaction. The paper derives an alternative set of coordination conditions which it rigorously grounds in the nature of monetary exchange under a fiat money regime, thereby developing the outlines of an alternative framework for macro-monetary theory.

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There is a conceptual incongruity at the centre of contemporary macro-monetary theory as represented by dynamic stochastic general equilibrium (DSGE) modelling. Its purported object of study is a monetary exchange economy under a fiat money regime. Yet its baseline Woodford (2003) model knows no commercial banks, has perfect financial markets and turns centuries of monetary thought on its head by treating money as a source of friction rather than lubrication. While these problems are usually frankly acknowledged, the common understanding is that, with sufficient time and effort, they can be overcome and that some significant strides forward have in fact already been made in this regard (for a comprehensive survey, see Brunnermeier et al., 2012). However, this paper seeks to demonstrate that DSGE analysis has some core properties which prevent it from ever adequately portraying how the financial sector interacts with real economy and that its technical sophistication masks a remarkable naivety about such matters.

Money and finance obviously play a key role in price and income determination. How exactly that role is theoretically modelled principally depends on something surprisingly simple: the shape of the theory's coordination conditions as consisting of its market clearing conditions and budget equations. Coordination conditions identify the particular behaviour plans by which coordination in market exchange (offers to supply = offers to demand) and coordination in funding (available funds = desired funds) are defined and interlinked. Both price and income levels are obviously determined via the demand and supply plans featuring in such

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conditions, since price and quantity mutually influence each other in a dynamic circular-causal process that may, but need not, gravitate towards market clearing. Given that macro-monetary theory is mainly concerned with macro-coordination levels (that is, aggregate income levels) and macro-price levels (that is, the general price level and the general interest rate level), its set of coordination conditions should minimally include an aggregate goods market clearing condition, an aggregate financial asset (bond) market clearing condition and an aggregate budget equation.

Coordination conditions thus establish the configuration of behaviour plans via which price and income levels are presumed to be determined. As such, they have explanatory value irrespective of how their constituent behaviours are explained or whether the conditions are assumed to hold or not. The descriptive value of macro-monetary theory is, therefore, to an important degree determined by how correctly its set of coordination conditions is specified. Interest in coordination conditions and their correct specification flowered for a relatively brief period some decades ago (Clower, 1965, 1967; Clower and Leijonhufvud, 1975; Tsiang, 1966, 1980; Kohn, 1981a, 1981b; Snippe, 1985, 1987), but has since died down and disappeared almost without leaving a trace. In the current post-crisis atmosphere of soul searching and revisiting of first principles, it may be appropriate for macro-monetary theorists to come back to the topic which has clearly lost nothing of its relevance.

In order to avoid misunderstanding it needs to be emphasised that the paper's focus on coordination conditions need not imply any form of equilibrium modelling, first, because no optimising behaviour is assumed (the paper abstracts from behavioural explanation) and, second, because the conditions need not hold. When considering the paper's coordination conditions, the reader's attention should not be on their equality sign which merely indicates the benchmark of coordination. Instead, the attention should be on their terms as they suggest of the types of behaviour plan via which price and income levels are to be determined, whatever the degree of coordination or discoordination these levels may represent. This paper is principally about (1) identifying the types of behaviour plan via which general price and aggregate income levels should, by their nature, be explained and (2) highlighting how DSGE analysis uses an incorrect set of behaviour plans in this regard, thereby distorting its view of financial-real sector interaction.

Accordingly, the paper has two main aims. The first is to ascertain what a set of market clearing conditions and budget equations should ideally look like if it conformed rigorously to the nature of monetary exchange under a contemporary fiat money regime. The second aim is to critique the coordination conditions of DSGE modelling in the light of that ideal set, showing how dynamic resource-constrained optimisation requires a set of conditions which incurably misrepresents how money and finance interact with the real economy. Because the paper focuses on coordination conditions and discounts behavioural explanation, it is free to ignore DSGE's complex of optimising conditions, thereby stripping it of almost all its sophisticated technical adornment and reducing it to an analytical core which can be assessed with the aid of conceptual, qualitative logic only. It is at a basic conceptual level that DSGE's vulnerabilities become manifest.

The paper is constructed as follows. Section 1 lays down some rock-bottom fundamentals of money and exchange, which point towards the primacy of the money budget over the resource budget and suggest the broad types of coordination condition needed to integrate monetary portfolio and real income-spending analysis. Subsequent sections 2 and 3 establish the precise form which these conditions should take. Section 2 derives the appropriate form of the aggregate goods market equilibrium condition and critiques DSGE's corresponding version, noting how it slants DSGE's theory of price as well as income. Section 3 shows how the aggregate monetary budget equation can have two equally appropriate forms, a Keynes-type and a Robertson-type form, the latter representing the dynamic circulatory income-spending stream with monetary injections and leakages. Sections 1 to 3 are largely preparation for sections 4 and 5, which make up the core of the paper. Section 4 demonstrates how the Robertson-type budget equation is indispensable in adequately portraying financial-real sector interaction in a fiat money world, highlighting the various ways in which DSGE analysis falls short in this regard. The section also derives a novel budget expression for the banking sector for which it uses the Keynes-type budget equation. Section 5 critiques DSGE's set of dynamic sectoral resource budget constraints, more in particular their implied view of how banking and finance influence aggregate spending.

## 1. Fundamentals of money and exchange

### *1.1 Market knowledge and the utility of money*

Our suggested alternative coordination conditions are all premised on the understanding that money functions first and foremost as generally accepted medium of exchange. While controversial in heterodox circles, there is no space here for a defence of this premise except to note that the implied secondary and derivative nature of the other traditional money functions (store of value and unit of account) takes nothing away from their relevance and importance. It serves our purpose briefly to illustrate this point by considering the rationale for money's utility.

It is already an old insight that the market coordination challenge is essentially about acquiring market knowledge, that is, knowledge of who offers to supply and demand what, where, when, in what quality/quantity and at what price – both at present and in the foreseeable future (Hayek, 1937). In view of this, money aids market coordination in three main ways. First, in accordance with its primary function as generally accepted medium of exchange, money economises on required market knowledge by ensuring that traders are prescient about the identity of one of the two commodities in every exchange (Brunner and Meltzer, 1971; Clower and Howitt, 1996). Demanders already know suppliers want money and suppliers already know demanders offer money. Strictly speaking, therefore, money does not set aside Jevons' requirement of a double coincidence of wants, but ensures that the knowledge needed for coincidence in one of the two wants is already obtained. Second, when money is generally accepted in exchange for goods, goods will nearly always be valued in units of that money (unit-of-account function). As such, money allows goods to have a single money price, which further economises on required market knowledge.[2] A single money price also unlocks available market knowledge by revealing current scarcities (Hayek, 1945). Third, as generally accepted medium of exchange, money is able to transport generalised buying power from the present into the future, albeit at the risk of incurring inflationary buying power losses (Keynes, 1936, 1937; Davidson, 1978; Bertocco, 2011). This time travel of generalised buying power (store-of-value function) is important because the information on which to base future expectations is typically of a better quality the closer to that future one moves. Money thus allows its holders to keep their buying options open in the anticipation of obtaining better

[2] A non-monetary means of economising on required market knowledge is provided by specialised middlemen (see Clower and Howitt, 1996, 2000).

information later on (the utility of "wait and see"), which explains why liquidity preference increases during times of heightened uncertainty. As such money also provides a means by which agents can enhance their market knowledge.

