# A Model of the Federal Reserve Act under the International Gold Standard System


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## Abstract

This paper expands Freeman [1996a, b] into a two-country model. Optimal allocation of resources requires an elastic money supply in both the foreign exchange market and the domestic credit market to clear all debts and foreign exchange at par value in the short run, and provide a constant money supply in the long run. Such monetary controls could be achieved by either an independent central bank or a private clearinghouse, but the governance structure of those institutions must reflect the interests of both debtors and creditors. Those features are consistent with the 1913 Federal Reserve Act.



**Key words:** Central Bank, Clearinghouse, Foreign Exchange Market

**JEL Classification:** E58



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This work is based on research conducted when the author was a Visiting Scholar at the Federal Reserve Bank of Minneapolis. The author would like to thank the Federal Reserve Bank of Minneapolis for their hospitality, and Edward Green and Ruilin Zhou for their helpful comments and suggestions. The author also thanks seminar participants at the Federal Reserve Bank of Minneapolis for their useful comments on the earlier version of this paper. However, the opinions expressed in this paper are those of the author, and do not necessarily represent those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

## 1. Introduction

Freeman (1996a, b) and Green (1997) describe the spirit of the 1913 Federal Reserve Act and eloquently explain the role of the central bank as a "settlement agency." Their models have the following features: (i) people make some purchases with debt; (ii) debts are repaid with fiat money; and (iii) there is an active market in second-hand debt. They suppose that agents are spatially separated, therefore, private debt is incurred between two parties and can only be redeemed with fiat currency at a central clearing area. If the arrival rates of debtors and creditors at the debt-settlement location are not the same, and if the amount of currency available at the central clearing area is less than the par value of debt, the equilibrium will be called liquidity-constrained. In such a situation, a central bank can issue money to help agents to clear all debts at par value. Once all debts are cleared, central bank loans should be repaid with fiat money, and the money stock should be constant. Such central bank intervention leads to an optimal allocation of resources. Therefore, the Freeman and Green models explain why both elastic money supply in the long run to smooth the seasonal fluctuations in the nominal interest rate based on the "Real Bills Doctrine" in the short run, and constant money supply , or price stability in the long run, are consistent and desirable policy objectives for a central bank.

This paper extends Freeman's model to highlight other aspects of the Federal Reserve Act. The first point is that the international gold standard, as well as the Real Bills Doctrine, were integral components of the structure of reform under the Federal Reserve Act as West (1974) points out. Therefore, this paper will extend Freeman's model into a two-country model, and examines the role of the central bank in the foreign exchange market. The other point discussed in this paper is the governance structure of the Federal Reserve System. Can monetary policy be delegated to the private bankers? Or, should governmental agencies participate in the decision making about monetary policy? More specifically, can any private arrangements work as a substitute for central banks in a two-country set-up as Green (1997) and Gorton and Mullineaux (1987) suggest? The outline of my model to discuss those points is summarized as follows.

Think about the two-country overlapping-generations model by Freeman, and suppose that old domestic creditors are subject to taste shock, and they want to consume young foreign debtors' goods in their second stage of life with a small probability. Suppose further that old domestic creditors know their preference for foreign goods only after they become old. I assume a so-called country-specific cash-in-advance constraint, namely, old domestic creditors must pay foreign currency to obtain foreign good. Therefore, old domestic creditors need to meet old foreign creditors to obtain foreign currency in exchange for domestic currency, and afterwards meet young foreign debtors to obtain young foreign debtors' goods. Suppose that the arrival rates of debtors and creditors at the debt-settlement location and those of old domestic creditors and old foreign creditors at the foreign exchange location are not the same. Suppose further that the amount of currency available at the central clearing area is less than the par value of debt, and the ratio of currency in the foreign exchange market is not the same as the fair value of foreign exchange. In such a situation, central bank intervention into both the debt market and the foreign exchange market will be useful to restore an efficient allocation of resources. In sum, apart from the addition of the country-specific cash-in-advance constraint, the foreign exchange market, and the taste shock, my model works exactly the same as those of Freeman (1996a, b) and Green (1997).

It is true that previous studies show that an independent central bank is the most important prerequisite for the conduct of monetary policy. However, the influential models in this field, such as Svensson (1997), Walsh (1995a), and Rogoff (1985) are framed in the context of macroeconomic dynamic inconsistency. Therefore, those models are not useful for the analysis of central banks in the short run. In particular, they cannot depict the role of the central bank as a settlement agency despite the fact that most of the central banks are important players in the money market and that they are offering services to settle the debt of banks. Moreover, those models do not explain the reasons why a central bank exists in the world, and why fiat money exists in the economy. As Walsh (1995b) stresses, the framework of dynamic inconsistency can be used to understand the Reserve Bank of New Zealand Act. I would like to stress that my simple model can be used to understand the 1913 Federal Reserve Act, and to provide a consistent explanation for both short run and long run effects of monetary policy.

The organization of this paper is as follows. Section 2 discusses the details of a basic two-country model with money. Section 3 shows that the monetary equilibrium obtained in Section 2 coincides with one of the technically feasible Pareto efficient allocations. Section 4 introduces the liquidity constraint. Section 5 discusses policy implications obtained from those models, and Section 6 concludes the paper.

