LEAKAGES IN DUAL EXCHANGE MARKETS

Fuhmei WANG*

Abstract:
The issue of determining inter-market foreign exchange flows under dual exchange markets has been hotly debated. Typically the literature has concentrated on the behavior of the financial premium, leaving aside equally important aspects such the reasons for and characteristics of incomplete separation. Our analytical results suggest that cross transactions arise as long as the government changes the commercial rate. Time inconsistency of policy brings opportunity for leakages between two markets. We also find that the more patient the government, the less likely the occurrence of commercial depreciation and leakages will be. Then reputation could be as a deterrent to leakages

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1. Introduction

Dual exchange markets have been a fact in many parts of the developing world. The potentially harmful effects of volatile capital movements provide a strong argument for conducting transactions of current and capital accounts at different exchange rates. It is hoped, by this mechanism, the problems related to the polar cases of fixed and flexible rates can be reduced.

As usual, the commercial exchange rate for current account transactions is fixed and the financial exchange rate for capital account transactions is free to float. Many countries, not limited to developing countries, have adopted such a regime in the last three decades. According to the issues of International Monetary Funds Annual Report on Exchange Arrangements and Exchange Restriction, many developed countries, such as Belgo-Luxembourg Economic Union (BLEU), have experienced separating exchange markets at different periods of time.

The temporariness is verified by country experiences, especially the stylized facts of Bangladesh and illustrated in Ahammad and Fane (2000). Though a dual exchange rate system might be a preferable intermediate step from a fixed exchan-

*) National Cheng Kung University, Tainan, Taiwan 701, R.O.C. (e-mail: fmwang@mail.ncku.edu.tw).
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ge rate to a flexible rate, the efficiency of such a regime depends on the complete separation between two markets (as represented by the current and capital accounts). Among research on separating exchange markets, the experiences of inter-market transactions in France, Italy, as well as in the BLEU, were noted by Lanyi (1975) and emphasized by Bhandari and Decaluwe (1987). The issue of determining inter-market foreign exchange flows has been hotly debated. Lizondo (1987), Gros (1988), and Kamin (1993) developed macroeconomic frameworks and concluded that there are definite incentives to conduct fake invoicing in the commercial exchange market if the financial rate is substantially higher than the commercial rate.

Bhandari and Végh (1990) apparently were the first to give a strong presence of inter-market leakages by developing an optimizing model in a cash-in-advance economy and indicate that levying tax on foreign bonds will result in inter-market transactions. Mullin (1993) drew on their work and shows that the financial premium is an increasing function of import tariffs and export subsidies, which plays an important role in determining inter-market arbitrage activities. Flood et al. (1998) indicated that incomplete separation between exchange markets might cause cycles in the financial premium and reserves but did not clarify the reasons for and the characteristics of leakages. All of the authors, therefore, have already provided some remarkable demonstrations of the relationship between the financial premium and cross transactions between two markets. However, in essence they might be fraught with the reasons for as well as characteristics of incomplete separation and concentrated on the behavior of the financial premium, leaving aside equally important aspects such as the resource of leakages with the credibility of the government. When government breaks its announcement and changes the commercial rate, the time inconsistency of policies arises. These events might bring opportunities for cross transactions and results in incomplete separation, and hence the erosion of this management.

The concepts of credibility and the particular example known as the "time-consistency problem" in macroeconomics has been addressed over the last two decades. This problem was first noted by Kydland and Prescott (1977) who showed that optimal macroeconomic policies could well be time inconsistent and argued for rules rather than discretion. The model of reputation was applied to monetary policy for the first time by Barro and Gordon (1983). Grossman and van Huyck (1986) and Barro (1983) applied it to the decision about inflation tax. The majority of studies (see Persson, 1988, for a survey) have focused on the trade-off between the rate of inflation and the level of employment or output in a closed economy because there are a number of conflicts in decisions between the government and economic agents. However, previous studies paid little attention to the role of credibility for the effects of a change in the exchange rate policy. Horn and Persson (1985) examined the interplay between wage setting and the exchange rate policy and found that a change in the exchange rate system is probably made to eliminate inflation in the beginning of an election period.

Among the demonstrations for the effects of reputation on exchange rate policies, none of them has looked at the time consistency consideration of dual-exchange-rate management. This paper attempts to investigate the role of credibility in such a regime. It focuses on time-consistency issues rather than on characterizing the optimal policy. I shall show that, with credibility and reputation, government could successfully separate exchange markets. Otherwise, cross transactions emerge.

As mentioned before, there are not only developing but also developed countries engaging in two-tier exchange rate practice. Production has been shrinking severely in these countries or the growth rate is much below the world average. Given a need for boosting real gross domestic product growth by conducting inflation policies, exchange rate policies should be designed across all phases of the expansion experience. On the other hand, Haan, Knot, and Sturm (1993) found that a credible exchange rate policy could reduce the cost of inflation policies. We then assume that governments have incentives to depreciate the commercial rate for raising output by improving the current account during a period of turbulence under a two-tier exchange rate system. The discussion is organized as follows. Section 2 describes the characteristics of complete separation in dual exchange markets, section 3 deals with incredible decisions as well as incomplete separation, section 4 presents credible commercial rates and section 5 draws some conclusions.