In sum, agents attach utility to the medium of exchange because it facilitates trade by economising on, unlocking and enhancing market knowledge. That is why people hold money in spite of it not necessarily having any intrinsic value or carrying any interest.

### *1.2 Radical uncertainty: primacy of money budget over resource budget*

If money acts as a market knowledge economising, unlocking and enhancing device, its usefulness is obviously relevant only to agents whose market knowledge is deficient to start with. In contrast, DSGE modelling conjures up a world where agents can stochastically predict the future consequences of their current actions with perfect reliability. Being endowed with such knowledge, DSGE's agents hardly face a market coordination challenge and will consequently find little use for money. Their chief remaining challenge is then optimally to use their resources, which is why optimisation is first and foremost constrained by available resources rather than available money. Accordingly DSGE's primary budget constraint is an endowed resource budget rather than a money budget.

In order to retain some resemblance to a money budget, money is usually included in the resource budget as one of the resources. Monetary or financial frictions may then emerge when supplementary money budgets like the cash in advance (CIA) or borrowing constraint interfere with optimal exchange plans. However, in the tradition of Brunner and Meltzer (1971), there are also general equilibrium models which do allow money to make a positive contribution towards efficient resource use. This materialises when uncertainty is assumed to produce transaction costs, which money reduces in ways superficially comparable to what was described above. Yet the crucial implicit assumption is that the relevant cost is quantifiable, which requires that the uncertainty be strictly stochastic. Stochastic uncertainty, rather than ruling out perfect knowledge, merely puts a price on its attainment. Uncertainty is thus reduced to a friction in a process that otherwise runs on pure resource-constrained optimisation, perfect knowledge and guaranteed market coordination. While not necessarily invoking transaction costs, DSGE treats uncertainty and other sources of market discoordination like price rigidity in essentially the same way.

It can thus be said, with Caballero (2010), Borio (2012) and Haldane (2012), that DSGE analysis suffers from a "pretence-of-knowledge" syndrome *à la* Hayek (1974). These authors suggest that the only credible way "to deal with the pretence-of-knowledge syndrome" is to allow for real ignorance and radical Knightian uncertainty. The analytical consequences are equally radical. Because Knightian uncertainty cannot be reduced to stochastic probability, no quantifiable cost can be attached to it; perfect knowledge is no longer for sale at any calculable price. Market coordination must then be acknowledged as requiring much more than just the removal of frictions like transaction costs or price rigidity. Because agents now operate under a continual and ineradicable knowledge deficit, money can come into its own as a market knowledge economising, unlocking and enhancing device. This will express itself in the fact that agents, first and foremost, consider their money holdings rather than their resource holdings when making their exchange plans, as they indeed do in the real world. The money budget will then have dethroned the resource budget as the primary budget in monetary theory, with resources being considered only after being converted into money – how much of it they are expected to cost and bring in. In a radically uncertain world, theories of market exchange require money-constrained optimisation rather than resource-constrained optimisation, if optimisation is still the word. Some form of bounded rationality seems, after all, implicit in radical uncertainty (Haldane, 2012).

Anxiety about radical uncertainty being destructive to all modelling and forecasting is unfounded.[3] Because applied quantitative modelling unavoidably contains strong elements of pragmatism and imprecision anyway (see e.g. Sims, 2012), its *reason d'être* is not under threat. However, the formal modelling techniques of pure theory do need to be rethought in the light of radical uncertainty, which, given that the present paper abstracts from behavioural explanation, cannot be undertaken here. One thing can be established here: monetary theory should at least have a monetary budget equation and afford it primary status. As will be amply illustrated throughout this paper, the root cause of contemporary theory's inability adequately to deal with money, banking and finance is that it either features no money budget at all or gives it only secondary, supplementary status.

### *1.3 The momentariness of exchange: reintegrating portfolio and spending analysis*

The claim is that commodities change hands at something close to a point in time (Myrdal, 1939; Harrison, 1980; Snippe, 1987), which is not contradicted by Greif's (1997, pp. 247-248) assertion that "exchange is always sequential, namely, some time elapses between the *quid* and the *quo*". The momentariness of exchange merely means that both the *quid* and the *quo* in exchange are attached to moments, not that these moments necessarily coincide (spot trade). Greif's (1997, 2000) institutional-historical analysis insists on the sequentiality of exchange in order to accentuate the risk inherent in future delivery. This is not a consideration in our analysis, which anyhow has no need to assume spot trade.

The claim that exchange is momentary may seem bland at first inspection but turns out to have powerful theoretical implications. To start with, it implies that transacted amounts should be regarded as momentary stocks rather than as periodic flows, as is the current convention. This convention can be traced back to Fisher (1906) who unwittingly employed two different, potentially inconsistent stock-flow distinctions. The first is between a stock as something that happens at a moment and a flow as something that develops over a period. For obvious semantic reasons, however, a stock can also be understood as an inventory of things, with a flow then referring to a change in such inventory. According to this second distinction, for instance, wealth and capital are stocks while income and investment are flows. When these two stock-flow distinctions get superimposed on each other, wealth and capital have to be treated as momentary stocks and transactions like income and investment necessarily become periodic flows. But income and investment can evidently also be stocks in the momentary sense, referring to the moment the income was received and the moment the spending on investment goods took place.

When income and spending are treated as periodic flows, it becomes analytically difficult to allow direct causal interaction between a momentary stock of money and periodic transaction flows. It is for that precise reason that, since Hicks (1935) and Keynes (1936), the convention in monetary theory developed of permitting money holding and money spending to influence each other only indirectly, through changes in the interest rate – a convention which DSGE

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[3] Haldane (2012) points out how models using heuristics based on radical uncertainty and bounded rationality may, in fact, outperform models grounded in strict optimisation and perfect knowledge equivalents.

analysis broadly maintains. However, once it is realised that both money holding and money spending can be expressed as momentary stocks, the original rationale for the convention evaporates. Portfolio and spending analysis can then be reintegrated by way of a momentary-monetary budget equation (Snippe, 1985). It is noteworthy that, while all the variables in such a budget equation are attached to moments, they need not all refer to the *same* moment. Momentary analysis does not imply static analysis. In fact, momentary analysis is more conducive to the proper treatment of dynamic change, because change is better captured by the comparison between moments than between periods, as was already noted by Myrdal (1939, pp. 43-45).

Furthermore, when transactions are acknowledged as being momentary, it becomes clear that the custom in conventional price theory of identifying supply with production and demand with consumption is unfortunate, because narrowly applicable to unstockable services only. For stockable material goods, production is never immediately supplied but first put in stock, just as consumption is never immediately demanded but first taken out of stock. The important analytical implication is that offers to demand and supply are equivalent to planned inventory changes, with the result that inventory equilibrium (actual inventory = desired inventory) is already implicit in market-exchange equilibrium (offers to demand = offers to supply). Hence, contrary to what is suggested by Sexton et al. (1992), price theory need not consider the former in addition to the latter. As Hicks (1965, p. 85) similarly observed: "As long as we hold to the principle of price determination by '… demand and supply', ... we have no call to attend to anything but transactions. We do not need to distinguish between stocks and flows."