## 2. Monetary equilibrium

Imagine a two-country overlapping-generations model. There are two types of agents, called creditors and debtors, in the domestic country and the foreign country. Their populations are normalized to one, and their lifetimes are two periods. Home creditors are endowed with $y$ units of good $y$ in their first period of life, and domestic debtors are endowed with $x$ units of good $x$ in their first period of life. Foreign creditors are endowed with $y^*$ units of good $y^*$ in their first period of life, and foreign debtors are endowed with $x^*$ units of good $x^*$ in their first period of life. Creditors consume in both periods of their lives, while debtors only consume in the first period.

Home creditors born at time t consume $c_{yt}$ units of good $y$ out of their endowment at time t. They exchange their remaining endowment of good $y$ for the loan certificates issued by the domestic debtors born at time t, who promise to pay amount $l_t$ of domestic currency at time t+1 to domestic creditors born at time t. The use of domestic currency for settlement is imposed exogenously here. However, for reasons below, this constraint does not cause appreciable departure from the agents' utility maximizing behavior.

At time t+1, old domestic creditors born at time t first obtain domestic currency from the old domestic debtors born at time t based on the loan contracts made at time t, and buy $c_{xt+1}$ of good $x$ from young domestic debtors born at time t+1. But with probability 1-$g$, where $g$ is positive but close to one, old domestic creditors born at time t want to buy $c_{xt+1}^*$ of good $x^*$ from young foreign debtors in time t+1. Note that young foreign debtors born at time t+1 already owe debt to young foreign creditors born at time t+1 payable in foreign currency at time t+2, when they meet old domestic creditors born at time t. Foreign young debtors born at time t+1 know that old domestic creditors born at time t will die at time t+2, therefore they refuse to accept the debt issued by old domestic creditors born at time t. Foreign young debtors born at time t+1 also know that at time t+2, they might meet the foreign creditors born at time t+1 who are willing to accept domestic currency if the creditors are subject to taste shock. However, I assume that all old creditors born at time t must pay foreign currency if they want to buy good $x^*$. Because creditors born at time t+1 expect to consume foreign goods only with a small probability, the complete specialization holding of currency as required by this constraint does not force them far from their ex-ante optimal behavior. In sum, having assumed a country-specific cash-in-advance constraint, even if there is a foreign exchange market, most of the domestic transactions are through local currency as is often assumed in the literature of international finance. Zhou (1997) shows that such an equilibrium exists in search-theoretic general equilibrium models, but in this model I simply assume that a country-specific cash-in-advance model.

By these assumptions, old domestic creditors born at time t must visit the foreign exchange market and find old foreign creditors born at time t who are interested in purchasing good $x$ from young domestic debtors born at time t+1. Old domestic creditors and old foreign creditors born at time t exchange domestic currency and foreign currency in order to obtain the good they want to consume. The behavior of foreign creditors, who are endowed with $y^*$ unit of goods in their first period of life, is a mirror image of that of domestic creditors.

Home debtors born at time t consume only at time t. They consume two kinds of goods: $d_{xt}$ of their own endowment $x$ and $d_{yt}$ of the domestic creditor's endowment. They obtain $d_{yt}$ from the domestic creditor born at time t in exchange for the promise of paying $h_t$ of the domestic currency at time t+1. Note that they need to obtain $d_{yt}$ before they receive any money. Therefore, they issue debt to the creditors born at time t.

After consuming $d_{yt}$ of good $y$, domestic debtors born at time t sell some of their endowment, good $x$, to the old creditors born at time t-1 and old foreign creditors born in time t-1, in exchange for domestic currency. At time t+1, domestic debtors born at time t become old, and visit old domestic creditors born at time t to pay their debt using domestic currency. The behavior of foreign debtors, who are endowed with $x^*$ unit of goods in their first lifetime, is a mirror image of that of domestic debtors.

To obtain a closed form solution, I suppose that domestic debtors born at time t have the following utility function:

$$ln(d_{xt}) + ln(d_{yt}). \tag{1}$$

Their budget constraints are:

$$xP_{xt} = d_{xt}\,P_{xt} + m_t\,,$$

$$m_t = h_t,$$

$$d_yP_{ytt} = h_t,$$

where $P_{xt}$ is the nominal price of good $x$, $m_t$ is the demand for domestic currency in order to pay back debt at time t+1, $h_t$ represents the debt to be paid at time t+1 in domestic currency, and $P_{yt}$ is the nominal price of good $y$. I summarize the budget constraint as,

$$x = d_{xt} + \left(\frac{P_{yt}}{P_{xt}}\right)d_{yt}\,. \tag{2}$$

Maximizing equation (1) subject to equation (2) by the choice of $d_{xt}$, $d_{yt}$, and $d_{yt}$* yields the following demand function of domestic debtors: $d_{xt} = x/2$ and $d_{yt} = (P_{xt}/P_{yt})(x/2)$.

Suppose that foreign debtors born at time t have the following utility function:

$$ln(\underline{d_{xt}}^*) + ln(\underline{d_{yt}}^*). \tag{3}$$

Note that lower bar is added to all choice variables for foreign agents. Foreign debtors face the budget constraint, equation (4), that is analogous to equation (2):

$$x^* = \underline{d_{xt}}^* + \left(\frac{P_{yt}^*}{P_{xt}^*}\right)\underline{d_{yt}}^*, \tag{4}$$

where $P_{xt}$* is the nominal price of foreign good $x$*, and $P_{yt}$* is the nominal price of foreign good $y$* in foreign currency.

