China's Renminbi Currency Logistics Network: A Brief Introduction

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Abstract

Currency logistics is becoming a field of increasing interest and importance both in government and academic circles. In this paper, a basic description of China's nationwide logistics network for the Renminbi is discussed and analyzed. In addition to its basic structure, its key problems such as production costs, inventory levels, and transportation and storage security are discussed.

Oftentimes, discussions of cash or the basic money supply measure, M_0(cash in circulation), is only the realm of macroeconomic theory and monetary policy. As valuable as these insights are, even in our increasingly digital economy, cash is still largely a physical medium of exchange. In almost all nations, physical cash and coins backed, minted or printed, and supplied by a central bank in cooperation with government and commercial banks and businesses across the country are the most accepted means of exchange. As has been stated in [1, 2, 3], the nature of the logistics and physical distribution of 'cash supply chains', 'cash chains', or 'currency chains' is still largely untouched in the published literature with the exception of discussions of institution cash management.

The central monetary authority of every nation, and those of supernational monetary authorities such as the European Central Bank (ECB), face the classic supply-demand and distribution issues that face most businesses or militaries when distributing goods. Among the most important decisions are to contract with a public or private mint and printing bureau to produce currency, ascertain the demand for cash both within and outside of the country, how to handle the physical notes and coins based on this demand and the financial and business sector framework, the extent of public or private management of the distribution and cash warehousing network, security in this distribution network, recirculation of banknotes and coins back to a central authority where obsolete and debilitated currency can be removed from circulation, and how to effectively cut out counterfeit currency from the supply chain.

A useful framework of the cash supply chain as a closed-loop supply chain where both forward distribution and reverse logistics are considered was men-

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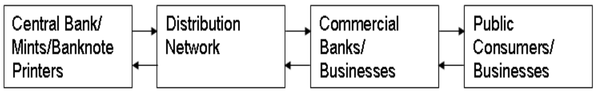

Figure 1: Basic structure of a closed-loop currency supply chain.

tioned by [1]. As seen in Figure 1, there is a forward and backward motion of notes throughout the supply chain as notes are distributed to the public and notes are taken back for sorting and many are removed from circulation. In [4, 5, 6] the cash supply chains of Austria in the context of the EU, Australia, and India are respectively discussed. Each of these countries has a system of logistics that is fit to its individual circumstances. In Austria's case, like other Euro countries, both the national central banks and the ECB work together to determine banknote demand and production and distribution across the Eurozone.

1. China: Economy and Institutions

The People's Republic of China has undergone a rapid and massive transformation since its economic liberalization began thirty years ago. China has now become the world's fourth largest economy, with an estimated 2008 GDP of $3.6 Trillion according to World Bank estimates, and has undergone double digit annual growth for the last several years. Having the world's largest population of 1.4 billion people, it unsurprisingly has the largest volume circulation

Figure 2: 100 RMB note design.

of banknotes in the world [7].

The Chinese currency, the Renminbi (RMB), is non-convertible and managed by the People's Bank of China (PBOC), the Chinese central bank. It is legal tender throughout mainland China but not Hong Kong S.A.R., Macau S.A.R. or Taiwan which will not be covered in this paper. Table 2, lists the coin and note denominations in the current fifth series of banknote styles which began rollout in 1999 and completed rollout in 2005 [8]. Figure 2 also shows a sample banknote, the 100 RMB denominated note. The official responsibility of cash currency policy given to the PBOC is laid out in the "People's Republic of China People's Bank of China Law" 《中国人民功和中国人民银行法》 guidelines [7]. In addition, the current currency strategy is outlined in the PBOC's"Currency Strategy"" 《货币政策》 documents available on its website. [10]. Like most modern currencies, the RMB has evolved over time in order to increase durability and has added a variety of anti-counterfeiting measures to the note.