When it comes to money, the situation is reversed. By virtue of being exchangeable for all goods, money does not have its own market and therefore does not require its own market clearing condition, which DSGE, like all general equilibrium analysis, nonetheless includes. Money's market equilibrium is already implicit in all the market equilibria of the goods against which it is traded (see section 2). Money does, however, require its own inventory equilibrium condition (actual money inventory = desired money inventory), which naturally takes the form of a monetary budget equation describing the distribution of agents' current money holdings over their preferred money destinations: the various forms of money spending as well as continued money holding (see section 3).

In fact, the money stock is the only inventory variable which macro-monetary theory needs to feature. Inventories of non-monetary goods can be ignored, because they impact on transactions in just their own market, the effect of which is already captured by the market equilibrium conditions of the relevant goods, as just noted. General equilibrium portfolio theory in the style of Tobin (1969) manages to confer multi-market significance on inventories of non-monetary financial assets (and goods) by allowing them to be directly bartered for each other, which is decidedly awkward if the analysis otherwise seeks to describe a monetary-exchange economy. And so, the only relevant portfolio decision in macro-monetary theory concerns the allocation of agents' money inventory over their preferred money destinations. Provided it includes financial assets as one of these destinations, the monetary budget equation is already quite capable of incorporating financial-real sector interaction, for the purpose of which no non-monetary wealth constraint is needed (see section 4). All this is not to suggest that non-monetary wealth effects are unimportant, but rather that these effects have macroeconomic impact (change aggregate spending) only via their influence on the terms of a monetary budget equation.

To conclude, an integrated monetary and real analysis requires (a) a set of momentary goods market clearing conditions with "goods" being considered broadly as including all non-money tradables; (b) a momentary-monetary budget equation; and (c) a momentary financial asset (bond) market equilibrium condition via whose terms the interest rate (the price of bonds) is to be determined. We proceed with a discussion of the appropriate form of these conditions. For reasons of space, however, the appropriate form of (c) will be ignored. Interest rate theory will thus be largely left unattended.

## 2. Plan coordination in the goods market: prices and income

### *2.1 Overall goods market coordination*

We start with the most basic and obvious requirement for overall goods market coordination:

$$y_t^s = y_t^d \quad \text{for each goods market } y = 1, 2, \ldots, n, \tag{1}$$

where $y_t^s$ and $y_t^d$ denote planned real quantities supplied and demanded for each market in goods set $y$ at the current moment *t*. Set of conditions 1 is obviously similar to the market clearing conditions of general equilibrium analysis, but with one important difference. While goods set $y$ should be understood as including all categories of goods (all non-money tradables) and as being traded by all categories of agents (all sectors), it does not contain all individual goods on offer nor are all individual agents involved. After all, the totality of all goods cannot be traded by the totality of all agents at every single trading moment. Momentary analysis thus facilitates the recognition of an important real-world attribute: continual trade in different goods among different traders.

This real-world attribute straightforwardly invalidates Walras's Law, understood as the necessary equality of the total value of goods brought to market and the total value of goods taken away from the market at its close. Walras's Law does not describe an intrinsic quality of market exchange, but results from the stylisation of a single trading round per period during which a given set of agents seeks to trade a given and uniformly priced set of goods among each other. Hence when the identities of goods and traders are in continual flux, as they are in the real world, Walras's Law fails (Tsiang, 1966). The scrapping of one arbitrarily chosen market facilitated by Walras's Law has, unsurprisingly, no imaginable counterpart in economic reality. It is an absurdity. Yet it continues to be invoked (e.g. by Brunnermeier and Sannikov, 2011) while textbook LM theory also still employs it to rid itself of the bond market.

Dealing in real quantities, condition set 1 suffices as a description of the coordination requirements for barter exchange. As a first step in uncovering the additional coordination requirements posed by monetary exchange, we identify its characteristic attribute. In accordance with money's primary function as generally accepted medium of exchange, monetary trade can be typified by the equivalence between supplying goods and demanding money as well as between demanding goods and supplying money (Clower, 1967). In symbols:

$$P^y y_t^s \equiv ME_t^d \tag{2}$$

$$P^y y_t^d \equiv ME_t^s \tag{3}$$

$ME_t^d$ and $ME_t^s$ signify the money demanded or supplied in exchange for good $y$ at the current moment $t$. $ME$, short for *M*oney in *E*xchange, denotes the active money balances (Robertson's "money on the wing") to be distinguished from the passive money inventory (Robertson's "money at rest") for which the conventional symbol $M$ will be used. While $M$ is a stock-as-inventory and $ME$ a flow-as-change-in-inventory (a transaction), both are stocks in the momentary sense by virtue of the momentariness of exchange. Nominal goods prices, $P^y$, make their appearance for the obvious reason the equations now record amounts of money.

Equations 2 and 3 are specimens of a larger genus called *equation of exchange,* which is neither a market coordination condition nor a budget equation but an expression of the *quid pro quo* in exchange (for a useful survey, see Fayazmanesh, 2006). The fact that equations of exchange appear – or ought to appear – in pairs (one for each side of the exchange) suggests that they do not indicate actual exchanges but merely the unilateral exchange plans of demanders and suppliers separately and independently. This dispels the common misconceptions, still present in Clower and Leijonhufvud (1975) and Fayazmanesh (2006), that equations of exchange presuppose spot trade and rule out theft or charity. It also exposes the inappropriateness of Clower's (1967) famous attempt to capture the *quid pro quo* in monetary exchange by way of a "matrix of exchange" involving the bilateral exchange plans of both demanders and suppliers, which needlessly complicates what the medium-of-exchange function is about.

Equations of exchange 2 and 3 allow us alternatively to write market clearing condition set 1 as:

$$ME_t^d = ME_t^s \quad \text{for each goods market } y = 1, 2, \ldots, n \tag{4}$$

What condition set 4 adds to condition set 1 is the requirement that the amount of money which demanders offer in exchange for good $y$ be equal to the amount of money which suppliers are willing to accept in exchange for good $y$. In a monetary exchange economy, market coordination necessitates not only that the physical quantities demanded and supplied match (equation set 1) but also that demanders are able and willing to dedicate money, in the appropriate amount, to their goods purchases (equation set 4). The coordination requirements inherent in condition sets 1 and 4 can thus be condensed into a single condition set stipulating equality between nominal notional supply and nominal effective demand

$$P^y y_t^s = \boldsymbol{P^y y_t^d} \quad \text{for each goods market } y = 1, 2, \ldots, n \tag{5}$$

Written in **bold** effective demand ("effectual demand" in Adam Smith's terms) is demand which is both planned and supported by sufficient monetary finance (Clower, 1965). With equation set 5 we have arrived at the overall goods market equilibrium condition for a monetary economy. It underscores the commonsense notion that money touches the goods market on its demand side, by facilitating or constraining planned demand.

