UNIVERSITY OF TECHNOLOGY SYDNEY

FINANCE DISCIPLINE GROUP

UTS BUSINESS SCHOOL

WORKING PAPER NO.184 August 2015

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ISSN: 1837-1221
http://www.business.uts.edu.au/finance/

A Critique of Modern Money Theory and the Disequilibrium Dynamics of Banking and Government Finance

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Abstract

The Modern Money Theory, originated from the seminal work of Knapp (1905) that established the "chartalism school of monetary theory" and later on, synthesized by so-called "neo-chartalists" such as Wray (2012), is a descriptive economic theory that examines the procedures and consequences of using government-issued tokens as the unit of money. Despite its high relevance in today's policy arena that demands a thorough understanding over the modern fiat monetary system, MMT is generally not well-received by mainstream academics due to some of its radical claims. In an experimental and preliminary manner, this paper proposes a set of disequilibrium models that aims to take a further investigation over the balance sheet effects of those transactions discussed by MMT from a dynamic perspective. We contend that some of the claims made by MMT are fallacious due to its omission of dynamic and behavioural aspects. The framework proposed in this paper would also be useful for future research from a dynamic MMT perspective.

Keywords: Modern Money Theory (MMT), endogenous money, interbank market, fiscal policy, disequilibrium dynamics
JEL classification: E12, E52, E62, G21.

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The author would like to thank Corrado Di Guilmi, Paola D'Orazio, Nadja Koenig, Wanting Xiong, and participants to INET 2014 plenary conference in Toronto, Canada for valuable feedback and comments. The usual disclaimer applies.

1. Introduction

> *(Arthur) Burns loved to provoke disagreements among his graduate students. One day, in a class about inflation's corrosive effect on national wealth, he went around the room asking, "what causes inflation?" None of us could give him an answer. Professor Burns puffed on his pipe, then took it out of his mouth and delared,* ***"Excess government spending causes inflation!"***
>
> *- Alan Greenspan (2007), The Age of Turbulence, page 35*

It is almost an unchallenged view in the contemporary macroeconomic thinking that money is originated from commodity. It evolves to become the medium of exchange from a barter economy in order to facilitate the exchange of a growing large number of commodities. Money is nothing but a veil over the real economic activities. This common wisdom is formalized by the Quantity Theory of Money and its variations, which leads to the following two well-received propositions that are taught from Econ101 to more advanced New-Keynesian DSGE model: (1) the source of inflation is ultimately from the growth rate of money supply, hence the expansionary monetary policy of the central bank will contribute to nothing but a higher inflation in the long run. In the short run, however, it temporarily raises output since prices are sticky; (2) the supply of money is best treated as an exogenous variable in the long run, since it plays a non-essential role in the real activity. The real variables - real output or real interest rates, are determined by real factors such as time preference of money and technology.

Indeed, this theory is fundamentally right in an ancient, hypothetical society where commodity money (specie) is circulated and banks are yet to be developed. However, it is questionable in the contemporary system of fiat money, where the definition of money in itself is subject to endless debate (Werner, 2012). In such a system, the government's deficit spending through issuing bonds ultimately increases the monetary base (in the form of bank reserves) in the banking system, which is asset for commercial banks and liability for the central bank; the reserves in turn provide a basis for the commercial banks' credit expansion. The creation of loans leads to further creation of private deposits, which is liability for the banks and asset for the depositors. The sum of reserves, currency (in circulation), and deposits (of various kind) thus becomes a working measure of the quantity of money by most central banks around the world.

The Modern Money Theory (MMT), which is originated from the seminal work of Knapp (1905) and later on, synthesized by so-called "neo-chartalists" such as Wray (2012), is a descriptive economic theory that alternates the Neo-classical theory on money and investigates the intricacy of modern fiat money and banking system. It addresses many important issues outside the standard, textbook approach such as the consequence of government's deficit spending, the process of endogenous money creation, the role of central bank and the effective conduct of monetary policy. The core of MMT can best be summarized by the following four propositions:

1. **Loans create deposits:** the money supply is endogenous, since the commercial banks have to power to create money through issuing loans. The commercial banks lend first and borrow later (from the interbank market or from the central bank), in order to maintain the reserve requirement.
2. **government spending creates reserves, taxation eliminates reserves:** the government spending leads to a simultaneous increase of reserves and private deposits in the commercial bank. The reverse happens when tax is paid from the private sector.
3. **Interest rate is exogenous, the quantity of reserve is endogenous:** since the central bank has a commitment to maintain an interest rate target through controlling the quantity of reserves via Open Market Operations or Discount Lending, the short-term interest rate is exogenous (in a control sense) and the amount of reserves is endogenous.
4. **Government spending lowers the short-term interest rate:** since government spending increases the aggregate supply of excess reserves in the banking sector, thus pushing down the short-term interest rate.

The first three propositions have more or less reached a consensus amongst academics of Post-Keynesian strand and, to a certain degree, amongst policy makers[2]. The last proposition is somehow controversial, since it contradicts the conventional IS-LM model that claims government spending "crowds out" private investment, thus pushes up interest rates.

