

Very Preliminary Draft Comments are most welcome!

How a Currency Board Fixes the Exchange Rate in a Crisis

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Abstract

Standard exchange rate theories that are largely macroeconomic in orientation have been criticized for yielding insufficient explanatory and forecasting power. This paper attempts to provide an alternative model of spot exchange rate determination based directly on the specifics of market activities. It looks at the behavior of two different camps in the foreign exchange market: the arbitrageurs and the speculators. The model is cast in such a framework that it is especially suitable for probing the operations of currency board arrangements (CBAs), which are heavily dependent on arbitrage efficiency in locking the spot exchange rate.

1. Introduction

Macroeconomic theory of exchange rate :

- the Keynesian models (Mundell, 1963; Fleming, 1962)
- monetary models with flexible prices (Frenkel and Johnson, 1978)
- sticky prices (Dornbusch, 1976),
- portfolio balance models (Branson and Henderson, 1985)
- target zone models (e.g. Krugman, 1991).

An emerging view:

⇒ the macroeconomic approach may not be very fruitful. (Taylor, 1995)

Historical and existing exchange rate systems:

- floating rate
- fixed and semi-fixed exchange rate systems

(A) government interventions

- ⇒ foreign exchange (esp. capital account) controls, e.g. China and Malaysia;
- ⇒ central bank interventions (ERM).

(B) market-driven mechanism.

- ⇒ old gold standard of the 19th century and the early 20th century
- ⇒ **currency board system**: previous British colonies and also Hong Kong, Argentina, Estonia, and Lithuania

This paper

- explores the micro behavior of the **arbitrageur** and the **speculator** in the foreign exchange spot market from an accounting perspective (T-account approach)
- exams how the spot rate can be fixed through the arbitrage mechanism in the
 - ⇒ interbank market
 - ⇒ open market
- builds a **theoretical model** of spot exchange rate based on arbitrage efficiency

Our paper serves three purposes:

- provides an alternative explanation of
 - ⇒ deviation of the spot exchange rate from its fundamental value in the case of a floating exchange rate system,
 - ⇒ deviation from its official central parity under a fixed exchange rate system.
- pinpoints the dilemma faced by the government in trying to stabilize the exchange rate with discretionary **intervention**.
- shows the *inefficiency* of the **cash arbitrage** mechanism of the *classical* currency board system and the *efficiency* of the **electronic arbitrage** mechanism of the *modern* currency board system (Tsang, 1998a, 1999).

What we talk and not to talk today:

- forex market (not stock market , i.e. no 'double-play')
- spot market (not forward , derivatives markets)
- core mechanism of arbitrage as fixability of the spot rate

(not supporting mechanisms for sustainability)

- two-way convertibility (not one-way)

2. The arbitrage mechanism from an accounting perspective

Background

We start with a semi-fixed exchange rate regime: **a soft peg**

- The official parity of the spot rate, $\bar{s}$, is ‘fixed’ by government discretionary intervention
- This implies that the exchange rate, s , is allowed to deviate from the official parity $\bar{s}$ from time to time.

Suppose that suddenly a financial crisis occurs to the economy.

- Foreign exchange traders’ confidence to the exchange rate regime is reduced
- The spot rate devalues from the official parity, $s > \bar{s}$.
- To restore the public confidence, suppose the government announces a firm convertibility undertaking at the official parity, i.e. HKD7.80/USD

- The convertibility undertaking is accessible to all banking institutions that maintained balances with the monetary authority.
- To simplify our analysis, we postulate that the transactions are done on a “T+0 day” basis, i.e., immediate settlement instead of the normal spot transaction practice (“T+2”).

There are two foreign exchange **spot** markets that we will look at:

- 1) the interbank market
- 2) the open market

First, we start with the interbank market.

2.1. The arbitrage mechanism in the interbank market

Suppose

- **Bank A is the speculator** who intends to devalue the HKD
- **Bank B is the arbitrage bank**. Bank B tries to make arbitrage profits by engaging in arbitrage transactions which, as a consequence, maintain the official parity.

Table 1. The T-account record of an arbitrage example on the interbank market

Bank A		Bank B		HKMA	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
(1) Payment to B: -80 HKD Payment from B: +10 USD		(2) Payment from A: +80 HKD Payment to A: -10 USD			
		(3) Payment to HKMA: -78 HKD Payment from HKMA: +10USD	Profit: +2HKD	(4) Payment from B: +78 HKD Payment to B: -10 USD	
A closes position at s=7.8 HKD/USD:					
(5)Payment to B: -10 USD Payment from B: +78 HKD	Profit: -2 HKD	(6) Payment from A: +10 USD Payment to A: -78 HKD		(7)Payment from B: +10 USD Payment to B: -78 HKD	
Bank A		Bank B		HKMA	
Net positions at the end:					
Speculation loss 2 HKD (plus transaction costs)		Arbitrage profits +2 HKD (minus transaction cost with HKMA)		Profit/loss: zero	

NB: 1) This table illustrates arbitrage via HKMA accounts. 2) All values are marked to the market in millions. 3) Official spot rate is set at s=7.8 HKD/USD and market spot rate at 8 HKD/USD. 4) Assets = Liabilities + Profits.