### *2.2 Macro- and microeconomic coordination*

Our next step is to establish the rationale for the aggregate, macroeconomic perspective, which follows, once again, from money's primary function as generally accepted medium of exchange. When money is routinely exchanged against *all* goods, the effect which a monetary shock may have on the goods market concerns the demand for *all* goods. Put differently, a change in aggregate effective demand must be accompanied by a change in the scarcity of money, that is by a monetary shock. Money neutrality may thus be understood as aggregate goods market clearing, which accords with Hayek's (1933) original meaning of the term (see Patinkin and Steiger, 1987):

$$\sum P^y y_t^s = \sum \boldsymbol{P^y y_t^d} \qquad (6)$$

Equation 6 is what we will refer to as the *macroeconomic equilibrium condition*, which aggregates over all goods *y* traded at moment *t* within a given economy. The supply side of equation 6 can be regarded as production at full capacity utilisation, which, contrary to DSGE analysis, would allow output gaps to be treated as goods market failures. A monetary disturbance can now be defined as a macroeconomic disequilibrium phenomenon: a monetary shock which accompanies a movement in aggregate spending away from planned aggregate supply. The various forms in which a monetary shock can occur are identifiable only with the aid of a monetary budget equation to be derived in section 3.[4]

Say's Law asserts money neutrality as macroeconomic equilibrium, but only roughly and approximately so. Its classical supporters by no means claimed the total absence of monetary disturbances, but rather that these are either relatively small and transient or, when larger and more persistent, attributable to exceptional circumstances like wars, banking crises or the discovery of large deposits of monetary precious metal (Sowell, 1972; Niehans, 1987). The consideration of money (non)neutrality in terms of Say's Law has strangely disappeared from contemporary theory, witness how DSGE defines the (non)neutrality of money with sole reference to the Quantity Theory. The ostensible reason is that DSGE lacks an aggregate goods market equilibrium condition in the style of equation 6, by which Say's Law must be benchmarked. We return to the issue below.

The introduction of a macroeconomic equilibrium condition entails a useful convenience. With slight adaptation, equilibrium condition set 1 applicable to barter can be maintained for a monetary economy as the requirement that the individual-market compositions of aggregate demand and supply are matching. As such it stipulates the absence or resolution of "disproportionalities", to dust off an old term in business cycle theory. We can rename it the *microeconomic equilibrium condition*. Overall goods market coordination (equation set 5) can then be broken down into microeconomic coordination (equation set 1) and macroeconomic coordination (equation 6). The former expresses the absence or resolution of real disturbances in the form of changes in tastes and technologies, while the latter signifies the absence or resolution of monetary disturbances in forms still to be identified. This micro-macro breakdown should obviously not be taken to mean that real disturbances cannot cause macroeconomic disequilibrium. Rather it means that real disturbances cannot cause macroeconomic disequilibrium unless they also generate monetary disturbances, as they often do – especially in a contemporary fiat money world with its flexible, largely endogenously determined money supply. Conversely, monetary disturbances may also generate microeconomic disequilibrium (disproportionalities) as a secondary effect, such as when a

[4] On our definition of the terms, a monetary disturbance may also occur without a monetary shock, namely when aggregate supply increases while aggregate demand stays put, just as a monetary shock may occur without a monetary disturbance, namely when aggregate demand increases commensurate with the increase in aggregate supply.

banking-crisis induced contraction lowers the appetite for risk which hits the investment goods market disproportionately hard (Hall, 2010).

The macroeconomic equilibrium condition can now be identified as the coordination requirement which monetary exchange adds to that of barter exchange. The fact that monetary exchange adds a coordination requirement clearly does not mean that plan coordination is harder to achieve in a money economy than in a barter economy. After all, monetary exchange also considerably lightens the burden of the coordination requirement carried over from barter (the microeconomic condition), which it does by economising on, unlocking and enhancing market knowledge, as noted in section 1. Hence money aids market coordination by making it easier to achieve microeconomic equilibrium (money as lubricant) but remains capable of upsetting market coordination through a failure of macroeconomic equilibrium (money as friction). Money's net influence will as a rule be lubricating, since monetary disturbances are not generally so large and persistent that they overwhelm money's lubrication. And even when a particular money does become dysfunctional, the public invariably settles on a superior money alternative rather than stay with barter. Money as mere friction, as implied by DSGE modelling, is a caricature (Rogers, 2008; Borio, 2012).

Our micro-macro breakdown has a further obvious pay-off. It facilitates a separate determination of relative prices and the general price level along the lines of the classical dichotomy. Relative prices can be determined via the real terms of the microeconomic equilibrium condition and the general price level via the nominal terms of the macroeconomic equilibrium condition.[5] The determination of relative prices in terms of only real quantities merely requires the fairly tame assumption that monetary disturbances cause no disproportionalities. But the reverse case of explaining real quantities in terms of only relative prices necessitates the much wilder assumption that monetary disturbances do not occur at all. Because monetary disturbances clearly cannot *a priori* be ruled out, aggregate income should be acknowledged as depending not only on relative prices but also on the level of aggregate effective demand. Such is the basic, obvious and hugely important proposition of Keynes (1936) which takes it for granted that monetary disturbances cannot always be neutralised by changes in the general price level and that, even if there were the requisite downward flexibility, a falling general price level more likely amplifies than nullifies the disturbance – for reasons to be indicated below. In sum, the classical dichotomy can be a more or less acceptable abstraction for price theory, but is decidedly inappropriate for income theory.

### *2.3 DSGE: macroeconomics without a macroeconomic equilibrium condition*

Contemporary DSGE analysis operates without the monetary goods market clearing conditions derived above. Its aggregate goods market condition takes the form of an aggregate microeconomic condition ( $\sum y_t^s = \sum y_t^d$ ) rather than a genuine macroeconomic

[5] Relative prices do not appear in the microeconomic equilibrium condition ($y_t = y_t$ for each market $y$) because they represent ratios of goods quantities. As a result, the microeconomic condition needs to specify only goods quantities in order to establish relative price quotes. Nominal prices, in contrast, must be quoted by specifying goods quantities *and* an amount of money, which is precisely the message of equations of exchange 2 and 3. As shown above, equations of exchange 2 and 3 underlie the monetary goods market clearing conditions of equations 5 and 6, which consequently do explicitly feature nominal prices. Of course, only barter traders actually quote relative prices. The relative prices quoted by monetary traders must be inferred from their nominal price quotes.

condition ( $\sum P^y y_t^s = \sum \boldsymbol{P^y y_t^d}$ ) which complicates DSGE's theory of price as well as income. We start with price.

Because DSGE's aggregate goods market clearing condition ( $\sum y_t^s = \sum y_t^d$ ) features no general price level term, it is prevented from determining the general price level in the market for goods via the aggregate nominal demand and supply of goods ( $\sum P^y y_t^s = \sum \boldsymbol{P^y y_t^d}$ ) – as common sense would suggest. As a way of solving the problem, older-generation models determined the general price level by the scarcity of money via the terms of the quantity equation, which had the drawback of negating the influence of supply factors on prices.[6]

Contemporary DSGE modelling offers an alternative solution, which seems to overcome this drawback. It compensates for the lack of a goods market theory of the general price level by substituting it for a goods market theory of the expected future inflation rate. Treating some past or present price level as empirically given, it determines the expected future price level, and the resultant inflation rate, with the aid of behavioural functions (the intertemporal IS and Phillips curve relations) in which both demand and supply factors do play a role.

This solution, however, holds various complications. First, at the level of pure theory, there can, strictly speaking, be no explanation of price change without an explanation of the absolute price level, as it would succumb to infinite regress. One cannot claim to have explained price change (inflation) if one has not somewhere explained an absolute price level. Second, despite appearances to the contrary, DSGE still determines inflation by demand factors only. Firms are presumed to set their cost-push price increases on the basis of their inflation expectations which are shaped by demand factors only (Weber et al., 2008).