Perhaps the most controversial claim made by MMT proponent is that "governments with the power to issue their own currency are always solvent,

[2]On the policy side, see McLeay et al. (2014), *"money creation in the modern economy"*, in the Quartely Bulletin of the Bank of England.

and can afford to buy anything for sale in their domestic unit of account even though they may face inflationary and political constraints" (Tymoigne and Wray, 2013). This claim has spurred wide criticisms toward MMT from various schools of thought. Paul Krugman (2011) points out that MMT goes too far in its support for government budget deficits regardless of its inflationary consequence. A more severe criticism is made by Murphy (2011), who outright denies the validity of MMT, stating that "the MMT world view doesn't live up to its promises" and that it seems to be "dead wrong".

The narrative framework of MMT is not wrong - it is no more than a factual demonstration of the balance sheet effects in the transactions between government, central bank, commercial banks and private sector. Some of the criticisms merely stem from a misunderstanding of MMT. As MMT proponent Randall Wray stresses: "just because government can afford to spend does not mean government ought to spend", since "too much spending can cause inflation" (Wray 2012, page 187-188). Yet the normative claim made by MMT is questionable due to an important drawback of its *static* "T-account" analysis: it only looks at the effect of one-period balance sheet change of each transaction, which fails to look beyond and to quantify the dynamic process of these transactions. Hence it is crucial to integrate dynamical analysis beyond the static MMT approach to reach more viable and accurate policy recommendations.

As an experimental and preliminary step, this paper proposes a set of dynamical models that aims to enrich the static analysis of MMT. It involves minimal technicality in mathematical terms, yet we are able to use these simple tools to demonstrate the balance sheet effects of these transactions discussed by MMT over the course of time and contradict some of its controversial claims. More importantly, it serves as a starting point for future research that investigates further along this path.

The rest of the paper is organized as follows: section 2 proposes a mathematical framework that describes the process of endogenous money creation and interbank settlement. Section 3 derives a dynamic model of open market operations, which is applied in the subsequent discussion over the monetary effect of fiscal policy in section 4. We contradict the *fourth* proposition of MMT presented above and argue that government spending will not necessarily lower the short-term interest rate. The effect varies depending on the lending attitude of banks. Section 5 discusses a special scenario where fiat money and banking system were just introduced to the hypothetical economy. In a "Genesis" setting, it derives the dynamical process of money creation with interactive public and private sectors. Contrary to the common wisdom that overrates central bank's attributes to inflation through expansionary monetary policy and underrates the monetary effect of government's fiscal expansion on growth, we take a different view that monetary expansion due to government's deficit spending will have a permanent impact on **both** growth and inflation. Section 6 continues the discussion and proposes the *"Golden Rule"* of government's deficit spending from MMT perspective.

2. The Process of Endogenous Money Creation and Interbank Settlement

Commercial Bank	
Asset	**Liability**
Loan +	Deposit +

Table 1: Loans Create Deposits

In the examination of commercial bank's lending activity, MMT maintains that loans create deposits. It refutes the notion of constant money multiplier. The money creation process can be postulated by the following equation according to Taylor (2004):

$$L = R\lambda(.) \tag{1}$$

Where

- L is the loan created by the bank
- R is the *unborrowed* reserves
- $\lambda(.)$ is a function that describes bank's leverage in terms of loan-to-reserve ratio: the ratio between loans and *unborrowed* reserves

Note that $\lambda(.)$ is determined either passively by the real sector (the commercial banks lend in order to accommodate the real expansion)[3], or actively by banker's lending attitude. Therefore

$$\dot{\lambda} = \lambda(\dot{y}, x) \tag{2}$$

Bank A	
Asset	**Liability**
Reserve +	Interbank Loan +
Bank B	
Asset	**Liability**
Reserve -	
Interbank Loan +	

Table 2: The Interbank Lending and Borrowing

where $\dot{y}$ is the change in real sector and x is the lending attitude of banks.

Despite the commercial bank's ability to create money out of thin air, banks still face the constraint of reserve requirement at the end of the day. In addition, banks may desire to hold excess reserves to meet unforeseen circumstances. One common way to acquire additional reserves is via interbank borrowing. Suppose that $\lambda^{\star}(.)$ is a function that captures the ratio between the amount of loans and the bank's desired amount of reserves. Some banks will borrow additional reserves when $\lambda(.) > \lambda^{\star}(.)$, while other banks will lend out their unwanted reserves when $\lambda(.) < \lambda^{\star}(.)$. More precisely, it can be expressed in the following two equations:

$$L_{+} = R\lambda_{+}(.) = (R_{+} + BR^{d})\lambda^{\star}(.) \quad (3)$$

$$L_{-} = R\lambda_{-}(.) = (R_{-} - BR^{s})\lambda^{\star}(.) \quad (4)$$

where

- L_{+} (L_{-}) is the loans created by over-lending (under-lending) banks
- R_{+} (R_{-}) is the *unborrowed* reserves of the over-lending (under-lending) banks
- λ_{+} (λ_{-}) is the loan-to-reserve ratio of over-lending (under-lending) banks
- BR^{d} (BR^{s}) is the demand (supply) of borrowed reserves

[3]See Lavoie (2003) for detailed discussion.