2. The Characteristics of Complete Separation

The nature about a small open economy, adopting completely separated exchange markets will be demonstrated as follows. The government adopts a dual exchange rate system by fixing the foreign bonds held by the private sector at a particular volume. There exist two exchange rates: a market-determined rate for capital account transactions called a financial exchange rate and an official rate for current account transactions called a commercial exchange rate. Both rates are expressed as the price of foreign currency in terms of home currencies.

The home price level equals the domestic currency value of the foreign price level which is assumed constant and is equal to one, implying that the commercial exchange rate is also a measure of home price. In other words, domestic inflation (disinflation) is equivalent to depreciation (appreciation) of commercial exchange rate. Here I assume that the unpredictable changes of spread, the difference between two rates, and leakages stem from unexpected commercial depreciation (appreciation) conducted by the government.[1] The small open economy has two sectors: one is the private sector and the other is consolidated public sector. We shall use the terms "government" and "monetary authority" interchangeably to present the public sector. There are a large, but fixed, number of identical consumers. We normalize the mass of these consumers to unity.

Leakages between two exchange markets arise from the following source. When government sets the commercial exchange rate, consumers trust that the monetary authority will maintain it. The volume of foreign bonds in the private sector is fixed. The single agent then chooses the financial exchange rate, which in turn determines both the price of foreign bonds and the spread between two rates. Once government breaks its announcement by depreciating commercial rate, however, it will improve the balance of trade. Without domestic credit, then the real money balance presents the balance of trade. Now, the financial exchange rate appreciates relatively, and hence, there is incentive for the consumer to under-invoice imports as well as purchase foreign currencies from the financial market to make the full payment to the foreign exporter, and over-invoice exports to get more foreign currencies at the commercial rate as well as purchase foreign bonds at the financial rate. Should the policy of commercial depreciation be adopted continually, leakages could exist. Moreover, the price of foreign bonds rises, resulting from excess demand for foreign bonds. Leakages cause the spread, the difference between financial and commercial rates, cease to exist. The erosion of separating exchange markets might occur.

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1) Precisely, it is regarded as devaluating rather than depreciating because government's policy switches of officially depreciating will success only once. The financial exchange rate will adjust upward when time inconsistency occurs and the spread will return to be a constant.

To maintain a successful two-tier exchange market, the monetary authority then trades the cost of administrating leakages, resulting from commercial depreciation, against the benefit of favourable balance of trade.

Before setting up the analytical model, I concentrate on definitions of variables and parameters as follows.

E_0 is the commercial exchange rate, the foreign currency in terms of domestic currencies at initial period,

E^e is the expected commercial exchange rate,

X is the financial exchange rate, the foreign currency in terms of domestic currencies,

π is the depreciation (appreciation) rate of commercial exchange rate when it is positive (negative),

m is the real money balance,

b is the volume of foreign bonds held by the private sector,

ϕ is the positive cost parameter of penalizing leakages,

T is finite time horizon,

δ is government time preferences and the positive discounting factor,

l is the leakage, a function of administrative costs.

To understand the nature of dual exchange markets, I describe the timing of setting up for two rates as follows:

– the monetary authority sets commercial exchange rate at E_0;

– consumers observe E_0 and then choose financial exchange rate (X_t), which in turn determines a constant spread, $X_t - E_0$, and hold the foreign bonds fixed at b_0.

The subscripts, t and 0 represent current and initial periods, respectively. Because of the assumption that the change of spread only results from unpredictable depreciation of commercial exchange rate, the single agent will fix the financial exchange rate after government sets the commercial exchange rate. As regards fixed financial exchange rate, the government could gain by choosing a bigger value of commercial exchange rate by deviating from a commercial rate target once announced. In other words, with promise where the government chooses commercial exchange rate and fixes it, a single agent trusts the government and chooses the financial exchange rate with fixed foreign bonds. However, this is not a credible decision in that the government could gain by depreciating commercial exchange rate from seigniorage. The variable of interest is thus the rate of unexpected depreciation of commercial exchange rate.

The working of dual exchange markets is that only unpredictable depreciation of commercial rate improves the balance of trade: [2)]

$$\begin{aligned} m_t &= m_0 + (E^e - E_t)m_0 \\ &= m_0 + \pi_t m_0 \end{aligned} \tag{1}$$

When actual and expected commercial exchange rates are the same, unpredictable depreciation rate does not exist. Two situations thus can be found:

– if $E^e = E_t$ then $\pi_t = 0$

– otherwise $\pi_t \neq 0$

Without domestic credit, foreign reserves present real money balance. Under dual rates, the variation of foreign reserves comes from the current account imbalance. The real money balance then depends postiviely on real commercial exchange rate. From the authority point of view, when government depreciates the com-

2) I assume that the initial value of commercial rate equals one and hence the depreciation rate of the commercial exchange rate is equal to π.

mercial rates, the policy maker derives a disutility or bears costs from administrating cross transactions resulting from fake invoicing for imports and exports. However, the policy maker is concerned about the improvement in the balance of trade and derives positive utility or gains when the commercial rate rises above the initial value due to surprise depreciation. Based on this concept, we then introduce a finitely-lived monetary authority and a finitely-lived single agent who has perfect foresight on commercial and financial exchange rates to illustrate the time consistency of monetary policy under such a regime within a finite time horizon.