2.2. The arbitrage mechanism in the foreign exchange open market

What about speculators outside the banking system?

The convertibility undertaking of 7.80 is accessible only to banks, not directly to all market participants.

Suppose

- a **speculator, client “C”**, wants to **devalue** the HKD, but he initially does not have liquid HKD funds.
- Bank A is a facilitator to C
- **Bank B is an arbitrageur.**

Table 2. The T-account record of an arbitrage example on the foreign exchange market

Client C		Bank A		Bank B		HKMA	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
(1) Payment from A: +80 HKD	Loan from A: +80 HKD	(2) Loan to C: +80 HKD	C's collateral: +80 HKD			(3) Credit to A's balance: +80 HKD	EFBN : +80 HKD
(4) Payment to B: -80 HKD Payment from B: +10 USD		(5) EFBNs: -80 HKD Balance with HKMA: +80 HKD		(6) Payment from C: +80 HKD Payment to C: -10 USD Pay to HKMA: -78 HKD Pay from HKMA: +10 USD	Profit : +2 HKD	(7) Payment from B: +70 HKD Payment to B: -10 USD	

Client C		Bank A		Bank B		HKMA	
C closes position at s=7.8 HKD/USD:							
(8) Payment to B: -10 USD Payment from B: +78 HKD Loan repayment to A: -80 HKD	Loan from A: -80 HKD Profit: -2 HKD	(9) Loan to C: -80 HKD Payment from C: +80 HKD Collateral released to C: -80 HKD	C's collateral: -80 HKD	(10) Payment from C: +10 USD Payment to C: -78 HKD		(11) Payment from B: +10 USD Payment to B: -78 HKD	
Net positions at the end:							
Client C		Bank A		Bank B		HKMA	
Speculation loss 2 HKD (plus interest payments and transaction costs)		Earns transaction commissions		Arbitrage profits +2 HKD (plus transaction commissions, minus transaction cost with HKMA)		Profit/loss: zero	

NB: 1) This table illustrates arbitrage via HKMA accounts. 2) All values are marked to the market in millions. 3) Official spot rate is set at s=7.8 HKD/USD and market spot rate at 8 HKD/USD. 4) Assets = Liabilities + Profits.

3. A model of spot exchange rate determination based on heterogeneous expectations

- We formally model the ideas exposed in the accounting examples
- At the beginning, there is no convertibility undertaking (CU) at the official parity, i.e. no arbitrage possibility.
- Later on, we introduce CU and assume that one of the speculators has the full confidence of the CU and becomes an arbitrageur.
- We then prove that the arbitrage mechanism is able to lock effectively the market exchange rate to its official parity.

A micro behavior model of the spot exchange rate

In a foreign exchange market without CU

- two heterogeneous speculators, a and b , whose objectives are profit-maximising.

- also some liquidity traders such as hedgers, exporters/importers, and one-way migrants who just do a fixed amount of transactions independent of the level of the spot exchange rate.
- There may or may not be government intervention, g , to move the market exchange rate to the official parity.
- s is defined as HKD per unit of USD. $s \uparrow \Rightarrow$ a devaluation of HKD against USD.
- Market agents have imperfect information about the *true* official intervention level, $\bar{s}$.
- A speculator, k ($k=a, b$), intends to drive the spot exchange rate to her *perceived* official intervention level, s_k . s_k is a random variable with *perceived* mean $\bar{s}_k$ and *perceived* variance σ_k^2 . $\bar{s}_k \neq \bar{s}$.
- $\bar{s}_b < \bar{s}_a$, i.e. speculator a believes that the observed spot rate s is undervalued. In other words, speculator a tries to buy up the domestic currency. Whilst b tries to do the opposite.
- Information is private. It is neither verifiable nor exchangeable
 $\Rightarrow$ the key that renders the failure of government intervention.

3.1. Strategy of speculator a

Speculator a believes the spot rate s is overvalued. Therefore he shorts domestic currency **HKD** and longs foreign currency **USD**. To close his position, he may reverse the transaction after the monetary authority (or its delegated agents) intervenes at the market. This is illustrated in the accounting records of Table 3.

Table 3. Accounting records of transaction by speculators

		In the current spot market		In the spot market in the future		Profits (5)=(1)+(2)+(3)+(4)
		Trade volume (1)	Transac- tion cost (2)	Trade volume (3)	Transac- tion cost (4)	
Speculat or a with $\bar{s}_a > s$	HKD	-a	-a.t	+a.s _a /s	-t.a.s _a /s	$a[(1-t).s_a/s - (1+t)]$
	USD	+a/s	-	-a/s	-	0

		In the current spot market		In the spot market in the future		Profits (5)=(1)+(2)+(3)+(4)
		Trade volume (1)	Transaction cost (2)	Trade volume (3)	Transaction cost (4)	
Speculator b with $\bar{s}_b < s$	HKD	+b	-b.t	-b.s _b /s	-t.b.s _b /s	$b[(1-t)-(1+t).s_b/s]$
	USD	-b/s	-	+b/s	-	0

NB: 1. “+” indicates buying and “-” indicates selling or a payment.