It is easy to derive the excess demand (ER^d) for reserves from Equation (3-4):

$$BR^d = \frac{L_+}{\lambda^\star(.)} - R_+ = R_+(\frac{\lambda_+}{\lambda^\star(.)} - 1) \tag{5}$$

$$BR^s = R_- - \frac{L_-}{\lambda^\star(.)} = R_-(1 - \frac{\lambda_-}{\lambda^\star(.)}) \tag{6}$$

$$ER^d = BR^d - BR^s \tag{7}$$

$$= R_+(\frac{\lambda_+}{\lambda^\star(.)} - 1) - R_-(1 - \frac{\lambda_-}{\lambda^\star(.)}) \tag{8}$$

$$= \frac{1}{\lambda^\star}(\lambda_+ R_+ + \lambda_- R_-) - (R_+ + R_-) \tag{9}$$

Note that there will be no excess demand for reserves from the central bank ($ER^d = 0$) if the reserves are sufficient to accommodate $\lambda^\star$ in the aggregate banking system ($\lambda^\star = \frac{\lambda_+ R_+ + \lambda_- R_-}{R_+ + R_-}$). However, the banks will need excess reserves from the central bank if $ER^d > 0 \rightarrow \lambda^\star < \frac{\lambda_+ R_+ + \lambda_- R_-}{R_+ + R_-}$, which may be acquired either through central bank's discount lending facility or through selling government bonds (normally in the form of repurchase agreement) in the Open Market Operation. This will be discussed in details in the following section.

3. The Disequilibrium Dynamics of Open Market Operation

Central Bank	
Asset	**Liability**
Government Bond +	Reserve +
Commercial Bank	
Asset	**Liability**
Government Bond -	
Reserve +	

Table 3: The Effect of Open Market Operation

In the discussion over the conduct of monetary policy, MMT holds that the central bank is not able to control the money supply or bank reserves. In order to maintain the target short-term interest rates, the central bank has to constantly accommodate the excess demand of reserves from commercial banks - as most central banks do throughout the world. The excess demand for reserves leads to an upward pressure on (interbank) money market rate, thus the central bank has to buy government bonds from commercial banks via Open Market Operation in order to counterbalance the excess demand, until the rate reverts back to the target level[4]. This process is dynamic in nature: the interbank market is constantly in disequilibrium in the presence of ever-changing demand for excess reserves, and the central bank has to constantly adjust its position. The dynamic interaction between the interbank market and the central bank can thus be captured by the following equation:

$$\dot{r} = f(ER^d, ER^s(r^\star)) \tag{10}$$

where

- ER^d is the excess demand for reserves,
- ER^s is the excess supply for reserves,
- $r^\star$ is the targeted interest rate set by the central bank.

In its parsimonious linear form, we specify that

$$\dot{r} = \beta_1 ER^d + \beta_2(r^\star - r) \tag{11}$$

where

- $\dot{r}$ is the time derivative of r;
- ER^d is the excess demand for borrowed reserves;
- $r^\star$ is the exogenous target rate set by the central bank;
- β_1 is the adjustment speed of interbank market;
- β_2 is the adjustment speed of the central bank.

[4]We have not yet discussed the effect of paying interest on excess reserves and central bank's discount lending facility.

The setting of Equation (11) is similar to that of the Fundamentalist-Chartist interaction in the classical HAM literature[5]. The central bank here represents a stabilizing "fundamentalist" whereas the commercial banks are similar to the "chartists" in the sense that they constantly destabilizes the market. It is important to stress that this simple equation is just one of the many forms to capture the dynamic interaction between the central bank and the commercial banks. The function ER^d may be highly nonlinear and complex when other dynamic variables such as the expectations over future rate are taken into account. The function ER^d maybe self-stabilizing if there exists a fixed point $\bar{r}$ that equates BR^d and BR^s and $\frac{\partial ER^d}{\partial r} < 0$. In this case the interbank rate will converge to $\bar{r}$ without the central bank's intervention. It may also contain components that are outside the central bank's control (at least under this linear setting), thus disabling central bank to maintain its interest rate target.

We can also rearrange equation (11) in the form of excess demand and excess supply of reserves:

$$\dot{r} = \beta_1(ER^d - ER^s) \tag{12}$$

where

- $ER^d = BR^d - BR^s$
- $ER^s = \frac{\beta_2}{\beta_1}(r - r^\star)$

Equation (12) derives the quantity of supply of excess reserves that the central bank ought to inject ($ER^s = \frac{\beta_2}{\beta_1}(r - r^\star)$), in order to achieve the desired target rate ($r^\star$). Here an implicit assumption is made: the relationship between ER^d and $\dot{r}$ is linear. Apparently this framework can be easily adopted to a scenario where a country pegged its currency to a foreign currency. The equation then becomes:

$$\begin{aligned} \dot{e} &= \gamma_1(EE^d) + \gamma_2(e^\star - e) = \gamma_1(EE^d - EE^s) && (13) \\ EE^s &= \frac{\gamma_2}{\gamma_1}(e - e^\star) && (14) \end{aligned}$$

where

[5]HAM stands for Heterogeneous Agent Model. For example, Beja and Goldman (1980) and Chiarella (1992) proposed a model of endogenous asset pricing with Fundamentalist-Chartist interaction.