3. Incredible Decisions and Incomplete Separation

A commercial exchange rate policy could be regarded as a monetary policy since domestic inflation (disinflation) is equivalent to the depreciation (appreciation) of commercial exchange rate. There are many factors causing cross transactions. Let's assume that the change of the volume of foreign bonds only results from the depreciation (appreciation) shock of the commercial exchange rate. Given a need for improving the balance of trade during a period of turbulence, as mentioned previously, I focus on the case that the government has incentives to depreciate commercial rate for raising real income for the economy.

3. 1 *Characteristics of Leakages*

With promise, the announced rate of commercial depreciation is zero initially. The single agent believes the government pledge and will maintain the foreign bonds at its initial volume. For simplicity, the time subscripts have been scrapped. We guess that there is an initial period, $0 \leq t \leq t^*$ (for some t^* to be determined), with no commercial depreciation. After t^*, government intends to improve its payoff by reneging on its prior announcement to zero commercial depreciation and depreciating at a rate of π.[3] The rational agent expects commercial depreciation rate at π and conducts illegal trade arising in the shape of faked invoicing, over-invoicing imports or under-invoicing exports, to reduce assessed payments or to increase assessed subsidies relatively to initially announced commercial exchange rates. The inter-market exchange flows cause excess demand for foreign bonds, which in turn results in an increase in the real price of foreign bonds. Thus, the spread between two rates is still constant. In the context of dual exchange markets, it serves to emphasize the phenomenon, a steady, narrow or zero spread can persist under rational expectation. This implication is also demonstrated by the experiences of some European countries which adopt two-tier markets and sustain a steady spread. Conclusion of Flood and Marion (1988, p. 5) is: "Contrary to popular belief, a narrow spread between the commercial and financial exchange rate doesn't necessarily imply that the authorities have been unsuccessful in partitioning the foreign exchange market. **Indeed, a narrow or zero spread can persist even when there are no leakages across markets**." To us, a narrow spread is in line with some country experiences especially European country practice. Then, surprise commercial depreciation causing cross transactions is the main cause of incomplete separation between two markets.

With constant spread, the adjustment path of the leakage will coincide with that of the commercial exchange rate after t^*; that is

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3) See note 2. When the volume of foreign bonds is normalized to unity, the variation rate of them will be coincident with that of commercial depreciation.

$$\dot{b} = \dot{E}$$
$$= \pi \tag{2}$$

When government depreciates the commercial exchange rate, it means that both commercial rate and leakages will exhibit jump discontinuities at t^* along the horizon. Then, the government's one period cost function of policy switches is:

$$\text{cost} = \phi(b_t - b_0) - \tfrac{1}{2}\pi^2 m_0 \qquad \phi > 0 \tag{3}$$

The first term, $\phi(b_t - b_0)$, is the administrative cost pertinent to penalizing leakages. An increase in leakages, $(b_t - b_0)$, raises costs. With completely separated markets, this term vanishes since the actual holdings of foreign bonds equal to the initial holdings of such bonds in the private sector. Undertaking an effectively operated dual exchange market, government only bears the cost of official intervention on the binding quota in the financial market, which is ϕb_0. With leakages, it has increased by $\phi(b_t - b_0)$ due to penalizing leakages. The second term is the resource on real money balances in any period from depreciating the commercial rate; a quadratic form indicates these resources rise at an increasing rate with the rate of depreciation, π_t.

The foregoing analysis revealed that the key factor underlying the arbitrage flows between commercial and financial markets is whether the government keeps to policy announcement or not. To improve the balance of trade, the government may renege on its prior announcement to fixed commercial rate and depreciate at a rate of π. Nevertheless, the final gains, inflating real balance, could less than compensate for any loss, penalizing leakage. This characteristics implies that the government's objective is to minimize its loss function. In what follows we examine how possibly the government will renege on its announcement and then analyze the implications of leakages arising from commercial depreciation. I assume that the commercial exchange rate must be returned to its initial value at the end of the horizon. Any other fixed time horizon would result in similar policy effects. The policy-planning problem of government becomes to minimize

$$\int_0^T \left[\phi(b_t - b_0) - \tfrac{1}{2}\pi^2 m_0\right] \exp(-\delta t)\, dt$$

subject to

$$\dot{b} = b_{t+1} - b_t = \pi$$
$$b(T) = b_0 + \int_0^T \dot{b}\, dt \tag{4}$$

I assume that leakages resulting from commercial depreciation arises at the same rate as that of commercial depreciation. Through the techniqes of bounded controls, the more definite form of depreciating rate is expressed as:

$$\pi(t) = 0 \qquad 0 \le t < t^*$$
$$\pi(t) = \frac{1}{m_0}\left\{\frac{\phi}{\delta} + \frac{\phi}{\delta}\exp\left[\delta(t - t^*)\right]\right\} \qquad t^* \le t \le T \tag{5}$$