Maximizing equation (3) subject to equation (4) by the choice of $\underline{d_{xt}}^*$ and $\underline{d_{yt}}^*$ yields the following demand functions of domestic debtors: $\underline{d_{xt}}^* = x^*/2$ and $\underline{d_{yt}}^* = (P_{yt}^* / P_{xt}^*)(x^*/2)$. Now suppose the domestic creditors born at time t have the expected utility function:

$$ln(c_{yt}) + g\, ln(c_{xt+1}) + (1\text{-}g)\, ln(c_{xt+1}^*), \qquad (5)$$

because at time t, they only know that they belong to the ($1$-g) fraction with probability $1$-g at time t+1. The budget constraints will be

$$yP_{yt} = c_{yt}\, P_{yt} + l_t, \qquad (6)$$

and

$$c_{xt+1}\, P_{xt+1} = l_t, \qquad (7)$$

with probability g, or

$$c_{xt+1}^* P_{xt+1}^* = \frac{l_t}{e_{t+1}}. \qquad (8)$$

with probability $1$-g, where $l_t$ is the amount of loans made to the debtors born at time t in the domestic country.

I assume that $e_{t+1}$ is the foreign exchange rate, agents have perfect foresight, and their expected exchange rate will be realized in the market. Maximizing equation (5) subject to equations (6), (7) and (8) by the choice of $c_{yt}$, $c_{xt+1}$, $c_{xt+1}^*$ and $l_t$ will yield the following results: $c_{yt} = y/2$, $c_{xt+1} = (P_{yt}/P_{xt+1})(y/2)$, and $c_{xt+1}^* = (P_{yt}/P_{xt+1}^*)(y/2)(1/e_{t+1})$.

Finally, suppose the foreign creditors born at time t have the expected utility function:

$$ln(\underline{c}_{yt}^{*}) + \gamma\, ln(\underline{c}_{xt+1}^{*}) + (1-\gamma)\, ln(\underline{c}_{xt+1}). \qquad \textbf{(9)}$$

Their budget constraint at time t will be

$$y^{*}P_{yt}^{*} = \underline{c}_{yt}^{*}\, \mathrm{P}_{\mathrm{yt}}^{*} + \underline{l}_{t}^{*}, \qquad \textbf{(10)}$$

where $\underline{l}_{t}^{*}$ is the amount of loans made to the debtors in the same cohort in the domestic country.

If they belong to the $\gamma$ fraction, they face equation (11) at time t+1:

$$\underline{c}_{xt+1}^{*}\; P_{xt+1}^{*} = \underline{l}_{t}^{*}, \qquad \textbf{(11)}$$

and if they belong to the (1-$\gamma$) fraction, they face equation (12) at time t+1:

$$\underline{c}_{xt+1}\, P_{xt+1} = \underline{l}_{t}^{*}\, e_{t+1}. \qquad \textbf{(12)}$$

Maximizing equation (9) subject to equations (10), (11) and (12) by the choice of $\underline{c}_{yt}^{*}$, $\underline{c}_{xt+1}^{*}$, $\underline{c}_{xt+1}$, and $\underline{l}_{t}^{*}$ will yield the following results: $\underline{c}_{yt}^{*} = y^{*}/2$, $\underline{c}_{xt+1}^{*} = (P_{yt}^{*}/P_{xt+1}^{*})(y^{*}/2)$, and $\underline{c}_{xt+1} = (P_{yt}^{*}/P_{xt+1})\,(y^{*}/2)\, e_{t+1}$.

Now I analyze the stationary equilibrium. The market clearing conditions in goods markets (equations (13) through (16)), currency markets (equations (17) and (18)), loan markets (equations (19) and (20)), and the foreign exchange market (equation (21)) will be as follows:

$$x = d_{xt} + \gamma\, c_{xt+1} + (1-\gamma)\, \underline{c}_{xt+1}, \qquad \textbf{(13)}$$

$$y = c_{yt} + d_{yt}, \qquad \textbf{(14)}$$

$$x^{*} = \underline{d}_{xt}^{*} + \gamma\, \underline{c}_{xt+1}^{*} + (1-\gamma)\, c_{xt+1}^{*}, \qquad \textbf{(15)}$$

$$y^* = \underline{c}_{yt}^{\,*} + \underline{d}_{yt}^{\,*}, \qquad (16)$$

$$M = m_t = h_t, \qquad (17)$$

$$M^* = \underline{m}_t^{\,*} = \underline{h}_t^{\,*}, \qquad (18)$$

$$l_t = h_t, \qquad (19)$$

$$\underline{l}_t^{\,*} = \underline{h}_t^{\,*}, \qquad (20)$$

$$(1\text{-}g)M = (1\text{-}g)M^* e_{t+1}, \qquad (21)$$

where M and M* are money supplies exogenously determined by the central bank in each country. We can solve equations (13) through (21), together with the relationships obtained by the optimizing behavior of debtors and creditors for the equilibrium prices and allocation of goods. Domestic nominal prices will be $P_{xt} = P_{xt+1} = 2M/x$ and $P_{yt} = 2M/y$. Domestic consumption will be $d_{xt} = x/2$, $d_{yt} = y/2$, $c_{yt} = y/2$, $c_{xt+1} = x/2$, and $c_{xt+1}^* = x^*/2$. The equilibrium foreign exchange rate will be $e_{t+1} = M/M^*$. Foreign nominal prices will be $P_{xt}^* = P_{xt+1}^* = 2M^*/x^*$ and $P_{yt}^* = 2M^*/y^*$. Finally, foreign consumption will be $\underline{d}_{xt}^{\,*} = x^*/2$, $\underline{d}_{yt}^{\,*} = y^*/2$, $\underline{c}_{yt}^{\,*} = y^*/2$, $\underline{c}_{xt+1}^{\,*} = x^*/2$, and $\underline{c}_{xt+1} = x/2$.