2. China's Currency Circulation, Denominations, and Structure

China has had to deal with an exponential growing money supply during its period of rapid growth over the last few decades. In Figures 3 and 4 are M_0 statistics from China over time. Figure 3 shows annual year-end M_0 since 1978 and Figure 4 shows monthly M_0 since December 1999. M_0 has grown from 21 billion RMB in 1978 to over 3 trillion RMB at present, a 147-fold increase [12]. Though the monetary policy aspects of this are widely discussed and debated, it

Coins (in“Yuan”)	Notes (in“yuan”)
0.1	1
0.5	5
1	10
	20
	50
	100

Table 1: Current fifth series Renminbi coin and banknote denominations.

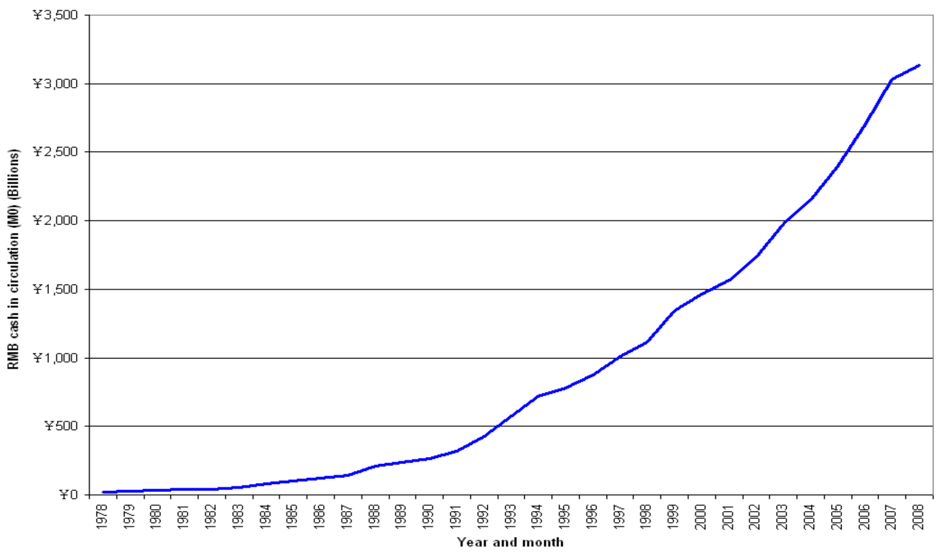

Figure 3: Annual M_0 by year form 1998 to October 2008.

presents a massive logistical challenge which would require a co-committed expansion in production, infrastructure, and distributional capabilities to prevent shortages.

A brief history of China’s cash policy until 1998 is given in [12] which divides the growth of the cash culture in China into three phases: 1978-1980, 1981-1984, 1985-1988, 1989-1993, 1994-1997 based largely on the increases of the average yearly net increase in M_0 in each period. China’s money supply as expected has largely increased due to the increasing needs of societal transactions, rises in consumer prices, and interest rate policies effect on the money supply.

Chinese currency denominations have changed from the first series to the current fifth series of banknotes. The general structure of the banknote composition of the money supply has changed with the needs of society as mentioned in [12]. In Table **??**, are the % of M_0 in the years 1978, 1987, 1988, and