Integrating equation (4) and employing equation (5), the value of foreign bond is:

$$b(t) = b_0 \qquad 0 \le t < t^*$$

$$b(t) = b_0 + \frac{1}{m_0}\left\{\frac{\phi}{\delta}t + \frac{\phi}{\delta^2}\exp\left[\delta\left(t - t^*\right)\right]\right\} \qquad t^* \le t \le T \tag{6}$$

Using the terminal condition of financial exchange rate in equation (4), t^* can be solved as

$$t^* = t - \frac{1}{\delta}\ln\left(\frac{m_0\overline{b}}{\phi}\delta^2 - \delta t\right) \tag{7}$$

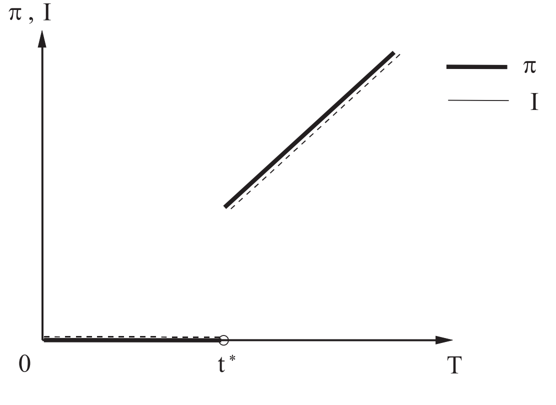
Given a finite time horizon T, from equation (7), it could be predicted that government might renege on its announcement at time t^*. When government depreciates commercial exchange rate at a rate π, time inconsistency and leakages occur simultaneously. Furthermore, I also predict that t^* will increase with the discounting factor, δ. The higher the time preference of government, the less likely the occurrence of time inconsistency will be. In other words, the depreciation rate, π, is decreasing with time preference δ. When the government is perfectly patient, it does not depreciate the commercial rate to improve the balance of trade, that is, $\delta = 1$ and $\pi = 0$. When time consistency of policies holds, completely separated exchange markets will be maintained.

3. 2 *Reasons for Leakages*

I will be interested in an equilibrium concept in which the private sector at time 0 is able to predict the optimal government policy in succeeding periods (i.e., the optimal government decision about commercial rate and depreciating rate at time t ($0 < t < T$) as discussed above) with perfect certainty. Under these circumstances, equation (4) holds, and hence, the volume of foreign bonds at time t is

$$b(T) = b_0 + \int_0^T \dot{b}dt \tag{8}$$

Figure 1
Discretion Causes Leakage



The latter would remove some incentives from government at time t^* to set $\pi > 0$, because it would involve leakages. It in turn eliminates the benefit but generates the cost from surprise commercial depreciation. When the policy maker deviates from the commercial rate announced initially at time t^*, it results in leakage. In Figure 1, π function jumps and is discontinuous at t^*. For perfect foresight, leakages, $\dot{b} = l$, jump and arise at the same rate simultaneously. After t^*, the former discontinuity is depicted by a heavy line while the latter is depicted by a dotted line. Therefore, in Figure 1, t^* is expected to be within finite horizon ($0 \sim T$) or out of it.

Equation (8) is a reaction function of the private sector. This relevance is depicted in Figure 1, indicating that in the period $0 \leq t < t^*$, time-consistency condition holds then the rate of commercial depreciation and leakages equal zero. However, I guess that the government will conduct commercial depreciation shock at time t^*. In other words, π function jumps and is discontinuous at t^*. For rational expectation, leakages, l, also jump at t^*.

The following proposition summarizes the discussions:

Proposition 1: Given a finite horizon T, for $0 \leq t < t^*$, government will adhere to its policy announcement; $\pi = 0$, $\dot{b} = 0$. On the other hand, for $t^* \leq t \leq T$, discretion occurs, then $\pi > 0$. For perfect foresight, leakages arise at the same rate simultaneously, then $\dot{b} = \pi$.

3. 3 *Reputation as a Deterrent to Leakages*

Let's proceed to make the numerical examples for credibility examinations in a finitely-lived economy with the government and the single agent. These examples investigate whether time t^* is realizable within a finite horizon or precisely whether the policy of commercial exchange rate is credible under a dual exchange rate system. From equation (7) as well as **Proposition 1**, the value of δ, b_0, ϕ, m_0, and T might affect the timing of time-inconsistency. Consequently, through numerical examples, the exact timing can be determined. Five cases are presented.

First, the discounting factor, δ, is set at a fixed common value of 0.25. Given a finite horizon $T = 100$, the initial real balance $m_0 = 1000$, the binding quota on foreign bonds $b_0 = 1$, then the cost parameter of penalizing leakages, ϕ, is changed from 0.1 to 0.9 in steps of 0.1. The timing on time-inconsistency, which in turn implies the occurrence of leakages, is given in Table 1. From Table 1, it indicates that the smaller the cost parameter ϕ, the earlier of time-inconsistency and the more li-

Table 1
Dependence of t^* on ϕ in Discretion and Leakages

$T = 100$	ϕ								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
t^*	75	78	80	81	82	83	84	85	85
π_{t^*}	0.0009	0.0017	0.0027	0.0034	0.0042	0.0051	0.0061	0.0072	0.0074
b_{t^*}	1.0319	1.0662	1.1019	1.1369	1.1729	1.2100	1.2484	1.2880	1.3211
t^*+1	76	79	81	82	83	84	85	86	86
π_{t^*+1}	0.0010	0.0020	0.0031	0.0039	0.0049	0.0059	0.0070	0.0083	0.0084
b_{t^*+1}	1.0328	1.0680	1.1048	1.1405	1.1774	1.2155	1.2549	1.2957	1.3289

kely the occurrence of leakages. Moreover, the depreciation rate, π_t, increases with further increases in t^*.