**3. Technically feasible allocation**

Suppose that there is a social planner who can freely move goods between two countries, whose objective function is:

$$\psi\{\beta[\ln(d_{xt})+\ln(d_{yt})]+(1-\beta)[\ln(c_{yt})+\gamma\ln(c_{xt+1})+(1-\gamma)\ln(c_{xt+1}^{*})]\}+ \tag{22}$$

$$(1-\psi)\{\beta^{*}[\ln(\underline{d}_{xt}^{\,*})+\ln(\underline{d}_{yt}^{\,*})]+(1-\beta^{*})[\ln(\underline{c}_{yt}^{\,*})+\gamma\ln(\underline{c}_{xt+1}^{\,*})+(1-\gamma)\ln(\underline{c}_{xt+1})]\},$$

subject to the four resource constraints equations (13) through (16), by the choice of each argument in the utility function. In equation (22), $\psi$ is a weight for the domestic agent ($0<\psi<1$), and $\beta$ and $\beta^{*}$, which also take on values between zero and one, represent the weights for debtors in each country respectively.

The equilibrium obtained in this way is a technically feasible-stationary-Pareto-efficient allocation when we treat all generations of debtors and creditors in each country equally. After solving for this technically feasible allocation, it is easy to show that by setting $\psi=\beta=\beta^{*}=(1/2)$, it is possible to reproduce the monetary equilibrium shown in Section 2; hence, it corresponds to one of the technically feasible Pareto efficient allocations.

## 4. Monetary equilibrium with liquidity constraint

Suppose all old domestic creditors come to the meeting point with the old domestic debtors, but only fraction $\lambda$ of old domestic debtors come. Before the remaining $(1-\lambda)$ fraction of old debtors come to the meeting point, fraction $(1-\alpha)$ of old creditors realize that they must leave the meeting point. If they belong to the $(1-\alpha)\gamma$ fraction, they visit the place where young domestic debtors wait to obtain goods in exchange for money. If they belong to the $(1-\alpha)(1-\gamma)$ fraction, they first meet foreign creditors to obtain foreign currency, and visit young foreign debtors. Later, the $(1-\lambda)$ fraction of old debtors come to the meeting point. Finally, the remaining fraction $\alpha$ of old creditors depart from the meeting point. If they belong to the $\alpha\gamma$ fraction, they visit the place where young domestic debtors wait to obtain goods in exchange for money. If they belong to the $\alpha(1-\gamma)$ fraction, they first meet foreign creditors to obtain foreign currency, and they visit young foreign debtors. I assume that the early and late departing creditors cannot meet in the foreign exchange market. Therefore, the foreign exchange market opens twice, and there is no chance for early departing creditors to ask late departing creditors to exchange their currency at par value. I assume $\gamma$ is the same for the two countries, but replace $\alpha$ and $\lambda$ in the foreign country $\alpha^*$ and $\lambda^*$ respectively.

As a result of these assumptions, domestic creditors born at time t do not know in advance if they belong to the $(1-\alpha)$ fraction or not. Therefore they maximize the following expected utility function:

$$ln(c_{yt}) + \gamma(1-\alpha)\, ln(c[1-\alpha]_{xt+1}) + \gamma\alpha\ \ ln(c[\alpha]_{xt+1}) \qquad (23)$$
$$+ (1-\gamma)(1-\alpha)\, ln(c[1-\alpha]_{xt+1}{}^*) + (1-\gamma)\alpha\ \ ln(c[\alpha]_{xt+1}{}^*),$$

where $c[1-\alpha]_{xt+1}$ is the domestic debtors' consumption at time t+1 if they belong to the $(1-\alpha)$ fraction, and $c[\alpha]_{xt+1}$ is the domestic debtors' consumption at time t+1 if they belong to the $\alpha$ fraction. This is subject to the budget constraint at time t,

$$yP_{yt} = c_{yt}P_{yt} + l_{t.} \qquad (24)$$

If they belong to the $\gamma(1-\alpha)$ fraction and the budget constraint at time t+1 is:

$$c[1-\alpha]_{xt+1}P_{xt+1} \ = \ \rho_{\,t+1}\ (1-\lambda)\ l_t \ + \lambda\ \ l_t. \qquad (25)$$

If they belong to the $\gamma\alpha$ fraction the budget constraint at time t+1 is:

$$c[\alpha]_{xt+1}P_{xt+1} = (1-\rho_{\,t+1})\ q_t \ + l_t., \qquad (26)$$

If they belong to the $(1-\gamma)$ $(1-\alpha)$ fraction the budget constraint at time t+1 is:

$$c[1-\alpha]_{xt+1}{}^{*}P_{xt+1}{}^{*} = \frac{\rho_{t+1}(1-\lambda)l_t + \lambda l_t}{e[1-\alpha]_{t+1}}\,. \qquad \textbf{( 27 )}$$

If they belong to the $(1-\gamma)\alpha$ fraction the budget constraint at time t+1 is:

$$c[\alpha]_{xt+1}{}^{*}P_{xt+1}{}^{*} = \frac{(1-\rho_{t+1})q_t + l_t}{e[\alpha]_{t+1}}\,. \qquad \textbf{( 28 )}$$