- e is the exchange rate
- EE^d is the excess demand for foreign exchange
- EE^s is the excess supply due to central bank's intervention

It can be seen that, in this scenario of exchange rate targeting, there is no guarantee that the country is able to do so continuously. If the central bank's foreign exchange reserves do not exceed the amount $\frac{\gamma_2}{\gamma_1}(e - e^\star)$, it will be unable to peg its currency.

4. The Monetary Effect of Fiscal Policy

Perhaps one of the most controversial claim made by MMT is on the effect of government spending over the short-term interest rates. Contrary to the conventional IS-LM view that the government spending "crowds out" the private spending thus leads to an upward pressure on interest rate, MMT maintains that the government deficit actually provides a downward pressure on the (short-term) interest rate, since deficit spending increases the amount of reserves in the banking system. Taxation, on the other hand, drains the reserves from banking system - thus raises short-term interest rate. This is illustrated in Table 4.

Suppose that the government deficit spending (δ) now enters the excess supply of reserves ($ER^s_{new} = ER^s + \delta$), equation (12) thus becomes:

$$\dot{r} = \beta_1(ER^d - ER^s - \delta) \tag{15}$$

where δ is the government deficit and $\delta = G - T$.

In order to see the effect of government deficit spending on the equilibrium level of interest rate, equation (15) is rearranged in the form that separates the market excess demand and policy intervention:

$$\dot{r} = \beta_1 ER^d + \beta_2[(r^\star - \frac{\beta_1}{\beta_2}\delta) - r] \tag{16}$$

Seemingly, from equation (16) we notice that the new level of interest rate is permanently lower than the target rate $r^\star$ by the amount $\frac{\beta_1}{\beta_2}\delta$. However, it ignores the fact that an increase of reserves will enable banks to extend more credit. Upon receiving the additional reserves, the banks will have three options: (1) to extend more private credit; (2) to lend it out to the

Effect of Government Spending		Effect of Taxation	
Government		**Government**	
Asset	**Liability**	**Asset**	**Liability**
Central Bank Deposit -		Central Bank Deposit +	Net Worth +
Bomb +			
Central Bank		**Central Bank**	
Asset	**Liability**	**Asset**	**Liability**
	Central Bank Deposit -		Central Bank Deposit +
	Reserve +		Reserve -
Commercial Bank		**Commercial Bank**	
Asset	**Liability**	**Asset**	**Liability**
Reserve +	Private Deposit +	Reserve -	Private Deposit -
Company		**Company**	
Asset	**Liability**	**Asset**	**Liability**
Private Deposit +		Private Deposit -	Net Worth -
Bomb -			

Table 4: The Monetary Effect of Government Spending (left) and Taxation (right)

(interbank) money market; and (3) to do nothing (liquidity hoarding). In the first scenario, the new level of demand for reserves becomes $ER^d_{new} = ER^d + \delta \Leftrightarrow \dot{r} = \beta_1(ER^d + \delta - \delta) + \beta_2(r^\star - r)$, hence more private loans are made and the interest rate is unaffected. It implies that the government's deficit spending may have a multiplier effect over the private sector's credit expansion. In the second scenario, however, δ is totally added to the excess supply of reserves ($ER^s_{new} = ER^s + \delta$) without affecting ER^d. The interest rate thus becomes permanently lower than the target one, as MMT claims. In the last scenario, nothing will happen since the additional reserves neither lead to credit expansion, nor enter the interbank market that pushes down interest rate.

- **The Fiscal Multiplier of Credit (FMC):** $d \uparrow \rightarrow R \uparrow (\Delta R = \delta) \rightarrow L \uparrow (\Delta L = \delta\lambda^{\star}) \rightarrow ER^{d} \uparrow (\Delta ER^{d} = \delta) \rightarrow \Delta r = 0$
- **Increase in Excess Reserve and OMO:** $\delta \uparrow \rightarrow R \uparrow (\Delta R = \delta) \rightarrow \Delta L = 0 \rightarrow ER^{s} \uparrow (\Delta ER^{s} = \delta) \rightarrow r \downarrow (\Delta r = -\frac{\beta_1}{\beta_2}\delta) \rightarrow ER^{s} \downarrow (\Delta ER^{s} = -\delta)$ (through OMO) $\rightarrow r \uparrow (r = r\star)$
- **Liquidity Hoarding:** nothing will happen.