Table 2
Dependence of t^* on δ in Discretion and Leakages

T =100	δ								
	0.1	0.15	0.2	0.25	...	0.85	0.9	0.95	1.0
t^*	77	78	80	82	...	92	92	93	93
π_{t^*}	0.01	0.0070	0.0052	0.0042	...	0.0015	0.0012	0.0017	0.0014
b_{t^*}	1.4351	1.2846	1.2137	1.1729	...	1.0552	1.0518	1.0502	1.0474
t^*+1	78	79	81	83	...	93	93	94	94
π_{t^*+1}	0.0105	0.0076	0.0059	0.0049	...	0.0027	0.0021	0.0035	0.0029
b_{t^*+1}	1.4454	1.2919	1.2193	1.1774	...	1.0572	1.0534	1.0526	1.0494

Second, we examine the dependence of t^* on δ in discretion and leakages. The discounting factor δ is changed from 0.1 to 1.0 in steps of 0.05 while the initial value of real balance, the binding quota on foreign bonds, and the given period of finite horizon are of the same: $\phi = 0.5$, $m_0 = 1000$, $b_0 = 1$, and $T = 100$. The dependence is presented in Table 2. Table 2 shows that t^* increases with the discounting factor δ. In other words, the higher the time preference, the less myopic the government will be; the higher the discounting factor, the less likely cross transactions will be realized.

Third, we examine the dependence of t^* on the initial volume of foreign bonds, the binding quota of them. That is, b_0 is changed from 1 to 1000 in steps of 10 times as much. Meanwhile, the relevant values are: $\phi = 0.5$, $m_0 = 1000$, $T = 100$, and $\delta = 0.25$. Table 3 expresses the situation that the more the binding quota on foreign bonds in the private sector, the earlier t^* will be, which in turn implies that the fewer the restrictions on holding foreign bonds, the earlier the time-inconsistency and leakages will take place.

Fourth, the discretion problem is tested through changing initial real balance, m_0, from 300 to 1200 in steps of 100. The other relevant values are $\phi = 0.5$, $b_0 = 1$,

Table 3
Dependence of t^* on b_0 in Discretion and Leakages

T=100	b_0			
	1	10	100	1000
t^*	82	72	63	54
π_{t^*}	0.0042	0.0042	0.0044	0.0045
b_{t^*}	1.1729	10.1529	100.1356	1000.1181
t^*+1	83	73	64	55
π_{t^*+1}	0.0049	0.0049	0.0051	0.00053
b_{t^*+1}	1.1774	10.1575	100.1403	1000.1230

$T = 100$, and $\delta = 0.25$ as before. Table 4 reveals that the more the initial real balance, the easier the government get resources from depreciating commercial rate and hence the more likely it is that the government will renege on its announcement. Consequently, cross transactions between two markets arise. Nonetheless, π decreases with earlier t^*. The dependence of discretion timing on m_0 is presented in Table 4.

Table 4
Dependence of t^* on m_0 in Discretion and Leakages

T =100	m_0									
	300	400	500	600	700	800	900	1000	1100	1200
t^*	90	88	86	85	84	83	83	82	82	81
π_{t^*}	0.0135	0.0112	0.0085	0.0073	0.0061	0.0052	0.0050	0.0042	0.0041	0.0035
b_{t^*}	1.6274	1.4649	1.3621	1.2990	1.2531	1.2182	1.1955	1.1729	1.1582	1.1422
t^*+1	91	89	87	86	85	84	84	83	83	82
π_{t^*+1}	0.0154	0.0130	0.0098	0.0084	0.0071	0.0059	0.0058	0.0049	0.0047	0.0040
b_{t^*+1}	1.6418	1.4770	1.3713	1.3608	1.2597	1.2237	1.2009	1.1774	1.1626	1.1459

Finally, given $\phi = 0.5$, $b_0 = 1$, $\delta = 0.25$, and $m_0 = 1000$, the length of finite horizon is changed from 100 to 200 in steps of 10. The time inconsistency always occurs at the point of roughly 82 per cent within the horizon. We might predict that there is no dependence of t^* on T. The finite horizon T does not affect the occurrence of time-inconsistency in a two-tier exchange rate system and can apply to infinite horizon. The relevant table is hence not provided here. Above all, the major factor affecting the credibility of commercial exchange rate policy is the discounting rate (δ), the time preferences of government. The depreciation rate (π), is decreasing with δ. The more patient the government, the less likely the occurrence of commercial depreciation and leakages. Moreover, we also find that the less penalizing cost of leakages or the more the binding quota on foreign bonds or the more the initial real money balances, the earlier the time-inconsistency and leakages.