The denominators $e[1\text{-}\alpha]_{t+1}$ and $e[\alpha]_{t+1}$ are the foreign exchange rates in the markets of the $1\text{-}\alpha$ fraction and the $\alpha$ fraction respectively, and $q_t$ is the par value of nominal debt purchased by those departing late. Also, $\rho_{t+1}$ is the discounted nominal value of one dollar of that debt at time t+1 in the secondary debt market, which is relevant because those creditors departing early will offer to sell their debt to those departing later. Note that I assume that the foreign exchange market opens twice for the sake of the $(1\text{-}\gamma)(1\text{-}\alpha)$ fraction and the $(1\text{-}\gamma)\alpha$ fraction.

The domestic creditors belonging to the $\alpha$ fraction face one more constraint:

$$\lambda l_t \;\geq\; \rho_{t+1} q_t\,. \qquad \textbf{( 29 )}$$

Equation (29) is a liquidity constraint indicating that the nominal value of debt purchased by late-departing creditors, $\rho_{t+1}q_t$, is less than or equal to the value available to creditors obtained from early arriving debtors, $\lambda l_t$.

Assuming that equation (29) is binding, I maximize equation (23) subject to equations (24) through (29) by the choice of $q_t$, $l_t$, $c_{yt}$, $c[1\text{-}\alpha]_{xt+1}$, $c[\alpha]_{xt+1}$, $c[1\text{-}\alpha]_{xt+1}{}^*$, and $c[\alpha]_{xt+1}{}^*$. After some manipulation, I find the following demands for goods and loans: $c_{yt} = y/2$, $c[1\text{-}\alpha]_{xt+1} = (y/2)(P_{yt}/P_{xt+1})[(1\text{-}\lambda)\rho_{t+1}+\lambda]$, $c[\alpha]_{xt+1} = (y/2)(P_{yt}/P_{xt+1})([\rho_{t+1}+(1\text{-}\rho_{t+1})\lambda]/\rho_{t+1})$, $c[1\text{-}\alpha]_{xt+1}{}^* = (y/2)(P_{yt}/P_{xt+1}{}^*)[(1\text{-}\lambda)\rho_{t+1}+\lambda]/e[1\text{-}\alpha]_{t+1}$, $c[\alpha]_{xt+1}{}^* = (y/2)(P_{yt}/P_{xt+1}{}^*)([\rho_{t+1}+(1\text{-}\rho_{t+1})\lambda]/\rho_{t+1}e[\alpha]_{t+1})$,

$l_t = (y/2)(1/P_{yt})$ and $\lambda l_t = \rho_{t+1} q_t$. The behavior of foreign creditors is the mirror image of that of domestic creditors, and debtors behave the same way as we have seen in Section 2. The stationary equilibrium in this model is very similar to the one we solved for in Section 2. We should modify the equilibrium conditions for good $x$ and $x^*$ to be:

$$x = d_{xt} + \gamma(1-\alpha)\, c[1-\alpha]_{xt+1} + \gamma\alpha c[\alpha]_{xt+1} + (1-\gamma)(1-\alpha^*)\,\underline{c[1-\alpha^*]_{xt+1}} \quad (30)$$

$$+ (1-\gamma)\alpha^*\,\underline{c[\alpha^*]_{xt+1}},$$

and

$$x^* = \underline{d_{xt+1}}^* + \gamma(1-\alpha^*)\,\underline{c[1-\alpha^*]_{xt+1}}^* + \gamma\alpha^*\,\underline{c[\alpha^*]_{xt+1}}^* + (1-\gamma)(1-\alpha^*)\, c[1-\alpha]_{xt+1}^* \quad (31)$$

$$+ (1-\gamma)\alpha\, c[\alpha]_{xt+1}^*,$$

the equilibrium conditions for the foreign exchange market to be:

$$(1-\gamma)\lambda\, l_t = (1-\gamma)\lambda^*\,\underline{l_t^*}\, e[1-\alpha]_{t+1}, \quad (32)$$

$$(1-\gamma)(1-\lambda)\, l_t = (1-\gamma)(1-\lambda^*)\,\underline{l_t^*}\, e[\alpha]_{t+1}. \quad (33)$$

and the equilibrium conditions for the secondary debt markets to be:

$$\alpha q_t = (1-\alpha)(1-\lambda)\, l_t, \quad (34)$$

$$\alpha^*\,\underline{q_t^*} = (1-\alpha^*)(1-\lambda^*)\,\underline{l_t^*}. \quad (35)$$

Equations (34) and (35) imply that $\rho_{t+1} = (\alpha/1-\alpha)(\lambda/1-\lambda)$ and $\rho_{t+1}^* = (\alpha^*/1-\alpha^*)(\lambda^*/1-\lambda^*)$ if equation (29) is binding. We need to assume that both $(\alpha/1-\alpha)(\lambda/1-\lambda)$ and $(\alpha^*/1-\alpha^*)(\lambda^*/1-\lambda^*)$ are less than one to have a liquidity constraint in equilibrium.