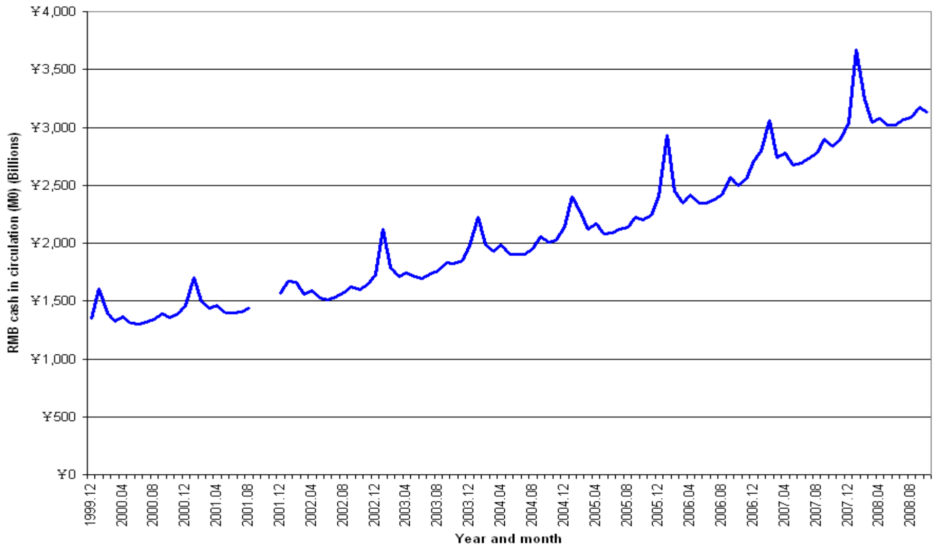

Figure 4: Monthly M_0 from December 1999 to October 2008. Annual spikes are due to increased withdrawals and circulation due to gift giving and purchases on the Chinese New Year holiday.

	1978	1987	1988	1998
1 & 2 RMB	16%	5%	5%	2%
5 RMB	30%	16%	16%	1%
10 RMB	49%	72%	48%	7%
20 RMB	4%	7%	8%	2%
50 RMB	N.A.	N.A.	13%	13%
100 RMB	N.A.	N.A.	11%	75%
All coins	1%	1%	N.A.	N.A.

Table 2: Percent of M_0 each banknote represents by year; 20 RMB was calculated using a plug for 100% since numbers were not given. 10 RMB in 1988 estimated based on percent in 1987 minus share capture from 50 and 100 RMB.

1998. Consistent with most currencies, the largest volume of bills are of small denominations which is necessary in order to produce change and allow small transactions. There have been some large changes in the structure of RMB denominations as the 50 and 100 RMB notes have taken huge share from the 5 and 10 RMB notes since their introduction in the 1987 and 1988 respectively. This is likely, in part to the increasing use and acceptance of ATMs as well as rising demand for high value cash transactions. Guo Ju'e further predicts that the 100 RMB note will continue to hold a large share, 80%+ of M_0 by value out until 2010. She also predicts the PBOC may eventually choose to introduce a 500 and 1000 RMB note though this is speculative.

	1978	1987	1988	1998
1 & 2 RMB	48%	22%	26%	38%
5 RMB	28%	24%	27%	8%
10 RMB	23%	52%	41%	20%
20 RMB	1%	2%	3%	3%
50 RMB	N.A.	N.A.	2%	8%
100 RMB	N.A.	N.A.	1%	23%

Table 3: Percent of total banknote volume each denomination represents by year; calculated using 1.5 used for value of 1 and 2 RMB set.

3. China's Currency Management and Distribution

According to the"Regulations of the People's Bank of the People's Republic of China" 《中华人民共和国中国人民银行法》 the PBOC is responsible for determining how RMB are produced [8]. The actual infrastructure for the minting/printing of Chinese currency is carried about by a state owned corporation, China Banknote Printing and Minting (CBPMC) (中国印钞造币总公司) headquartered in Beijing. CBPMC uses a network of printing and engraving and minting facilities around the country (see Figure 5) to produce banknotes and coins for subsequent distribution. Banknote printing facilities are based in Beijing, Shanghai, Chengdu, Xi'an, Shijiazhuang, and Nanchang. Mints are located in Nanjing, Shanghai, and Shenyang. Also, high grade paper for the banknotes is produced at two facilities in Baoding and Kunshan. The Baoding facility is the largest facility in the world dedicated to developing banknote material [11]. In addition, the PBOC has its own printing technology research division which researches new techniques for creating banknotes and making counterfeit more difficult.