5. Genesis: A Special Scenario

This section continues with the discussion by considering a special scenario in a hypothetical economy where, at the beginning of time, the government had just introduced fiat currency. At $t = 0$, the government procures a commodity (bomb) from the private sector with the value δ by issuing bond, and the bond eventually reaches the central bank's balance sheet[6]. The balance sheet effect is illustrated in Table 5-I. Note that there is a simultaneous increase of reserves and private deposits in the commercial bank's balance sheet.

Upon receiving the additional reserves, the commercial bank decides to keep a portion of it as a basis ($\alpha\delta$) for private lending. Given a loan-to-reserve ratio of λ, it leads to an increase of deposits by the amount $\alpha\delta\lambda$. The other portion is intended to be lent out to the (interbank) money market by the amount $(1-\alpha)\delta$. This is illustrated in Table 5-II.

Since this intended amount of excess supply of reserves ($(1-\alpha)\delta$) poses a downward pressure toward the money market rate, the central bank decides to pre-emptively sell part of the bond by equal amount in order to counterbalance this excess supply of reserves and maintain the original money market rate.[7] Now the money market is stabilized, and commercial bank holds government bonds by the amount $(1-\alpha)\delta$. This is illustrated in Table 5-III. It is also important to note from the final position that the quantity of one-period government's deficit spending equals to the quantity of the private

[6]This is purely a simplification, since in reality the central bank cannot purchase government bond directly in the primary market.

[7]This simplification is made so that we don't have to worry about the balance sheet of money market dealer.

I			
Government		**Central Bank**	
Asset	**Liability**	**Asset**	**Liability**
Bomb + (δ)	Bond + (δ)	Bond + (δ)	Reserve + (δ)
Commercial Bank		**Private Sector**	
Asset	**Liability**	**Asset**	**Liability**
Reserve + (δ)	Private Deposit + (δ)	Private Deposit + (δ)	
		Bomb - (δ)	
II			
Commercial Bank		**Private**	
Asset	**Liability**	**Asset**	**Liability**
Loans + (αδλ)	Private Deposit + (αδλ)	Private Deposit + (αδλ)	Loans + (αδλ)
Reserve - ((1−α)δ)			
Intended Interbank Loan +((1−α)δ)			
III			
Commercial Bank			
Asset	**Liability**		
Reserve - ((1−α)δ)			
Bond + ((1−α)δ)			
Central Bank			
Asset	**Liability**		
Bond − ((1−α)δ)	Reserve − ((1−α)δ)		
The Final Position			
Government		**Central Bank**	
Asset	**Liability**	**Asset**	**Liability**
Bomb (δ)	Bond (δ)	Bond (αδ)	Reserve (αδ)
Commercial Bank		**Private Sector**	
Asset	**Liability**	**Asset**	**Liability**
Reserve (aδ)	Private Deposit (δ+αδλ)	Private Deposit (δ+αδλ)	Loan (αδλ)
Bond ((1−α)δ)			Net Wealth (δ)
Loan (αδλ)			

Table 5: The Fiscal Multiplier of Credit

sector's net worth, regardless of the intermediate financial transactions. In Randy Wray's words: "Private debt is debt, but government debt is financial wealth to the private sector."

Now suppose that the three variables being discussed - the deficit spending, the bank's lending attitude, and the bank's leverage ratio, are expressed as implicit functions: $\delta(.)$, $\alpha(.)$, and $\lambda(.)$. The one-period increment of money supply ($\dot{M}$), defined as the sum of reserves plus private deposits, is therefore given by the following equation:

$$\begin{aligned}\dot{M} &= \delta(.) + \alpha(.)\delta(.) + \alpha(.)\delta(.)\lambda(.) &(17)\\ &= \delta(.)[1 + \alpha(.) + \alpha(.)\lambda(.)] &(18)\end{aligned}$$

Note that in Equation (17), $\delta(.)$ reflects the increase of the private deposit due to government's deficit spending; $\alpha(.)\delta(.)$ is the amount of reserves kept in the bank as money base[8]; and $\alpha(.)\delta(.)\lambda(.)$ is the quantity of deposit created by banks through private lending.

We integrate $\dot{M}$ in order to derive the stock of money over time:

$$M = \int_0^T \delta(.)[1 + \alpha(.) + \alpha(.)\lambda(.)]dt \tag{19}$$

With $M(t = 0) = 0$.