2. s is the observed spot exchange rate, s_a and s_b are perceived spot rates, which are random variables with mean of $\bar{s}_a$ and $\bar{s}_b$, in the future by speculators of a and b , respectively, while t is the transaction cost.

3. All profits are denominated in HKD for simplicity.

3.2. Strategy of speculator b

The speculator b will do exactly the opposite.

He will short the foreign currency USD and long the domestic currency HKD in the spot market. He may reverse the transaction later to close his position.

3.3. Liquidity traders and government intervention

- Liquidity traders such as hedging exporters/importers, migrants have a *net* supply of HKD:

$S.C_h$

- HKD demand by the government: s.g.

3.4. Market Equilibrium

- the aggregate demand for domestic currency HKD by speculators and the government intervention is equal to

- the aggregate supply of domestic currency by speculators plus the net supply of liquidity traders, i.e.:

$$b + s.g = a + s.c_h. \quad (14)$$

Solving for the equilibrium spot rate s^* , we have:

$$(17) \Rightarrow s^* = \theta_0 + \theta_1.g,$$

Conclusion: government intervention is ineffective.

BUT: what about the market arbitrage mechanism?

4. Arbitrage mechanism to fix the spot exchange rate

There are three sufficient conditions to set $s^* = \bar{s}$:

- (i) There must be a committed official convertibility undertaking (CU) rate $\bar{s}$ which convinces speculator b to believe that $s_b = \bar{s}_b = \bar{s}$ without uncertainty, i.e., $s_{sb}^2 = 0$.

=> **speculator b** is turned into an **arbitrageur**

As a result of (i), from (17) we have:

$$\lim_{\sigma_{sb}^2 \rightarrow 0} s^* = \bar{s}(1+t)/(1-t).$$

This implies the spot rate is locked to $\bar{s}$ subject to the transaction cost.

- Under the “convertible reserves” system of ‘AEL’ model (Tsang, 1996, 1998a, 1999), arbitrage can be carried out by banks against each other and settled electronically through the inter-bank clearing system hosted by the monetary authority.

- (ii) $t=0$ (no transaction cost).

Conditions (i) and (ii) together imply that:

$$\lim_{\substack{\sigma_{sb}^2 \rightarrow 0 \\ t \rightarrow 0}} s^* = \bar{s}.$$

- A real-time gross settlement system (RTGS) operated by the monetary authority, like what Hong Kong implemented in late 1996, will provide such a kind of efficient arbitrage facility. **This represents a breakthrough in arbitrage efficiency**, higher than that of cash arbitrage under the classical currency board and that of trans-Atlantic arbitrage under the old gold standard (Tsang, 1999).

(iii) Abundant arbitrage funds and official foreign reserves.

Condition (iii) makes sure that s^* is always locked to $\bar{s}$ no matter how big the speculation activities are.

- “**electronic arbitrage**” should also increase substantially the available arbitrage fund, subject to the speed and cost of the settlement system. The mobilized **arbitrage fund** can be **recycled** swiftly and the upper limit may not be hit within a period that is required for the market exchange rate to converge to the official parity.

4.1. Modern currency board arrangements

In CBAs like those of Argentina, Estonia and Lithuania, the so-called “AEL model” (Tsang, 1996, 1998a, 1999), a modern arrangement of convertibility undertaking by the monetary authority has been adopted. We argue that these CBAs **fulfil the three sufficient conditions (i) to (iii)** identified in this paper and therefore have been able to lock their spot market exchange rates to their official parities.

Empirical evidence suggests this indeed has been the case. For example, Argentina's fixed exchange rate 1 peso against 1 USD has never been de-railed. Even in 1995, when **Argentina** faced a serious **economic crisis** under which 20% of bank deposits were lost in a few months, the economy contracted by 4.6%, and unemployment shot up to 16%, the spot rate in foreign exchange market adhered strictly to the official rate. The same "miracle" occurred in **Lithuania**. A **banking crisis** broke out in December 1995. The nation's two

largest banks were suspended, and bank deposits fell by 15% in the first quarter of 1996. Yet the official rate of 4 litas against 1 US dollar was not challenged at all (Baliño and Enoch, 1997; Tsang, 1998a).

It is interesting to note that, during the Asian financial crisis, the Hong Kong Monetary Authority adopted the “seven technical measures” on 5 September 1999 (Hong Kong Monetary Authority, 1998), which represented a partial adoption of the AEL model of CBAs (Tsang, 1998a, 1999), with a firm CU on the official parity (albeit one-way). Since then, financial calm has returned to Hong Kong despite some remaining problems (Tsang, 2000).

5. Conclusion

- From an accounting perspective, this paper attempts to look at the behavior of two different camps in the foreign exchange market: the arbitrageurs and the speculators.
- The theoretical model is especially suitable for probing the operations of currency board arrangements (CBAs), which is heavily dependent on arbitrage efficiency in locking the spot exchange rate.

THE END

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