Third, while older-generation models overstated the role of money by explaining the general price level as a function of the scarcity of money as expressed by the quantity equation, contemporary DSGE modelling altogether ignores the influence of money on prices. It is thereby taken for granted that the central bank's policy interest rate can adequately control demand (and hence inflation) without the mediation of changes in the money stock, which presupposes that the money stock passively adapts itself to demand plans. This may indeed be the case insofar demand is financed with bank credit (newly created money) and banks accommodate the public's credit requests as informed by their demand plans. But since, at any given trading moment, only a small part of total demand is likely to be financed with bank credit, the presupposition can only be partially true. And when the banking sector is in distress and tightens its credit rationing criteria, the presupposition may become outright false. The money stock may then fall (or grow less) and exercise a constraining influence on total demand for reasons largely unrelated to the policy interest rate, as the recent crisis has shown (Arestis and Sawyer, 2008; Arestis, 2009). And when money becomes the constraining factor on spending, it makes more sense to model the effect of quantitative easing (QE) on spending via its influence on the money stock rather than on the shape of the yield curve as the relevant DSGE models suggest (Joyce, 2012; Bridges and Thomas, 2012).

[6] It can be shown, for which there is no space here, that the Fisherite quantity equation ($MV = PT$) is really not an equation of exchange (that is, an expression of the *quid pro quo* in monetary exchange) but a periodic monetary budget equation with $MV$ being the periodic supply of monetary finance and $PT$ its periodic demand. The Cambridge version ($M = kPY$ ), by contrast, is a momentary Walrasian money market equilibrium condition ($M_s = M_d$), in which $M_d$ is further specified as a function of income ($M_d = kPY$ ). The transactions demand for money is ignored in the Cambridge equation, even if it explains the demand for passive money ($M_d$) as a function of the volume of transactions ($PY$), which is odd indeed.

The lack of a macroeconomic equilibrium condition slants DSGE's theory of income along very much the same lines. In essence, it means that DSGE negates the monetary dimension to aggregate demand changes. As a result, it cannot recognise how changes in the scarcity of money may directly constrain or facilitate demand, and hence income, in case the general price level is insufficiently flexible (as it almost always is). In DSGE analysis, price rigidity is allowed to influence income only indirectly, via its influence on real-relative prices. Insofar CIA or borrowing constraints directly constrain spending, the influence is treated as a friction in a real business cycle mechanism rather than as an integral part of an alternative mechanism in which money features crucially (Borio et al., 2013). And, as noted in section 1, the principal way in which money features crucially is when the pivotal explanatory mechanism incorporates a monetary budget equation and affords it primary status. It is to the appropriate form of the monetary budget equation that we now turn.

## 3. Plan coordination in monetary finance

This section demonstrates how the aggregate monetary budget equation can, in fact, be expressed in two equally appropriate ways, one which captures money inventory equilibrium (a Keynes-type budget equation) and one which, by incorporating an income-spending lag, portrays the dynamic circulatory income-spending stream (a Robertson-type budget equation). While these budget equations are shown to be logically compatible, the Robertsonian version proves to be particularly useful for the purpose of modelling the financial-real sector interaction in a fiat money world. For heuristic reasons, however, this section still assumes a pure commodity money world without banking, financial markets and international trade, which will be relaxed in the next section.

### *3.1 Keynes's budget equation: money inventory equilibrium*

There are two reasons why agents do not collectively spend their money all at once and why velocity is consequently never unity. First, in a radically uncertain world agents cannot and do not anticipate all their future needs. And second, to the extent that agents do anticipate their future needs, these needs are met by goods whose storage costs are generally higher than that of money (Keynes, 1936, 1937). What this means for the aggregate budget equation is that the current money stock ( $\sum M_t^s$ ) must be sufficient to meet plans for current spending ( $\sum P^y y_t^d$ ) as well as plans for continued money holding in the immediate future ( $\sum M_{t+1}^d$ )

$$\sum M_t^s = \sum P^y y_t^d + \sum M_{t+1}^d \qquad (7)$$

The momentary nature of equation 7 has various theoretically interesting consequences which can briefly be mentioned. First, because its supply side refers to the actual money inventory of the present moment $t$ ( $\sum M_t^s$ ) which cannot now be changed, its demand for passive money holding must express desires for what the money inventory should be like *in the immediate future* ($t$+*1*), which is why we write it as $\sum M_{t+1}^d$. The whole demand side of equation 7 ( $\sum P^y y_t^d$ + $\sum M_{t+1}^d$) then refers to past desires for what money holding should be like *in the present* (*t*), which can be given as $\sum M_t^d$ . Equation 7 is thus an elaboration of money inventory equilibrium expressed as $\sum M_t^s = \sum M_t^d$ .

Second, by virtue of its momentary nature, equation 7 must be a demanders' budget equation, since only the goods demanders of any trading moment need money as finance for spending. And since the goods demanders of any trading moment obviously represent only a small subsection of all agents, its $\sum M^s$and $\sum M^d$ terms must also represent only a small part of the total money stock, which is fortunate because it allows them to diverge. The total demand and supply of money held by all agents must be identically equal by virtue of "money that is anywhere must be somewhere", which would turn money inventory equilibrium into a meaningless tautology (Robertson's *Grand Monetary Tautology*). The momentary approach is indispensable to monetary theory.

Last, while plan formation and plan execution can happen during the same period, they cannot occur at the same moment. Consequently, plan formation must precede the plan execution of moment *t*. Financial planning errors are thus possible in principle and the budget equation may fail. Contrary to what is suggested by Buiter (2002), budget equations can be equilibrium conditions rather than identities, although they may turn into identities when all their terms are given in realised, *ex post* form.

When a budget equation holds in *ex ante* terms, we have achieved what may be called money inventory equilibrium, monetary equilibrium or, in Keynes's (1936) parlance, money market equilibrium. Keynes's term is a bit awkward as money does not have its own market and the budget equation expresses financial planning rather than market-exchange equilibrium. Keynes's own version (1936, p. 199) closely resembles equation 7 but is also different in various subtle but significant ways. Most importantly, although Keynes's money market condition carries all the hallmarks of a monetary budget equation, it primarily serves as a financial asset (bond) market equilibrium condition in his model, witness how the interest rate (the price of bonds) is determined via its terms. Because interest rate theory is not at issue here, we can ignore that quality of Keynes's money market condition and treat it purely as a monetary budget equation, which it clearly also is.