In [7, 8, 9] Zhang Lele, Zhu Nan & Wang Long, and Chen Baoshan detail the distribution and logistics network of the RMB throughout China. In Figure 6, is a diagram of the Chinese cash supply chain based on [7]. Banknotes and coins are first forwarded to a central distribution center from which they are distributed to regional and provincial distribution centers. These subsequently feed into regional"central payment distribution centers" which feed local level payment distribution centers and commercial banks. Finally, these banks distribute the banknotes and coins to businesses and the public through withdrawals and financial transactions. About 80% of the cash currency is in the hands of citizens divided roughly between cities and rural areas as 25% to 75% [14]. The reverse logistics portion of the chain is similar where the public deposits notes in banks which forward the bills to local or central payment distribution centers. At the central payment distribution centers or regional distribution centers the bills and coins are sorted, unfit or counterfeit bills and coins are removed from circulation, and subsequently sent to be destroyed. There is no reverse flow of currency back to the central distribution center.

As of 2005, throughout the entire distribution network, there is one cen-

Figure 5: Location of banknote printing facilities and mints in China. Blue circles are mints, green circles are banknote printers, and red circles are note paper producers.

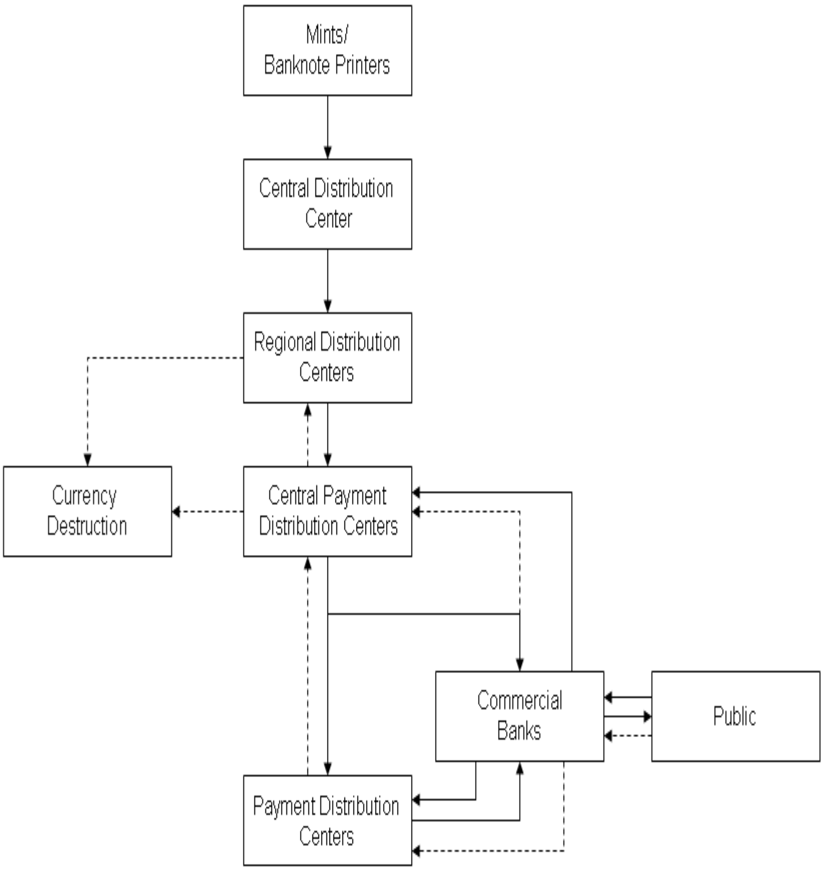

Figure 6: China's currency chain according to [7].