Solving for these equations, the equilibrium allocation will be: $P_{xt} = P_{xt+1} = 2M/x$, $P_{yt} = 2M/y$, $d_{xt} = x/2$, $d_{yt} = y/2$, $c_{yt} = y/2$, $c[1\text{-a}]_{xt+1} = (x/2)(\text{l}/1\text{-a})$, $c[\text{a}]_{xt+1} = (x/2)(1\text{-l})/\text{a}$, $c[1\text{-a}]_{xt+1}{}^{*} = (x^{*}/2)(\text{l}^{*}/1\text{-a})$, and $c[\text{a}]_{xt+1}{}^{*} = (x^{*}/2)(1\text{-l}^{*})/\text{a}$ for the domestic country, and $P_{xt}{}^{*} = P_{xt+1}{}^{*} = 2M^{*}/x^{*}$, $P_{yt}{}^{*} = 2M^{*}/y^{*}$, $\underline{d_{xt}} = x^{*}/2$, $\underline{d_{yt}} = y/2$, $\underline{c_{yt}}^{*} = y^{*}/2$, $\underline{c[1-\text{a}^{*}]_{xt+1}}^{*} = (x^{*}/2)(\text{l}^{*}/1\text{-a}^{*})$, $\underline{c[\text{a}^{*}]_{xt+1}}^{*} = (x^{*}/2)(1\text{-l}^{*})/\text{a}^{*}$, $\underline{c[1-\text{a}^{*}]_{xt+1}} = (x/2)(\text{l}/1\text{-a}^{*})$, and $\underline{c[\text{a}^{*}]_{xt+1}} = (x/2)(1\text{-l})/\text{a}^{*}$ for the foreign country. The equilibrium exchange rates will be $e[\text{a}]_t = M(1\text{-l})/M^{*}(1\text{-l}^{*})$ and $e[1\text{-a}]_t = M\text{l}/M^{*}\text{l}^{*}$.

Table 1 summarizes the equilibrium prices and allocations of goods in order to compare the equilibrium obtained in this section and those obtained in Section 2. Figure 1 clarifies the solutions we have obtained so far. The horizontal axis shows the ex-ante expected utility of debtors and the vertical axis measures the ex-ante expected utility of creditors. The locus UU' shows the technically feasible allocations obtained in Section 3. Point E1 shows the monetary equilibrium obtained in Section 2, which lies somewhere on the locus of technically feasible allocations. Inspection of Table 1 shows that debtors are indifferent between those two equilibria because their consumption plans do not vary across equilibria. On the other hand, under the liquidity constraint, it is true that late departing creditors will be better off ex post at the sacrifice of early departing creditors, however, ex ante, creditors are worse off on average compared with the monetary equilibrium in Section 2. Therefore, the monetary equilibrium obtained in Section 4 must correspond to the point E3 in Figure 1.

## 5. Policy Implications

*5.1. Optimal monetary policy based on the Real Bills Doctrine*

An interesting special case of the model in Section 4 is where equation (29) is not binding in equilibrium. In this case, the equilibrium will be as follows: $P_{xt} = P_{xt+1} = 2M/x$, $P_{yt} = 2M/y$, $e[\alpha]_t = M(1-\lambda)/M^*(1-\lambda^*)$, $e[1-\alpha]_t = M\lambda/M^*\lambda^*$, $d_{xt} = x/2$, $d_{yt} = y/2$, $c_{yt} = y/2$, $c[1-\alpha]_{xt+1} = c[\alpha] = x/2$, $c[1-\alpha]_{xt+1}^* = (x^*/2)(1-\alpha^*/1-\alpha)$, and $c[\alpha]_{xt+1}^* = (x^*/2)(\alpha^*/\alpha)$ for domestic country, and the solution for the foreign country is a mirror image of that of the domestic country. The equilibrium foreign exchange rates will be $e[1-\alpha]_t = M(1-\alpha)/M^*(1-\alpha^*)$ and $e[\alpha]_t = M\alpha/M^*\alpha^*$. Observe that $c[1-\alpha]_{xt+1} = c[\alpha]_{xt+1} = x/2$; hence, the creditors can consume the same amount of goods $x$ as in the equilibrium obtained in Section 2. However, due to the differences in the timing of arrival in the foreign exchange market, $c[1-\alpha]_{xt+1}^* \neq c[\alpha]_{xt+1}^*$. In Figure 1, such an equilibrium corresponds with a point something like E2.

Therefore, if there is a monetary authority that temporarily supplies enough money in each country to make liquidity constraints (i.e. equation (29)) nonbinding, and requires that the central bank loans be repaid with fiat money later, such an institution can realize the point E1 in Figure 1 *only if* $\alpha^* = \alpha$. Although such an institution restores the efficient allocation for fraction $\gamma$, they cannot restore the efficient allocation for fraction $1-\gamma$.