### *3.2 Robertson's budget equation: the circulatory income-spending stream*

The income-spending lag is deemed important in monetary theory because it establishes the sequential nature of monetary exchange processes and captures the common notion that monetary exchange separates the acts of supplying goods (receiving money) and demanding goods (spending money) which are united under barter. Robertson's (1940) budget equation provides a useful template for the type of monetary budget equation which incorporates the income-spending lag (Tsiang, 1980; Kohn, 1981a; Snippe, 1985). To arrive at Robertson's version, the supply side of the Keynesian budget equation 7 ( $\sum M_t^s$ ) merely needs to be divided up into various components representing the various ways in which current goods demanders could have obtained their money in the past. Designating the income-spending lag as period *p*, these components are: (1) money income as realised goods supply ( $\sum P^y y_{t-p}^s$ ) whereby we assume that the demanders of moment *t* were all suppliers at *t-p*; (2) realised money creation ( $\sum \Delta M_{t-p}^s$ ) which we conveniently also attach to moment *t-p*; and (3) the money inheritance from a past before *t-p* as the net outcome of all prior income-spending rounds ( $\sum M_{t-p}^d$ ). Breaking $\sum M_t^s$ down into $\sum P^y y_{t-p}^s$ + $\sum \Delta M_{t-p}^s$ + $\sum M_{t-p}^d$ and rewriting $\sum M_{t+1}^d$ - $\sum M_{t-p}^d$ as $\sum \Delta M_{t+1}^d$ the Keynesian budget equation 7 turns into:

$$\sum P^y y_{t-p}^s + \sum \Delta M_{t-p}^s = \sum P^y y_t^d + \sum \Delta M_{t+1}^d \qquad (8)$$

The meaning of equation 8 is straightforward: the income ($\sum P^y y_{t-p}^s$ ) and money creation ( $\sum \Delta M_{t-p}^s$ ) realised in the past must be sufficient to facilitate planned spending for the present

( $\sum P^y y_t^d$ ) and planned increases in passive money holding for the immediate future ( $\sum \Delta M_{t+1}^d$ ). This budget equation indeed closely resembles Robertson's (1940) version except that the latter is periodic and expresses income and spending more narrowly as saving and investment (the supply and demand for loanable funds), because Robertson, like Keynes, also uses his budget equation as a financial asset (bond) market equilibrium condition. We will again ignore the merits or demerits of equation 8 as a financial asset market equilibrium condition and consider it purely as a monetary budget equation. As a result, the criticisms of loanable funds theory by Bibow (2004) and Hayes (2010) need not concern us.

Although the Keynesian and Robertsonian budget expressions 7 and 8 are logically compatible and each has its own useful applications, the latter has one outstandingly helpful quality which the Keynesian version lacks: it is a portrayal of the dynamic circular income-spending stream with money creation the typical injection into that stream and increases in passive money holding (hoarding) the typical leakage from it.[7] Defining a change in aggregate demand as a change in its current level relative to past aggregate income ( $\sum \Delta P^y y_t^d = \sum P^y y_t^d - \sum P^y y_{t-p}^s$ ), the Robertsonian budget equation reduces to:

$$\sum \Delta P^y y_t^d = \sum \Delta M_{t-p}^s - \sum \Delta M_{t+1}^d \qquad (9)$$

The message is clear: aggregate demand changes must be accompanied by net monetary injections into the income-spending stream or net leakages from that stream. Hence monetary shocks manifest as monetary injections or leakages, additional forms of which will be considered in the next section.

## 4. Financial-real sector interaction in a fiat money world

The Robertsonian budget equation has the further advantage of facilitating a simple yet effective way of adapting the analysis to a contemporary fiat money world characterised by bank money creation, financial trade, financial intermediation and international trade. As it turns out, any advance over the most basic form of commodity money exchange exerts its influence on the circulatory income-spending stream in the same way: by introducing an additional type of injection into it or leakage from it.

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[7] Taking his cue from Clower (1965), Lucas's (1982) expressly stated purpose in introducing the CIA constraint was to give recognition to the income-spending lag. However, the form which he gives to the CIA constraint ( $\sum M_{t-1}^s \geq \sum P^y y_t^d$ ) is curious. It suggests a money-spending lag rather than an income-spending lag, which is odd because there is no money-spending lag. As also indicated by the Keynesian budget equation 7, present spending does not need "cash in advance"; it merely needs "cash in the present" which was received as "income in advance". It may furthermore be noted that Keynes (1936) also suggests a circulatory income-spending stream which is, however, not captured by his money market analysis (that is, his monetary budget equation) but by his goods market analysis. Injections and leakages then take the form of investments and savings rather than of money creations and raised hoardings. A more in-depth discussion of Keynes's way of treating the circular income-spending stream falls outside the scope of this paper (but see Van Eeghen, 2014).

### *4.1 Bank money creation*

It would appear that bank money creation merely changes the method of money creation (from coin production to banks raising their deposit issue) without having to introduce an additional injection/leakage term. But this is not so. Non-bank agents can use part of their financial resources to service their bank debt or buy assets from banks, which constitutes a leakage from the current goods spending round as well as a negative injection into the next spending round given that the applicable payments entail money destruction.[8] This leakage-*cum*-negative-injection term is analytically significant in a number of ways.

Among other things, it plays a key role in Fisher's (1933) debt deflation effect. A falling general price level raises the real value of bank indebtedness which creates an incentive for accelerated repayment of existing bank debt as well as a disincentive to take up any new bank debt. The resultant reduction in the money stock depresses spending, thereby putting further downward pressure on prices and reinforcing the spiral. It is for this exact reason that deflation is so dangerous and so difficult to combat in a fiat money world. For instance, the monetary stimulation of the Bank of Japan's QE largely failed to stimulate total spending, not mainly because liquidity preference increased as argued by Krugman (2012), but more importantly because the Japanese public used its extra money to pay off more bank debt thereby virtually neutralising the initial monetary stimulus. Since DSGE's budget expressions do not have this this leakage-*cum*-negative-injection term, attempts by Brunnermeier and Sannikov (2011, 2013) and Eggertson and Krugman (2012) to integrate Fisherite debt-deflation effects into a DSGE model, must seriously misrepresent and understate them.

### *4.2 Change in secondary financial trade volumes*

Keynes's (1936, pp. 66-75) strictures on user cost and the resultant integration of the logic of national income accounting into macroeconomic theory has also had a downside. In accordance with the logic of national income accounting, macroeconomics has traditionally considered only trade in final goods. But it should, in accordance with the logic of monetary exchange, take account of trade in all goods: any and every type of tradable gives rise to a supply of monetary finance at the moment it is sold, and to a demand for monetary finance at the moment it is bought. Consequently, an unchanged volume of trade in intermediary goods (including original factors), non-recently produced goods (mainly existing real estate and second-hand cars) and secondary financial assets, does not take up additional finance. But an increase in the volume of such trade does require additional finance and therefore constitutes a leakage potentially capable of crowding out demand for current final output, which Keynes (1930), interestingly enough, acknowledged for the case of an increase in secondary financial trade.

It is important to note, however, that the potentially highly disruptive impact of a huge, and hugely variable, financial circulation on the goods circulation is mitigated by a number of

[8] It is a matter of plain observation that virtually all payments between banks and non-banks are conducted in the banks' own deposits. It follows that any disbursement by banks in favour of non-banks causes money creation (deposits appear) just as any disbursement by non-banks in favour of banks gives rise to money destruction (deposits vanish). Such is the logical basis for the role which commercial banking plays in the creation or destruction of money. Textbook writers are strangely reluctant to acknowledge this role, preferring to represent banks as pure intermediaries (see Häring, 2013). The same applies to DSGE theorists, as will be seen below. Central bank officials tend to be more forthright. Mervyn King (2012) is a case in point: "When banks extend loans to their customers, they create money by crediting their customers' accounts".

institutional factors like clearinghouse netting, financial traders' access to flexible trade credit at their banks (injections and leakages cancel out), and the fact that a significant part of financial trade is conducted by banks between themselves which they can finance with cash reserves (central bank deposits) rather than money proper. The increased size and variability of secondary financial trade over the last couple of decades is, of course, also mainly responsible for the break-down in the correlation between money and spending, which means that, if the relevant net leakages could be isolated, a reliable relationship between money and spending could in principle be re-established (see van Eeghen, 2014).