tral distribution center, 15 regional distribution centers, and 32 provincial distribution centers. For the payment distribution centers there are 335 central payment distribution centers and 1,393 local payment distribution centers nationwide [7] for a total of 1,775 currency-related distribution centers. Though the exact volumes are not known, it is likely the largest volumes of banknotes are transported to the four prominent state-owned banking institutions, the Bank of China, China Construction Bank, China Industrial Commercial Bank, and China Agricultural Bank. Safety reserve (stock) levels within the distribution system are typically very high compared to other countries. According to [8], safety reserve requirements dictate that enough currency to satisfy at least 24 months of currency issuing demand must be on stock at all times, though which levels of distribution this is mostly held at is unclear, which would only generate $\frac{1}{2}$ of a turn of currency stock per year on average. Given the net increase in M_0 over 2007 was 652 billion RMB (about $80 billion USD) this would imply that safety stocks would be massive to keep up with such high demand.

Currency maintained within the central and regional distribution centers is both cycle and safety stock which is not considered in circulation. These distribution centers funnel money out to the commercial banks and businesses theoretically using a FIFO system (though this is not always consistent) [8]. Under a FIFO queuing system, then the average bill or coin would spend almost two years in reserve stock before entering circulation. They report this safety reserve level as being twelve times higher than the typical standard in Western developed nations. Despite these regulations, inventory management in currency warehouses and distribution centers is still not standardized and is in need of continued modernization and the use of advanced information technology.

In regulations established in 1988, "Provisional Regulations on Cash Management 《现 金管理暂行条例》" and "Detailed Implementation Regulations for Cash Management 《现金管理暂行条例实施细则》", the PBOC has declared that it is the responsibility of each bank or division to be responsible for the transport and security of the physical currency it receives and transports. Therefore, most distribution centers and commercial banks use their own armored cars and hire their own security and handling personnel. In some banks, personnel relating to the functions of security and cash management can make up $\frac{1}{3}$ of all employees [8, 13].

4. Risks and Problems

4.1. Reverse Logistics and Currency Destruction

Reverse logistics, being one of the most important facets of the currency process, is an area of intense focus in the Chinese currency chain. First, the ratio of returned currency to issued currency per year is high, averaging 68% per year from 1993-2003 [14]. A main motivation for banks to return currency for sorting is not just to remove unfit currency but to take the storage and possibly non-interest earning currency off of their books and send it to the central bank which would pay them interest on deposited currency. Since not all of this currency is unfit and destroyed, it indicates that it is likely the PBOC or CBMPC subsidize the storage and operations of bill and coin sorting and reissuing. Many nations, including the United States and Australia, have begun to outsource this non-core process further down the currency chain to commercial banks or charge a fee so that such large volumes of currency will not be returned for sorting [2, 5]. Some nations such as South Africa have already privatized the entire process [1].

The ratio of unfit bills, however, is so large it necessitates the return of such large volumes of currency for sorting. The amount of unfit currency which is destroyed each year is usually about 30% of that year's issue [8, 15] giving currency an average life of only 3 years. Reverse logistics of currency, both cleaning and destruction, are among the greatest challenges facing China's currency chain. In a 2005 report on the PBOC website [16]. Chen Baoshan, an expert at the PBOC who has worked in both currency logistics and anti-counterfeiting and written many of the standard texts on currency logistics in China, gave statistics on the growing issues in the reverse logistics of the Renminbi. In 2004, China sorted 7.92 billion Renminbi, a small percentage of total circulation but a 46% jump from the previous year. Also, 15,000 metric tons of Renminbi were destroyed as being unfit or obsolete currency. This was in fact only 58% of all currency destroyed nationwide (natural processes, manual destruction) so the actual amount of destroyed currency amounted to 26,000 metric tons. By the end of 2004, there was a nationwide network of 20 cash handling centers who purchased an additional 45 currency sorting machines and 5 currency destruction machines bringing the nationwide total to 310 currency sorting machines and 67 currency destruction machines. According to [7] each sorting machine costs about 1 million RMB to purchase and about 300,000 RMB per year to maintain. Each currency destruction machine costs about 18 million RMB. This puts the total purchases for reverse logistics by the PBOC at about 135 million RMB (about $20 million USD).