To lead the economy to the point E1 in Figure 1, central banks must intervene not only in the domestic debt market, but also in the foreign exchange market. Suppose that $\alpha > \alpha^*$. Then, in the foreign exchange market for the $(1-\alpha)$ fraction, foreign currency is relatively abundant. The domestic central bank receives all of the money both domestic creditors and foreign creditors have, and exchanges it at the fair price $M/M^*$. To do so, the central bank must issue $(\alpha-\alpha^*)M$ of domestic currency, and they obtain $(\alpha-\alpha^*)M^*$ of foreign currency as a reserve. In the foreign exchange market for the $\alpha$ fraction, the domestic central bank again receives all of the money creditors bring, and again exchanges it at the fair price $M/M^*$. Such intervention requires the central banks to issue $(\alpha-\alpha^*)M^*$ of foreign currency, but they have that amount of foreign currency on reserve as a result of the market intervention for the $(1-\alpha)$ fraction. The domestic central bank also obtains $(\alpha-\alpha^*)M$ of domestic currency, but they should take it out of circulation because they issued new money in the market for the $(1-\alpha)$ fraction. Such intervention will keep total money supply constant over time. If $\alpha < \alpha^*$, the foreign central bank must step into the foreign exchange market and do the same thing that the domestic central bank does. As long as central banks have commitment to long run price stability, they can intervene in that way, and they can lead the economy from point E3 to point E1 in Figure 1. Freeman's model sets the money supply exogenously, but that is a reasonable assumption if the central bank is operated under the gold standard. The total money supply is predetermined by the amount of gold on reserve, and central banks intervene into the foreign exchange market to make the price of each currency consistent with the gold standard. Thus, I would like to argue that my model generalizes the model of Freeman (1996b), and that the international gold standard as a guideline for the long run monetary policy and the Real Bills Doctrine for the short run conduct of monetary policy are theoretically consistent policy objectives as the 1913 Federal Reserve Act .

### *5.2. Independent central bank versus private clearinghouse*

The central bank in this model certainly has instrument independence since it determines the level of money stock. The central bank here may not have goal independence, because the best analogy to a central bank in this model is that under a gold standard. Nonetheless, the model shows that an independent central bank defined in this way is a useful institutions for the achievement of an optimal allocation of resources.

Suppose that there is no central bank in the domestic country, however, domestic private clearing house can issue a perfect substitute for local currency. If $a > a^*$, the domestic private clearinghouse can do the same thing that the domestic central bank does. Indeed, the use of clearinghouse loan certificates during the nineteenth century bank crisis demonstrates how private institutions can work as renderers of last resort as Timberlake (1978) stresses, although the clearinghouses in those days may not have worried about the foreign exchange market.

Note that if a private clearinghouse does not destroy $(a-a^*)M$ of domestic currency after their second intervention in the foreign exchange market, it can achieve the same efficient allocation of goods, but prices will go up in the domestic country as Freeman (1996a) points out. If the private domestic clearinghouse has an incentive to use new currency for its own consumption, it will distort the allocation of resources. Those considerations lead to the conclusion that both an independent central bank and a clearinghouse can achieve an optimum allocation of resources by supplying enough money to clear all the debts and foreign exchange at par value. It is important to control for total money supply as a central bank under the gold standard did, which is consistent with the policy implications of Freeman (1996a). The competitive devaluation of currencies must be refrained from in this framework.

To achieve an optimal allocation of resources, the governance structure of central banks and clearinghouses matters as Green (1997) has stressed. Note that the level of utility of debtors is the same in both the equilibrium in Section 2 (point E1 in Figure 1) and that in Section 4 (point E3 in Figure 1), whereas creditors prefer the equilibrium in Section 2 to that in Section 4. If the governance of central banks and clearinghouses is dictated by the interest of debtors only, it may be possible that such institutions would not like to intervene in the credit and foreign exchange markets because they do not care about the utility of creditors. Therefore, the governance structure of both an independent central bank and a private clearinghouse must take into account the utility of both creditors and debtors. For example, in 1910, Paul Warberg proposed a mixed board of directors for the new central bank in the United States of which three fifths would be bankers appointed by associations of bankers, one fifth would be chosen from commercial interests by the vote of stockholders, and one fifth would consist of ex officio government members (Rowe (1965)). Such ideas can also be seen in the Glass bill, and throughout the debate on the Glass bill in congress, Congressman Glass defended the Federal Reserve Board, saying that no financial interest could pervert or control the Board. Opponents to the bill were worried that some money center banks would pursue their objectives selfishly (Moore (1990)). President Wilson's solution to this problem was to exclude bankers from the Federal Reserve Board, whose members are wholly appointed by the President on the one hand, and the establishment of bankers' advisory council on the other.

My model can put some restrictions on the governance structure of both an independent central bank and a private clearinghouse which can potentially achieve an optimal allocation of resources. However, it is again difficult from the efficiency point of view alone to make an explicit ranking between an independent central bank and a private clearinghouse governed optimally as Green (1997) stressed. Indeed, looking back at the history of American central banks, the accumulated experiences since the First and the Second Bank of the United States, the Free banking and Independent Treasury System, and developments in foreign countries shaped the Federal Reserve Act. The emergence of the Federal Reserve System in the United States reflects not only the efficiency viewpoint but also the testing of both time and institutional arrangements and the compromises of sincere men, as Rowe (1965) concludes.

*5.3 Some implications for current monetary and banking policy*

I would like to consider a style of monetary policy based on inflation targeting as a device to force central banks to pursue the stability of price levels and the money supply in the long run without the constraint of a gold standard. It makes the short run and long run operations of a central bank consistent with each other, and increases the credibility of a central bank. Indeed, Timberlake (1978) stresses the need to impose rules for a central bank that result in monetary expansion that approximates what was achieved under the gold standard. The model in this paper suggests that the Real Bills Doctrine together with inflation targeting, if ever practically possible, can provide important guidelines for monetary policy even now.