Needless to say, DSGE models ignore the potential impact of variable secondary financial trade volumes on aggregate goods spending, as also evidenced by the fact that the inverse income velocity is widely used as a measure of average passive money holding. The measure is unreliable in view of potentially strong variation in secondary financial trade as well as in intermediary and non-recently produced goods trade.

### *4.3 Lending and borrowing*

Contrary to secondary financial trade, trade in primary financial markets (lending and borrowing) does *not* require the introduction of an additional leakage/injection term. In fact lending and borrowing, because they cancel out in aggregation, should not feature in an aggregate monetary budget equation at all (Kohn, 1981b). Lending and borrowing can influence aggregate spending only indirectly, via the leakage and injection terms already present in the Robertsonian budget equation 8. When funds are non-intermediated or non-bank intermediated, the successful channelling of funds from surplus to deficit units creates scope for more spending by generating a negative leakage in the form of a reduction in overall passive money holding; what borrowers gain in monetary finance, lenders lose in monetary finance, so that aggregate spending can increase only when borrowers have a lower liquidity preference than lenders. In contrast, when funds are bank intermediated, bank lending to non-banks makes space for increased aggregate spending by generating a positive injection in the form of bank money creation. In the former case increased finance for spending is created by more efficiently using existing liquidity, while in the latter case it is created by adding liquidity (Bossone, 2001). This distinction, which is clearly significant, is consistently overlooked in DSGE modelling.

Since borrowing does not directly influence total spending, the borrowing constraint is an unsuitable way of modelling the influence of financial dysfunction on total spending. It is nonetheless universally employed for that purpose in DSGE analysis.

### *4.4 Sectoral budget equations and the budget equation of commercial banks*

Although lending and borrowing along with transfers should not feature in an aggregate budget equation, they may legitimately appear in sectoral budget equations. The budget equations of firms, households, non-bank intermediaries and government can otherwise follow the templates provided by equations 7 or 8.

The budget equation of the banking sector is fundamentally different. Banks are unique in that they can finance their lending and spending with their own deposit IOUs. While non-bank financial intermediaries have to finance their assets with previously deposited or borrowed funds, banks can issue their borrowers and asset sellers with their own, newly created deposits. The banking sector's ability to create its own deposit finance is, however, not for free. When the banking sector raises its monetary deposit issue, it faces an increased cash drain to the public due to increased withdrawals (for an unchanged propensity to hold money as cash). Banks will also be confronted with a cash drain to foreign banks due to a worsened balance of payments position, *ceteris paribus* all other influences on that position. In addition, banks will experience a larger transactions demand for cash in view of a larger volume of interbank payments traffic.

The conclusion is that the banking sector as a whole is not constrained in its assets acquisitions by its ability to attract deposits but by its ability to obtain cash. Furthermore, because bank deposits are the predominant means of payment, they must also be the predominant means by which the non-bank public pays for its investment in the banking sector's other forms of balance-sheet funding: non-monetary deposits, debt and equity. Monetary deposits are, therefore, the original source of all bank balance-sheet funding (Bagehot, 1919 [1873], p. 181; Disyatat, 2011).

It follows that the banking sector has two budget equations: 1. a balance-sheet funding equation and 2. a liquidity constraint. The first is best expressed verbally:

*Assets Acquired ≡ Monetary Deposits Issued* (10)

The equation is given as an identity because it necessarily holds by virtue of the nature of commercial banking. The second budget equation confronts the banking sector's current cash holdings with the cash needed to sustain its current *Monetary Deposits Issued*. This cash budget equation, which is the only potentially constraining one, can be given the same general form as the Keynesian equation 7 except that money ($M$) is narrowed to cash money ($Mc$):

$$\sum Mc_t^s = \sum P^y y_t^d + \sum Mc_{t+1}^d \quad (11)$$

$\sum Mc_t^s$ refers to the current cash inventory of banks, which is not conventionally considered as part of the money stock. $\sum P^y y_t^d$ captures the demand for cash necessary to finance the cash drains (to the public and foreign banks) and the interbank transactions resulting from payments traffic on a given deposit issue. $\sum Mc_{t+1}^d$ identifies the desired cash holding for the immediate future. The fact that banks have a cash budget constraint is indirectly confirmed by the fact that the interest rate on bank lending is driven by the interest rate on cash rather than the interest rate on loanable funds or money more broadly, which exposes a fundamental weakness in both loanable funds and liquidity preference theory. It also transpires that the universal practice since Bernanke and Blinder (1988) of deriving the banking sector's budget constraint from its consolidated balance sheet is mistaken; the procedure generates a money or loanable funds budget, not a cash budget.

### *4.5 Cash constraint on banks*

Under a commodity money standard when cash was specie, banks had to attract additional specie in order to sustain an increased bank money issue – specie which ultimately had to come from non-bank hoarders and producers thereof. Now that cash exclusively consists of central-bank issued money, the banking system's only source of cash is the central bank. As a result, the central bank has no choice but fully to accommodate the banking system's cash needs, whether it be the regular cash needs of normal times or the exceptional cash needs of crisis times (see Goodfriend and King, 1988; Moore, 1989; Goodhart, 1989). It cannot withhold banks their lifeblood when banks cannot obtain that lifeblood elsewhere. For that reason the banking sector as a whole, whether healthy or in crisis, faces no quantity-of-cash constraint on its supply of credit but only a price-of-cash (=interest rate) constraint on the public's demand for credit (Disyatat, 2011), which is precisely why the interest rate is – and always has been – the main instrumental target of monetary policy (Goodfriend, 1990; Bindseil, 2004). Of course, commercial banks are not mere passive accommodators of the public's credit demand; by their credit rationing and asset buying decisions they can still actively influence their credit extension and deposit money issue. And while the deposit money creation by the banking sector as a whole cannot be constrained by a shortage of cash, it can be facilitated by a surplus of cash without necessarily driving down the interest rate to zero, which is the idea behind QE (Goodfriend, 2002).

The inescapable conclusion is that the banking sector as a whole faces no liquidity constraint. The same applies to an individual bank for as long as it grows its deposit issue apace with the banking sector as a whole, keeps its risk profile in line with that of the sector as a whole, and has a sufficiently well diversified depositorship over all non-bank sectors and regions. This lack of a liquidity constraint critically undermines the logic of DSGE models like those of Diamond and Rajan (2005, 2010) and Brunnermeier and Sannikov (2011, 2013) which attribute the banking sector's fragility to the risk of becoming illiquid. Only non-bank intermediary sectors like pure savings banking, stand-alone investment banking or shadow banking are susceptible to illiquidity.

Even so, the dramatic asset price falls of the recent crisis did impair the lending capacity of banks with significant toxic asset holdings. This happened, however, not because these banks became cash-constrained – central banks made sure of that – but because they became equity-constrained, partly under the influence of capital adequacy requirements. When banks subsequently reduced their debt (issued fewer deposits by lending and spending less) and increased their equity (distributed fewer profits and sold more shares – if they could), the money stock contracted with the ensuing real effects. That is why banks deleverage at the expense of the real economy; the greater the losses and the more capital needs to be rebuilt, the greater the damage to the real economy. It is no coincidence that macro-prudential regulation focusses mainly on bank capital rather than bank liquidity. Contrary to what DSGE models like that of Eggertson and Krugman (2012) suggest, it is deleveraging on the part of banks rather than of non-banks which damages the real economy. The main aim of QE policies is indeed to mitigate the damage of private bank deleveraging by counteracting it with increased central bank leveraging.