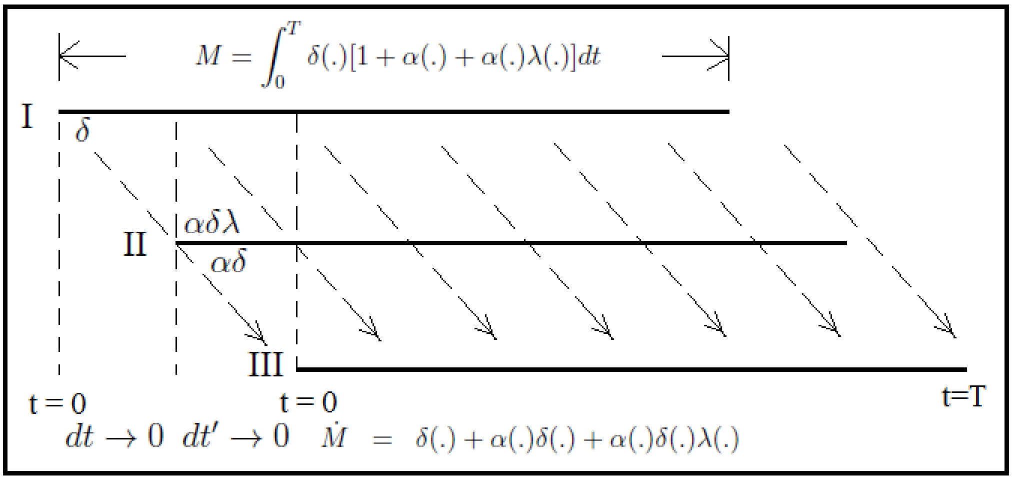

Figure 1: The Dynamics of Monetary Growth: An Illustration

We further illustrate this process in Figure 1: at time ($t = 0$), the three transactions I, II, and III are assumed to happen in vertical terms ($dt \to 0$ and $dt' \to 0$), from which we can derive the one-period increment of money $\dot{M}$. As the three transactions $I \to II \to III$ repeat over the course of time, we can derive the aggregate stock of money $M = \int_0^T \delta(.)[1+\alpha(.)+\alpha(.)\lambda(.)]dt$.

[8]For simplicity, we assume that there are no private withdrawal, hence there is no currency in circulation.

Now we revisit the classical Quantity Theory of Money with constant velocity:

$$MV = PY \Rightarrow \frac{\dot{M}}{M} = \pi(.) + g(.) \tag{20}$$

Substituting Equation (17) and (19) into Equation (20) we have:

$$\frac{\delta(.)[1 + \alpha(.) + \alpha(.)\lambda(.)]}{\int_0^T \delta(.)[1 + \alpha(.) + \alpha(.)\lambda(.)]dt} = \pi(.) + g(.) \tag{21}$$

Equation (21) essentially captures the dynamical process of money creation from a behavioural perspective that consists of both government and private sectors. To emphasize on the government side, we set the private-sector variables as constant: $(1 + \alpha(.) + \alpha(.)\lambda(.) = 1 + \bar{\alpha} + \bar{\alpha}\bar{\lambda})$. We assume that the government deficit grows at the rate s $(\delta(t) = e^{st})$[9]. Equation (21) thus becomes

$$\pi(.) + g(.) = \frac{e^{st}}{\int_0^T e^{st}dt} = s \tag{22}$$

"Excess government spending causes inflation!", as Arthur Burns claims in Alan Greenspan's graduate classroom in his formative years. Without legal or political constraint, the government has unlimited power to spend through deficit. Consequently, it will create new reserves and increase the monetary base in the banking sector. Amongst all other factors that causes inflation, the excess growth of government's deficit spending into unproductive sectors is the most detrimental one that contributes to permanent inflation $\pi(.)$. However, if the government wields its power of deficit spending wisely into productive sectors such as infrastructure building and supporting R&D, it will potentially stimulate permanent growth $g(.)$. It is important to stress that the growth effect is merely catalytic in this context. The

[9]Here we have implicitly made three underlying assumptions: *(i)*, we assume that the government issues perpetuity; *(ii)* we assume a zero-interest-rate borrowing for the government; *(ii)* we assume that there is no tax payment involved. these assumptions are only for mathematical convenience, which can be loosened up later on. It is also important to be reminded that according to MMT, taxation is essential for the existence of fiat money as it imposes a legal obligation for the private sector to accept government-issued token to pay tax.

ultimate driving force behind real growth still lies in the supply-side factors such as labour productivity, technology, and capital, which has been well-documented and discussed thoroughly in the literature of Neo-Classical growth theory and is beyond the scope of this paper. Intuitively, with a burgeoning private sector, it demands a constant expansion and improvement of the public sector to accommodate growth, which can only be achieved by a dedicated government. It is also noteworthy to mention, as we can see from Equation (21), that private credit expansion due to a rising λ does not have a permanent impact on either growth or inflation since λ is not able to grow in unlimited terms. It is subjected to recurrent fluctuations that cause short-to-medium term financial instability and lead to boom-bust cycles in the asset markets, as we have witnessed in the history of financial crisis. Yet the boundary of λ could be loosened and circumvented to a certain degree, thanks to various kinds of financial innovations such as the invention of bill-of-exchange, the computerization of money, and securitization[10].

6. The "Golden Rule" of Government's Deficit Spending

It is important, therefore, to consider how and how much should government spend to maximize the stimulative effect of growth while minimizing inflation. We consider a scenario where the link between growth/inflation and government deficit spending are determined only in quantitative terms. In a generalized sense we consider the following two functions of $g(.)$ and $\pi(.)$:

$$g(.) = g(s, x_i | i = 1, ..., N) \tag{23}$$

$$\pi(.) = \pi(s, x_i | i = 1, ..., N) \tag{24}$$

Where $g(.)$ is the implicit function for growth and $\pi(.)$ is the implicit function for inflation; s is the growth rate of government spending; $[x_i | i = 1, ..., N]$ is a vector of non-governmental factors that influences and determines both $g(.)$ and $\pi(.)$ such as supply-side factors (i.e. labour productivity, technology, and capital, etc.).