Note that the principle of lender of last resort, which suggests that banks be allowed to borrow as much as they want at the penalty rate during financial panic, does not apply to the central bank behavior in this model.[1] This is because the central bank lending in this model reduces the nominal interest rate to the level of the risk-free rate, and this model does not have any aggregate risk except that involving the timing of settlement. The fluctuations in money supply in the short run are consistent with the "banking policy" proposed by Goodfriend and King (1988). They argue that daylight overdraft is a kind of safety net, and it is not monetary policy since it does not increase the high powered money. The short run increase in money supply in the domestic credit market seems to play a similar role as daylight overdraft does. The fluctuation of money supply in the foreign exchange market is related with the policy coordination of central banks under the gold standard. Nonetheless, the model has a strong policy implication for the policy coordination among central banks under the de-fact global standard of real time gross settlement system by the year 2000 with the active supply of daylight overdraft in each financial markets.

## 6. Conclusion

Using a two-country version of the model by Freeman (1996b), I find the following policy implications. The mixture of an elastic money supply in the short run in both the foreign exchange market and the domestic credit market, and a constant money supply or zero inflation targeting in the long run, is consistent with the optimum allocation of resources in this framework. Both an independent central bank and a clearinghouse can achieve an optimum allocation of resources by supplying enough money to clear all the debts and foreign exchange at par value. However, to achieve an optimal allocation of resources, the governance structure of both institutions must represent the utility of debtors and creditors optimally. Those features are consistent with the 1913 Federal Reserve Act based on the Real Bills Doctrine and the international gold standard.

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[1] See Bordo (1990) for various interpretations of lender of last resort.

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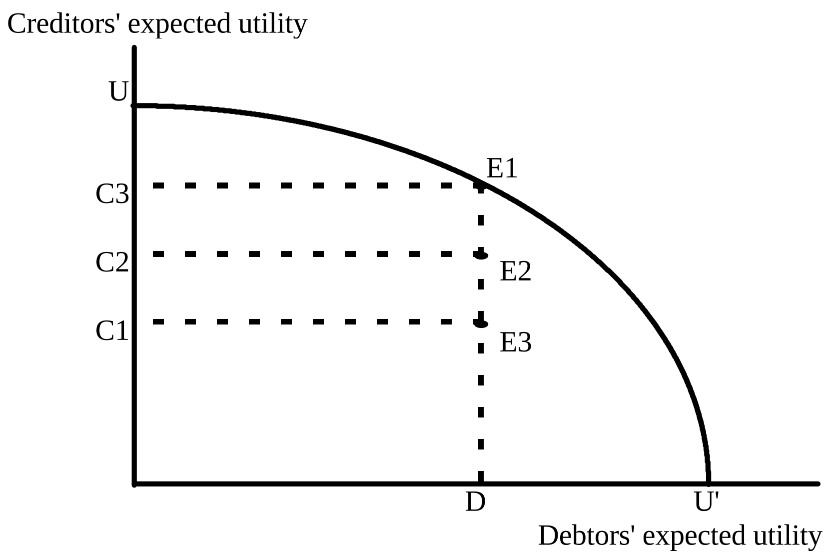
Table 1

Equilibrium Allocation of Goods and Prices

| | No Liquidity Constraint | With Liquidity Constraint |
|---|---|---|
| $P_{xt}$ | $2M/x$ | $2M/x$ |
| $P_{xt+1}$ | $2M/x$ | $2M/x$ |
| $P_{yt}$ | $2M/y$ | $2M/y$ |
| $P_{xt}*$ | $2M*/x*$ | $2M*/x*$ |
| $P_{xt+1}*$ | $2M*/x*$ | $2M*/x*$ |
| $P_{yt}*$ | $2M*/y*$ | $2M*/y*$ |
| $e_t$ | $M/M*$ | |
| $e[1\text{-a}]_t$ | | $Ml/M*l*$ |
| $e[\text{a}]_t$ | | $M(1\text{-}l)/M*(1\text{-}l*)$ |
| $d_{xt}$ | $x/2$ | $x/2$ |
| $d_{yt}$ | $y/2$ | $y/2$ |
| $c_{yt}$ | $y/2$ | $y/2$ |
| $c_{xt+1}$ | $x/2$ | |
| $c_{xt+1}*$ | $x*/2$ | |
| $c[1\text{-a}]_{xt+1}$ | | $(x/2)(l/1\text{-a})$ |
| $c[\text{a}]_{xt+1}$ | | $(x/2)(1\text{-}l)/\text{a}$ |
| $c[1\text{-a}]_{xt+1}*$ | | $(x*/2)(l*/1\text{-a})$ |
| $c[\text{a}]_{xt+1}*$ | | $(x*/2)(1\text{-}l*)/\text{a}$ |
| $d_{xt}^*$ | $x*/2$ | $x*/2$ |
| $d_{yt}^*$ | $y*/2$ | $y*/2$ |
| $c_{yt}^*$ | $y*/2$ | $y*/2$ |
| $c_{xt+1}^*$ | $x*/2$ | |
| $c_{xt+1}$ | $x/2$ | |
| $c[1-\text{a}^*]_{xt+1}^*$ | | $(x*/2)(l*/1\text{-a}*)$ |
| $c[\text{a}^*]_{xt+1}^*$ | | $(x*/2)(1\text{-}l*)/\text{a}*$ |
| $c[1-\text{a}^*]_{xt+1}$ | | $(x/2)(l/1\text{-a}*)$ |
| $c[\text{a}^*]_{xt+1}$ | | $(x/2)(1\text{-}l)/\text{a}*$ |

Figure 1


Creditors' expected utility
U
E1
C3
C2
E2
C1
E3
D
U'
Debtors' expected utility