To illustrate temptation in government and enforcement, it could be assumed that the government can move one step before the single agent at t^*. At time t^*, government not only bears costs from administrating leakages but also benefits from the improvement on the current account by deviating from the depreciation rate target once announced. The increase in benefit thus tempts government to conduct commercial depreciation. Following the definition of temptation in Gärtner (1993) who defined temptation as: an increase in utility, resulting from cheating rather than playing honestly, from the objective function in equation (4), the government's temptation to break its promise then is expressed as:

$$\text{temptation} = -[\text{cost}(\pi^e \neq \pi, \pi^e = 0) - \text{cost}(\pi^e = \pi = 0)]$$
$$= \tfrac{1}{2}\pi_{t^*}^2 m_0 \tag{9}$$

where π^e is the expected commercial depreciation rate which is also the announced rate of commercial depreciation and equals zero. Obviously, the cost (disutility) of policy reneging on announcement for government is less than that of the policy of sticking to its promise. In other words, the government's utility in the former is higher than that in the latter. From equation (9), it thus implies that government's temptation to cheat is positive.

However, from t^*+1, government will bear the cost of commercial depreciation since the single agent can expect the commercial exchange rate and conduct cross transactions, causing excess demand for foreign bonds and an increase in the price of foreign bonds. The spread will return to be a constant. This cost might reduce some government incentives to break its promise and might be regarded as a mechanism to enforce government to keep to its announcement. Following again the definition of enforcement in Gärtner (1993) who defined enforcement as: the present value of all future losses by deviating from some announced policy today, enforcement could be expresses as.

$$\begin{aligned}\text{enforcement} &= \int_{t^*+1}^{T}\left[\phi\left(b_{t^*+1}-b_0\right)-\frac{1}{2}\pi_{t^*+1}^{2}m_0\right]\exp\left(-\delta t\right)dt \\ &= -\frac{1}{\delta}\left[\phi\left(b_{t^*+1}-b_0\right)-\frac{1}{2}\pi_{t^*+1}^{2}m_0\right]\left[\exp\left(-\delta T\right)-\exp\left(-\delta\left(t^*+1\right)\right)\right]\end{aligned} \qquad (10)$$

From equation (10), after t^*+1, government will incur the administrative costs of penalizing leakages. Since t^*+1 is within the finite horizon T, the sign of third term is negative. Combining this condition with a positive value for the discounting factor, the value of enforcement should also be positive when the depreciation rate is small enough.

To examine the terms, temptation and enforcement, more clearly, we pick the simulated value of actual depreciation rate from relevant tables and set the common value, $\phi = 0.5$, $m_0 = 1000$, $b_0 = 1$, $T = 100$, and $\delta = 0.25$. The length of finite horizon T, is fixed at 100 since the result of case 5 indicates that the length of the finite horizon is not a factor on which t^* depends. As we know, the shock of commercial depreciation will occur at 82, that is, leakages will occur at the point $t^* = 82$. The value of depreciation rate at time 82 is $\pi_{t^*} = 0.0042$.

From equation (9), when government reneges on its announcement, its cost will be less than that of sticking to its promise by 0.0088. In other words, the temptation is 0.0088. The temptation to cheat is positive since its utility increases. On the other hand, employing Table 2, we find $\pi_{83} = 0.0049$, then, from equation (10), the enforcement is 2.94426609×10^{-10}.

Obviously the value of temptation is much higher than that of enforcement. It suggests that an optimal commercial exchange rate policy ($\pi = 0$) is not a time-consistent decision in that the single agent has perfect foresight for both exchange rates and the government has temptation to deviate from its announced rate. Moreover, discretion is not kept up for the next period. Under rational expectations, the gain from discretion can only last one period, the consumer expects a discretionary depreciation rate at next period, t^*+1. That is

a) $\pi_{t^*+1}^{e} = 0 \text{ if } \pi_{t^*} = 0$

b) otherwise, $\pi_{t^*+1}^{e} = \pi_{t^*+1}^{d}$ (11)

where $\pi_{t^*+1}^{d}$ is the discretionary depreciation rate for t^*+1. As noted by Barro and Gordon (1983), government's credibility is restored at t^*+2 when it follows the announcement at t^*+1. Therefore, the foreign bonds will return to their initial value. On the other hand, from the second part of equation (11), leakages will stand for the following periods and the economy might end up with incomplete separation and hence the erosion of this management if the government reneges on its announcement continuously.

4. Credible Commercial Rates

Although $\pi^e = \pi = 0$ is an optimal policy, it is not a time-consistent decision in that the temptation is still higher than the enforcement as previously pointed out. I intend to search the optimal depreciation rate by minimizing government's temptation. When government conducts commercial depreciation at announced rate, π^a, as expected, the spread between commercial and financial rate remains constant. There exists no arbitrage benefit and hence cross transactions do not occur. Equation (9) becomes

$$\begin{aligned} \text{temptation} &= -\left[\text{cost}\left(\pi_{t^*} \neq \pi^a\right) - \text{cost}\left(\pi_{t^*} = \pi^a\right)\right] \\ &= -\left[\phi\left(b_t - b_0\right) - \frac{1}{2}\pi_{t^*}^2 m_0 + \frac{1}{2}\left(\pi^a\right)^2 m_0\right] \end{aligned} \tag{12}$$

where π^a is the announced rate of commercial depreciation. Solving equation (12), the optimal announced rate of commercial depreciation is $-\phi l'/m_0$. Meanwhile, we have used the assumption that the function of leakages, $\dot{b} = l$, is a decreasing function of the announced depreciation rate and l' is the first derivative. The higher the announced depreciation rate, the smaller the difference between real and expected depreciation rates and hence the smaller arbitrage gains from leakages.