[10]See Kindleberger (1989) for a detailed reference.

The objective function of the government (Π) is therefore to maximize growth while minimizing inflation. Hence:

$$\Pi(.) = \max\left[g(.) - \omega\pi(.)\right] \tag{25}$$

Where ω is the parameter that determines the weight of inflationary consideration by the government. The higher ω, the more government is concerned about inflation over growth.

It is reasonable to assume a scenario where: *ceteris paribus*, *(i)* inflation increases proportionately to the growth of deficit spending and *(ii)* there is a diminishing marginal effect of government's deficit spending in stimulating real growth. Hence, let's consider the following two specifications:

$$g(s) = \kappa s^{\alpha}(0 < \alpha < 1) \tag{26}$$

$$\pi(s) = \theta s(0 < \theta \leq 1) \tag{27}$$

Substituting Equation (26) and (27) into Equation (25) we have:

$$\Pi(s) = \max\left[\kappa s^{\alpha} - \omega\theta s\right] \tag{28}$$

By solving Equation (28) we have:

$$\frac{\partial \Pi(s)}{\partial s} = 0 \tag{29}$$

$$s^{\star} = (\frac{\omega\theta}{\alpha\kappa})^{1-\alpha} \tag{30}$$

Which indicates, in Equation (30), the optimum growth rate of the government's deficit spending.

We also consider a case where growth effect equally weights inflationary effect. Hence $\theta s = \kappa s^{\alpha} \leftrightarrow s = (\frac{\kappa}{\theta})^{\alpha-1}$. Given that $s^{\star} = (\frac{\omega\theta}{\alpha\kappa})^{1-\alpha}$, it is easy to derive that $\omega = \alpha$ in this scenario.

The discussion above can best be summarized by Figure 2. The horizontal axis is the growth rate of government deficit spending (s) whereas the vertical axis represents the real and inflationary effect of government's deficit spending($g(s)$ and $\pi(s)$). The concave line corresponds to $g(s)$ whereas the straight line corresponds to $\pi(s)$. At the point where these two curves intersect we have $g(s) = \pi(s)$. Hence in this case, $s = (\frac{\kappa}{\theta})^{\alpha-1}$ and $\omega = \alpha$. The

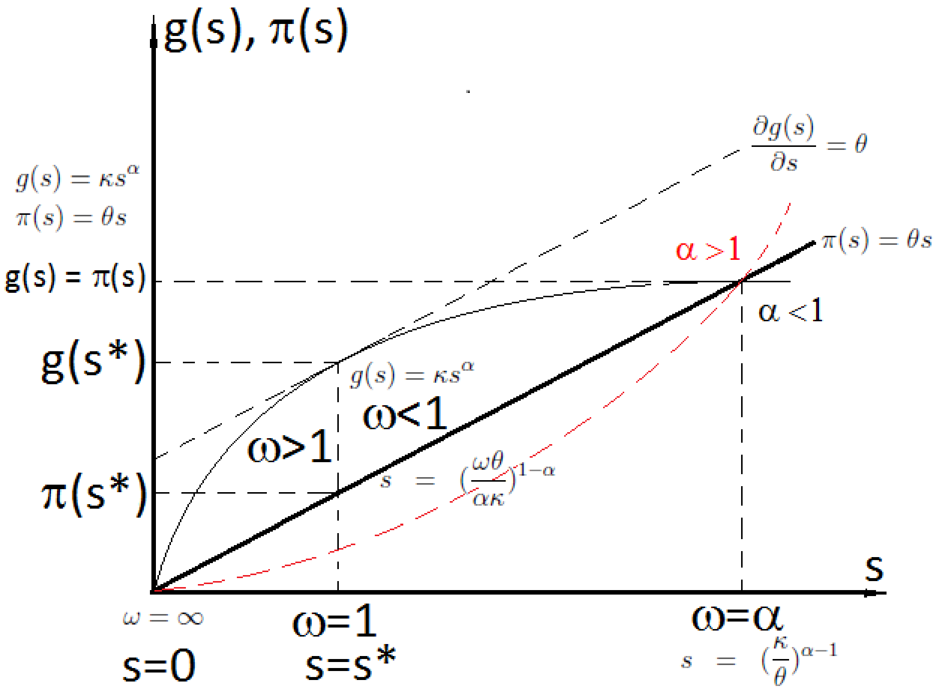

Figure 2: Optimal Growth of Government Deficit Spending

tangent point of the linear function $\frac{\partial g(s)}{\partial s} = \theta$, which is parallel with $\pi(s)$, describes the "Golden Rule" of the government's deficit spending where the government achieves the highest possible growth rate with relatively low inflation ($\omega = 1$). The government is more willing to curb inflation at the expense of lower growth during the interval $[s = 0(\omega = \infty), s = s^{\star}(\omega = 1)]$, and the government is more willing to achieve higher growth at the expense of higher inflation during the interval $[s = s^{\star}(\omega = 1), s = (\frac{\kappa}{\theta})^{\alpha-1}(\omega = \alpha)]$. Clearly our discussion only considers the case where $\alpha < 1$ (there is a diminished marginal effect of $g(s)$ on s). In an unrealistic, hypothetical case where $\alpha > 1$, which is captured by the red dashed line, s will rise toward infinity.