### *4.6 International trade and summing up*

Imports and exports have a dual nature. Imports represent a form of spending as well as a reduction in the local money stock, just as exports are a source of income as well as an increase in the local money stock. They are part of the income-spending stream as well as a leakage from, or injection into, that stream. To prevent a double-count, imports and exports should, therefore, be incorporated either as part of income and spending or as changes in the money stock (preferably the latter), but not as both. Textbook Keynesian income-spending analysis fortuitously avoids such a double-count by not featuring monetary injections and leakages at all. International trade in securities can *mutatis mutandis* be handled in the same way.

To sum up, then, the financial and real sectors are interlinked through monetary injections and leakages: (1) changes in the money stock, in the various different ways in which such changes can be effected, (2) changes in the level of passive money holding and (3) changes in the volume of trade in secondary asset markets. Models wishing to take account of the financial system will have to incorporate these three injection/leakage terms and determine their net effect. An alternative approach to the monetary transmission mechanism now also presents itself naturally, which is to gauge the influence of the (conventional or unconventional) policy variable on the various injection and leakage terms separately and independently (see Bridges and Thomas, 2012; van Eeghen, 2014).

## 5. Money and banking in DSGE's dynamic budget constraints

DSGE modelling uses a sequence of periodic household budget constraints. Significant variation in their form exists, but the basic structure can in nominal terms be given like this:

$$P^n n_t^s + W_{bt}^s = P^y y_t^d + W_{et}^d + T_t \qquad (12)$$

$P^n n_t^s$ and $P^y y_t^d$ represent this-period supply of labour ($n$) and demand for consumption goods ($y$). Inventories of wealth potentially consist of money, bonds and capital ($W = M + B + K$) connected to either the beginning-of-period moment ($bt$) or the end-of-period moment ($et$). The end-of-period demand for wealth ($W_{et}^d$) turns into a supply of wealth at the beginning of the next period ($W_{bt+1}^s$). $T_t$ represents transfers.

The household budget of equation 12 is combined with the budget equations of several other sectors. However, instead of adding all these sectoral budgets together and so arrive at an aggregate version, DSGE analysis integrates the budgets of its non-household sectors into the budget of its household sector. In essence, non-household budgets take resources out of the household budget (labour, capital, tax payment, bonds), possibly add some of their own resources (say, newly issued money), and then put all these resources back into the household budget in a different form (as goods, profit, bond repayments, money or interest). The end result for the household budget is that labour supply gets substituted for goods supply and that some wealth items are added. These changed wealth holdings carry over into period $t+1$ where they facilitate changed goods spending.

DSGE's lack of an aggregate budget equation is puzzling. Insofar budget equations play a role in the explanation of aggregate spending, they should surely also be given in their aggregate form. Some DSGE models like the workhorse Smets and Wouters (2007) version do specify what is referred to as an "aggregate resource budget" which, however, takes the shape of a Keynesian goods market equilibrium condition ($Y = C + I + G$) rather than a genuine budget equation. The fact that DSGE analysis shuns a genuine aggregate budget is, of course, not surprising as it would mean that lending and borrowing (and transfers) need to be scrapped as they cancel out in aggregation. The effect of lending and borrowing on aggregate spending would then need to be explained via their effect on monetary injections and leakages, which resource budgets cannot accommodate – even when a CIA constraint is added. Of course, lending and borrowing do indeed disappear from DSGE's life-time resource budget equation, which, however, does not happen in the aggregation over all sectors for a given period but in the aggregation over all periods for a given sector.

All these problems culminate in a deficient explanation for the inverse relationship between the interest rate and aggregate spending. It suggests that, say, a decrease in the interest rate stimulates current spending by lowering the reward for current lending in favour of future spending. But as noted several times by now, lending or borrowing cannot in themselves influence aggregate spending, but do so only via their effect on the money stock (injections) or the level of passive money holding (leakages). How the interest rate impacts the money stock and the level of passive money holding would thus need to be established (see van Eeghen, 2014).

But DSGE analysis cannot adequately model the relationship between the interest rate and the money stock because, in the absence of a commercial banking sector, private lending and borrowing does not affect the money stock. Since only cash is customarily considered as money, only the central bank is regarded as capable of impacting the money stock. All the influential, post-crisis attempts to incorporate banks and banking crises into DSGE modelling such as those by Cúrdia and Woodford (2009), Gertler and Karadi (2011) and Martin and Ventura (2011), still consider banks as pure intermediaries unable to create or destroy any money (see also Arestis and Sawyer, 2008; Arestis, 2009). The absence of a commercial banking sector also clashes with DSGE's acceptance of the interest rate as conventional policy instrument which presupposes a commercial banking sector – as explained in the previous section.

In addition, the absence of a commercial banking system makes it difficult for DSGE analysis to model the credit cycle. The amplification mechanism of the classic Minsky cycle is plain: increased optimism leads to increased bank lending which generates a larger money stock, increased incomes, more spending, higher asset prices and better balance sheets, which feeds back into increased optimism and bank lending again – and *vice versa* for the downturn. In contrast, the financial accelerator models of Bernanke, Gertler and Gilchrist (1999) and Kiyotaki and Moore (1997, 2012) attribute shock amplification to expansions and contractions in household lending to firms due to self-reinforcing changes in firm net worth. Brunnermeier (2013) adds intermediation to this scheme, in which case the net worth of the intermediary also features. But, crucially, there are no bank-credit induced monetary expansions and contractions in such models, which takes the heart out of the credit cycle as empirically confirmed by Schularick and Taylor (2012).

## 6. Conclusion

The financial and real sectors are interlinked through monetary injections and leakages: changes in the money stock, changes in the level of passive money holding, and changes in the volume of trade in secondary asset markets. In order to capture financial-real sector interaction, macro-monetary models need to feature an aggregate monetary budget capable of incorporating these injection and leakage terms.

DSGE analysis cannot adequately model financial-real sector interaction because (a) its aggregate goods market clearing condition prevents monetary injections/leakages from directly impacting aggregate spending and (b) its periodic resource budget equations cannot incorporate monetary injections and leakages. DSGE's modelling of how the interest rate influences total spending is deficient because changes in current lending cannot explain changes in current aggregate spending. For the same reason, DSGE's borrowing constraint cannot transmit financial dysfunction through to the real economy. The same applies to

DSGE's CIA constraint for as long as there is no commercial banking sector capable of influencing the money stock. The lack of a money-creating and -destroying commercial banking sector also disqualifies DSGE analysis from satisfactorily modelling the credit cycle as well as debt-deflation effects. By treating commercial banks as pure intermediaries, DSGE models overlook the fact that commercial banks have a cash budget equation and that the central bank has no choice but to ensure that the sector as a whole faces no cash constraint on its credit extension. The banking sector as a whole is constrained only by a lack of equity not a lack of liquidity. All these deficiencies make DSGE analysis unsuited as a vehicle for macro-monetary theorising.

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