The enforcement in equation (10) becomes

$$\begin{aligned} \text{enforcement} &= \int_{t^*+1}^{T}\left[\phi\left(b_{t^*+1} - b_0\right) - \frac{1}{2}\pi_{t^*+1}^2 m_0\right]\exp(-\delta t)dt - \int_{t^*+1}^{T} -\frac{1}{2}\left[\left(\pi^a\right)^2 m_0\right]\exp(-\delta t)dt \\ &= -\frac{1}{\delta}\left[\phi\left(b_t - b_0\right) - \frac{1}{2}\left(\pi_{t^*+1}\right)^2 m_0 - \frac{1}{2}\left(\pi^a\right)^2 m_0\right]\left[\exp(-\delta T) - \exp\left(-\delta\left(t^* + 1\right)\right)\right] \end{aligned} \tag{13}$$

Following the mechanism used in Barro and Gordon (1983), we try to define **the best enforceable rule** [4] as minimizing

$$\text{enforcement} = \int_{t^*+1}^{T}\left[\phi\left(b_{t^*+1} - b_0\right) - \frac{1}{2}\pi_{t^*+1}^2 m_0\right]\exp(-\delta t)dt - \int_{t^*+1}^{T} -\frac{1}{2}\left[\left(\pi^a\right)^2 m_0\right]\exp(-\delta t)dt$$

subject to

$$\begin{aligned} &\int_{t^*+1}^{T}\left[\phi\left(b_{t^*+1} - b_0\right) - \frac{1}{2}\pi_{t^*+1}^2 m_0\right]\exp(-\delta t)dt - \int_{t^*+1}^{T} -\frac{1}{2}\left[\left(\pi^a\right)^2 m_0\right]\exp(-\delta t)dt \\ &\geq -\left[\phi\left(b_t - b_0\right) - \frac{1}{2}\pi_{t^*}^2 m_0 + \frac{1}{2}\left(\pi^a\right)^2 m_0\right] \end{aligned} \tag{14}$$

By Kuhn-Tucker theorems and Lagrangian techniques, it yields

4) Barro and Gordon (1983) called it the best enforcement rule. Gärtner (1993) also called it the best credible rule.

$$\pi^a = \frac{\phi I' \left\{ \lambda + \left(\frac{1}{\delta} + \frac{\lambda}{\delta} \right) \left[\exp(-\delta T) - \exp\left(-\delta\left(t^* + 1\right)\right) \right] \right\}}{m_0 \left\{ -\lambda + \left(\frac{1}{\delta} + \frac{\lambda}{\delta} \right) \left[\exp(-\delta T) - \exp\left(-\delta\left(t^* + 1\right)\right) \right] \right\}} \tag{15}$$

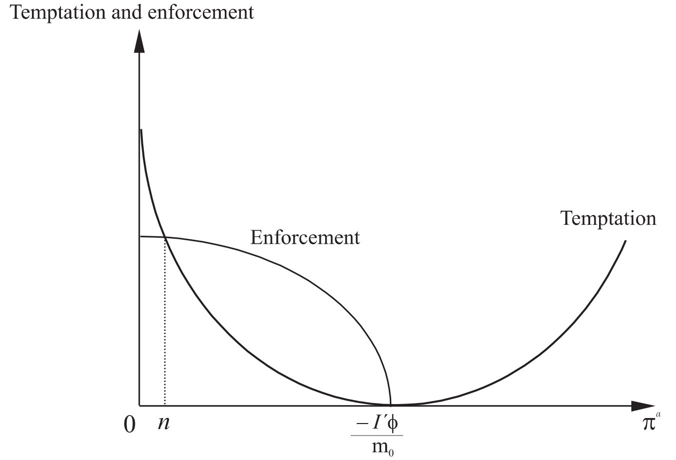
where λ is Lagrangian multiplier. Our discussion is summarized in Figure 2, where $n = \frac{\phi I' \left\{ \lambda + \left(\frac{1}{\delta} + \frac{\lambda}{\delta} \right) \left[\exp(-\delta T) - \exp\left(-\delta\left(t^* + 1\right)\right) \right] \right\}}{m_0 \left\{ -\lambda + \left(\frac{1}{\delta} + \frac{\lambda}{\delta} \right) \left[\exp(-\delta T) - \exp\left(-\delta\left(t^* + 1\right)\right) \right] \right\}}$ is the announced depreciation rate for the best enforcement rule. Three situations emerge:

– if λ is greater than one, then the announced depreciation rate of the best enforcement rule is less than the optimal announced rate of commercial depreciation;

– if λ is equal to one, then the announced depreciation rate of the best enforcement rule equals the optimal announced rate of commercial depreciation;

– if λ is less than one, then the announced depreciation rate of the best enforcement rule is greater than the optimal announced rate of commercial depreciation.