7. Conclusion

Nearly 110 years ago, Georg Friedrich Knapp, driven by his enquiry over the mechanics of using modern fiat money by sovereign governments, wrote "The State Theory of Money" that established the chartalist school of monetary theory. In recent years, there is a surge of "neo-chartalistist" movements that strives to bring more realism to the analysis of monetary and fiscal policy through a detailed balance sheet approach. Despite its high relevance in today's policy arena that demands a thorough understanding over the mechanism of fiat money system, MMT is generally not well-received by mainstream academics due to some of its radical claims, especially in its audacious support for government's deficit spending regardless of its potential inflationary effect.

This paper proposes a set of models that aims to take a further investigation over the balance sheet effects of those transactions discussed by MMT from a dynamic perspective. It is, to a certain extent, inspired by earlier works of disequilibrium asset pricing and macro-dynamical models (Beja and Goldman, 1980; Chiarella, 1992). We contend that some of the claims made by MMT are fallacious due to its omission of dynamic and behavioural aspects. We make a brief summary of this paper in the following three propositions:

1. **The Fiscal Multiplier of Credit:** the government's deficit spending eventually increases the monetary base in the form of bank reserves. Yet, contrary to what MMT claims, it will not necessarily lead to a downward pressure over the short-term interest rates. It may encourage private sector's credit expansion due to loosened reserve constraints.

In other words, the government may act as a multiplier over private sector's credit expansion through its power of expanding reserves from deficit spending.

2. **Excess leverage in private sector causes financial instability; excess government spending causes permanent inflation:** while private banks are capable of creating money out of thin air, it is still limited by its capital constraints in various forms. Thus the effect of monetary expansion due to private sector's credit creation will not have a permanent effect over growth and inflation. It will eventually lead to short-to-medium term financial instability as Minsky (1975) has also alluded. On the other hand, monetary expansion due to government's deficit spending will have a permanent impact on both growth and inflation. If the government wields its power of deficit spending wisely into productive sectors, it will potentially stimulate permanent growth. If the government overstretches its deficit into unproductive sectors, it will cause permanent inflation.
3. **The "Golden Rule" of Government's deficit spending:** it is therefore important to consider the state of optimal fiscal policy. In simple terms, we argue that the "Golden Rule" of the government's deficit spending lies at the point where the marginal effect of deficit spending on stimulating growth equals to the marginal effect on inflation.

More importantly, the modelling framework proposed in this paper may serve as a path for future research. One particular area that deserves further investigation is the dynamics of private sector leverage and the heterogeneity of banking sector in propagating the credit cycles (for example, the modelling of over-lending and under-lending banks as is briefly discussed previously). This could potentially be achieved in the spirit of theories in nonlinear economic dynamics and heterogeneous agent modelling.

References

Beja, A., Goldman, M. B., 1980. On the Dynamic Behavior of Prices in Disequilibrium. Journal of Finance 35 (2), 235–48.

Chiarella, C., 1992. The Dynamics of Speculative Behaviour. Working Paper Series 13, Finance Discipline Group, UTS Business School, University of Technology, Sydney.

Greenspan, A., 2007. The Age of Turbulence: Adventures in a New World. The Penguin Press, New York.

Kindleberger, C. P., 1989. Manias, Panics, and Crashes: A History of Financial Crises. Macmillan, London.

Knapp, G. F., 1905. Staatliche Theorie des Geldes (The State Theory of Money). Duncker & Humblot, Muenchen und Leipzig.

Krugman, P., 2011. Deficits and the printing press (somewhat wonkish).

Lavoie, M., 2003. Modern Theories of Money: The Nature and Role of Money in Capitalist Economies. Edward Elgar Publishing, Ch. A Primer on Endogenous Credit-Money, pp. 506–43.

McLeay, M., Radia, A., Thomas, R., 2014. Money creation in the modern economy. Quarterly Bulletin Q1, Bank of England.

Minsky, H. P., 1975. John Maynard Keynes. Macmillan, New York.

Murphy, R., 2011. The upside-down world of mmt.

Taylor, L., 2004. Reconstructing Macroeconomics: structuralist proposals and critiques of the mainstream. Harvard University Press, Cambridge, Massachusetts.

Tymoigne, E., Wray, R., 2013. Modern money theory 101: A reply to critics. Working paper 778, Levy Economic Institute.

Werner, R., 2012. The quantity theory of credit and some of its applications. Presentation slides, Centre for Banking, Finance, and Sustainable Development, University of Southampton.

Wray, R., 2012. Modern Money Theory - A Primer on Macroeconomics for Sovereign Monetary Systems. Palgrave Macmillan, New York.