Many of the unfit bills, though it is not clear how much, are due to counterfeits, especially in the high denominations. In addition, Chinese banknotes apparently have a propensity to grow fungus over time. In [8], it is said about 180,000 banknotes of total unknown value have to be removed because of fungal damage. It is unknown how much of this process will eventually be outsourced or updated in the future, however, unless the number of unfit and counterfeit bills can be reduced, the challenges of reverse currency logistics will only continue to increase.

4.2. High Production and Transport Costs

The recent, and mercifully brief, commodity price boom brought attention to the possibility of many coins around the world of having negative seigniorage due to costs of production and transport per weight being more than the face value of the coin. According to [1] this has been an issue for China since at least 2005. He states that for the jiao (10 fen/cent) coins and the 1 jiao note the production costs had already exceeded the face values. The 1 RMB coin and the 2 jiao banknote production costs were roughly equal to the face value. Given the 6.05g weight of the 1 RMB coin given by the CBPMC, it can be estimated that minting production costs for coins are roughly 0.165 RMB/g. Given the 1 jiao and 5 jiao coins weigh 2.2g and 3.8g respectively their estimated production costs could be 0.36 RMB(3.6 jiao) and 0.63 RMB (6.3 jiao) showing the magnitude of the problem with these small coins. Similarly with the jiao notes, if a 2 jiao note was roughly breakeven and has a dimension of 120x55 mm then the cost per mm^2 is about $3x10^{-3}$ jiao per mm^2 and with a 1 jiao note of dimensions 115x52 shows a production cost of 1.8 RMB (0.18 jiao). It is plausible that during the recent commodity boom, even the 1 RMB coin and possibly some of the RMB banknotes had negative seigniorage.

4.3. Transport and Storage Security Risks

Security of currency transport as discussed earlier, is the responsibility of lower level recipients and distributors and not the PBOC. This throws into relief the fact that risks for transportation security can often be on weaker members of the currency chain. Given the lack of standardization or outsourced vendors for this process, security and safety of currency transport is a continuing issue. [7, 8] both mention a sharp rise in currency theft and heists in recent years. In 2006, there were 26 cases of armed holdups and 31 thefts of bank or safe currency. For example in November 2006 in Hubei province's Yicheng , 2.6 million RMB (about $325,000 USD) was stolen from currency being transported from a payment distribution center. In April 2007, in Hebei province's Handan rural currency distribution warehouse, a theft of almost 51 million RMB (about $7.3 million USD) occurred. The security of transporting and storing currency is an increasingly urgent problem, especially with the explosive growth of the money supply and will be a key issue for the future.

5. Concluding Remarks

As on e of the currencies with growing importance in the world financial system, the efficiency and effectiveness of the Renminbi logistics system will impact not only China but the rest of the world. This impact will likely become more marked at the point in the future that China decides to allow full convertibility for the Renminbi and more open capital flows. Renminbi are already present in significant quantities in neighboring states such as Mongolia and the Central Asian states due to burgeoning trade [17]. It is too early to say whether physical Renminbi will become a major regional or even global currency on full convertibility but it is sure this event will emphasize the even greater need for modern logistics and management.

More efficient transport and inventory policies will allow lower safety stock levels as well as possibly lower rates of unfit bills. In addition, possibly moves like other countries to outsource or privatize a segment of the operations could take a great weight off the hand of the PBOC and CBPMC to allow more focus on the production aspects and lower the amount of sorting required. It seems, however, that Chinese government officials and academics have taken this problem to heart and are working for successful solutions. Earlier currency shortages such as those in Guangdong and Zhejiang in 1994 [8] are almost unheard of now. Indeed, the author found more academic articles and full books on currency logistics in the Chinese literature than the English language academic literature. Therefore such a mainstream and studied subject will most likely soon both improve China's on currency logistics and provide successful examples to the rest of the world.

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