Figure 2
Credible Announced Depreciation Rates



Following the best enforcement rule, the enforcement is much higher than the temptation and the Lagrangian multiplier is not less than one. From Figure 2, although, at period 0, $\pi^a = 0$ is the perfect possible announcement rate for commercial depreciation, according to **Proposition 1**, we guess that the time-inconsistency will occur within a finite horizon. In other words, $\pi^a = 0$ is not credible if that temptation is much higher than enforcement.

Should $\pi^a = -\phi I'/m_0$ hold, it is an optimal and credible choice. Nevertheless, viewed through the payoff to government, it is not able to minimize the cost function in equation (4). It implies that $\pi^a = n$ is the best enforcement rule where not only enforcement equals temptation but also the payoff (cost) to government is a maximum (minimum). Any announcement rates lying between *n* and $-\phi I'/m_0$ are credible policies because the enforcement is higher than the temptation and there is no incentive for government to deviate from its announcement. Furthermore, the payoffs to government of these rates are preferable to that of $\pi^a = -\phi I'/m_0$, which can be proved by equation (4).

This implication is in line with Barro and Gordon (1983) and Gärtner (1993) in macroeconomics. Nonetheless it is the first step to the road of designing a commercial exchange rate policy with successfully completely separated exchange markets.

5. Conclusion

Up to this point I find that leakages exist as long as the commercial depreciation rate deviates from the announcement rate. Furthermore, reputation will be only responsible for cross transactions. Our theoretical and numerical analyses suggest that cross transactions arise as long as government reneges on policy announcement. Whilst the temptation to renege is positive, the enforcement for maintaining a completely separated dual-exchange-market exists. Analytical results also indicate that government's reputation could be as a deterrent to leakages. Then, it gives a formal development of the idea of credibility to discuss incomplete separation between commercial and financial exchange markets.

This analysis provides an illustration of the nature of dual exchange markets and the clarification of time consistency of monetary policy for this exchange rate arrangement. It focuses on the credibility issues rather than on characterizing the optimal policy. Although the announcement without commercial depreciation is the optimal decision, it is not a credible policy. Given a finite time horizon, when government announces depreciation rate at zero at initial period, it is predicted to renege on its announcement within the finite horizon in that, under such an announcement, temptation is higher than enforcement. When announced rates are between the rates of the best credible rule and discretionary policy, they will be time consistent.

As mentioned in the context, the efficiency of such a regime depends on the complete separation between two markets and the credibility of the government. When government breaks its announcement and changes the commercial rate, the time inconsistency of monetary policy arises. This event might result in incomplete separation and hence the erosion of this management.

Fixed exchange rates allow the current account to be protected from the uncertainty caused by fluctuating exchange rates. Where export promotion is a policy strategy under export promoting industrialization, export volatility due to exchange fluctuations can have serious impact on a country's long term's growth rates. Countries might also wish to import capital goods which are essential intermediates in long term growth and may also contribute to research and development and technical progress through learning by doing. In addition, the existence of exchange rate uncertainty *per se* reduces the volume of international trade, discourages inward investment and generally increases the problems that are faced (for example by migrants) in insuring human capital in incomplete asset markets. These features are common to developing countries, hence, the impetus towards keeping exchange rates fixed for the determinants (exports and imports) of the current account.

However, the exchange rate is difficult to peg in the face of large and increasing financial capital mobility. In recent years, developing countries have witnessed large capital flows, particularly for emerging stock markets. Often, the reserves of the domestic central bank are not large enough to withstand speculative pressures unless there are stringent capital controls. It is becoming increasingly difficult, within a framework of integrating capital markets and factor mobility, to maintain artificially pegged exchange rates and prevent black markets from operating and destroying the ability of the authorities to stop illegal transactions in the foreign exchange markets. The share of capital flows in gross domestic product is high for many developing countries and shows an increasing trend for most developing countries.

The most important problem and difficulty for fixed exchange rate is the impotence of domestic monetary policy. Stabilization policy via monetary means becomes difficult and even impossible and over reliance on fiscal policy creates difficulties at a microeconomic level (such as setting suitable targets for health, education, defense and the structure of taxation). With a fixed exchange rate, and sticky domestic prices, a foreign shock can change the terms of trade and the real exchange rate. This in turn will have adverse impact on either export or import, creating similar problems as when nominal rates were volatile. If purchasing power parity always held there would be fewer problems but most empirical and policy oriented analyses show that such parity conditions rarely hold except in the very long run. Clearly, a system which attempts to combine the better features of both exchange rates is the most beneficial exchange rate regime that developing countries would like to have. The dual exchange rate system contains these attractive features. The commercial rate is fixed so that the current account is insulated and protected. The financial rate is allowed to be flexible to act as a shock absorber to capital flows and to allow limited autonomy in monetary policy. The capital account transactions then obey the laws of demand and supply with flexible prices while rigid prices for the current account gives insulation and protection to vital components of the gross domestic product.

The major issues debated in the existing literature regard the question, how we can successfully separate commercial and financial exchange markets. In the previous context I have tackled this topic from theoretical and simulation study perspectives. This paper has carried us beyond orthodox analyses of inter-market foreign exchange flows under dual exchange markets. Then, effective implementation under such a regime could well be undertaken.

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