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The Impact of Participatory Notes on the Indian Rupee Exchange Rate

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THE EFFECT OF PARTICIPATORY NOTES ON THE INDIAN RUPEE EXCHANGE RATE

SUBMITTED TO
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AND
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Abstract

Since 1992, India has grown as a global player in the finance world. In spite of its success, India has not been able to rid itself of potentially harmful practices. One such practice is the issuing of Participatory Notes (PN) to foreign investors, so that they can anonymously purchase securities or derivatives listed on the Indian Stock Exchanges. This instrument came into public view when it accounted for approximately 50% of all foreign portfolio assets in India. Since then, the laws regarding PNs have evolved to become a more transparent version of the old rules. Although PN levels are not close to as high as 2007, a rising trend in PNs has been observed from September to November 2012. Regulation may have helped figure out who the end PN holder is, but it has not helped mitigate the inherent volatility that some scholars argued PNs had. This paper follows previous researchers claims to try to resolve the issue using rigorous econometric analysis. It uses the Vector Auto Regression (VAR) Model to find the coefficient of change in Participatory Note volume when regressed against the U.S. Dollar Indian Rupee Nominal Exchange Rate. Although the model’s results are interpreted, a problem of serial correlation existed in the model, thus impairing the results.
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I would like to thank Claremont McKenna College for being a home, (really far) away from home. Before I came here, I had no idea it was possible to learn, while living in North Quad. Although, I might not leave here with a stellar academic performance, I will leave here with a much larger, and more diverse, pool of knowledge. I will leave smarter, and much more of a global citizen than I was before I transferred to CMC. Most importantly, I will leave here longing to come back.

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\(^1\) Sports injury
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# List of Abbreviations

## General

1. AuC – Assets Under Custody
2. BoP – Balance of Payments
3. BSE – Bombay Stock Exchange
4. DFI – Development Finance Institutes
5. DTAA – Double Tax Avoidance Agreement
6. ECB – External Commercial Borrowings
7. FDI - Foreign Direct Investor
8. FERA – Foreign Exchange Regulation Act
9. FII – Foreign Institutional Investor
10. FVCI – Foreign Venture Capital Invesment
11. IMF - International Monetary Fund
12. INR – Indian National Rupee
13. KYC – Know Your Client
14. MoU – Memorandum of Understanding
15. NRI – Non-Resident Indian
16. NSE – National Stock Exchange
17. ODI – Overseas Derivative Instrument
18. PN – Participatory Note
19. RBI – Reserve Bank of India
20. PIO – Person of Indian Origin
21. SEBI – Securities and Exchange Board of India
Data and Analysis

1. ARCH – Autoregressive Conditional Heteroskedasticity
2. GARCH – General Autoregressive Conditional Heteroskedasticity
3. M3 – Broad Money
4. VAR – Vector Autoregression
5. USDXY – US Dollar Spot Rate Index
6. AUCNPN – Assests under FIIs, not including Participatory Notes


**Background**

India is a unique country in many ways. The structure of India’s economy has evolved in a unique manner over its independent history. Politically, it has undergone an interesting metamorphosis. Numerous kingdoms ruled India before the British colonized and unified the country in the 19th century. After achieving independence in 1947, India decided to remain non-aligned during the Cold War, in its quest to maintain strategic autonomy and economic independence. This political sentiment had an immense impact on the development of India’s economy. India’s early leaders instituted a state-controlled economic system, dubbed the “Licence Raj”, and it existed from independence until its eventual dismantling at the end of the Cold War in the early 1990s.

“Licence Raj” is translated into English as the ‘rule of licenses’. The term refers to the Soviet-inspired central planning approach that India adopted, following its independence in 1947. Although the private sector was nominally allowed to operate, it could only do so after facing numerous regulations, permits, and quotas that together served as symbols of India’s infamous red tape bureaucracy. Effectively, the only significant private industries in India prior to economic liberalization were firms that were supported by the state through special licenses and permits.

**1991 Balance-of-Payments Crisis**

In the 1980’s, India ushered in a period of relatively unprecedented economic growth through a rapid escalation of public expenditure, which was financed by unsustainable borrowing. By 1985, the Rupee began to depreciate against the dollar, boosting exports. In spite of this jump in exports, the soaring debt caused an increase in the current account deficit from
1.7% of GDP in 1981 to 3.1% of GDP in 1989.\(^2\) In 1990, India’s exports crashed, as a result of economic slowdowns in India’s biggest export partners. Credit started freezing up as a result of a downgrade of government debt from investment grade to junk. India’s foreign exchange reserves had dropped to merely 7 weeks worth of exports by mid 1990, when the Gulf War began. This war led to a global oil supply shock, and Indian exports began to dry up. On the other hand, petroleum imports to India increased by more than 2 billion USD.\(^3\) This exacerbation of the current account deficit spilled over to affect the capital account. Political instability, a credit crunch, and the current accounts crisis led to a dip in investor confidence. While investors began to pull their money out, creditors refused to buy short-term debt, and NRIs (Non-resident indians, or Indian expatriates), the only significant source of foreign portfolio investment at the time, began to rapidly pull their money out of India\(^4\). This balance of payments crisis manifested itself as the foreign exchange reserves fell to three weeks worth of imports. The urgency of this crisis was evident when the Finance Minister told parliament that the crisis “constitutes a serious threat to the sustainability of growth processes and orderly implementation of our development programs.”\(^5\) In order to avoid default, India used all its gold reserves as collateral to secure a loan of 1.8 billion dollars from the IMF in January 1991.\(^6\)

The Indian government secured the IMF loan during the interim tenure of the Janata Dal (Secular) government. Elections were scheduled for May 1991, but were delayed till June because of the assassination of a prominent opposition candidate and former Prime Minister,

Rajiv Gandhi. In June, the minority coalition government of P.V. Narasimha Rao was elected, and it pioneered sweeping reforms under its new Finance Minister, the economist and former RBI governor, Dr. Manmohan Singh. Although some of the improvements were covenants of the IMF loan, the government indicated its intention to bring about an era of liberalization in all sectors of the economy, including crucially, in the financial sector.

**Post-Crisis Reforms**

In order to comply with the IMF’s Balance of Payments Manual, India was forced to undertake many important changes in its fiscal and monetary policy. The High Level Committee on Balance of Payments (henceforth Rangarajan Committee) and the Committee on Financial Sector Reforms (henceforth Narasimham Committee), were set up to leverage these changes to create a strategy for future growth. To rebuild foreign exchange reserves, and begin the implementation of market reforms, the new government devalued the Rupee by 23% against the dollar.\(^7\) The Rangarajan committee suggested the introduction of a floating exchange rate, and current account convertibility. As recommended by the Narasimham committee, the government also decided to deregulate interest rates, and allowed prices to be determined by the market. Credit controls were withdrawn, and there was a decrease in the reserve requirements.\(^8\) Entrepreneurship was allowed to thrive when the barriers to entry were lowered, even though many industries remained under government control. The financial industry was given special attention because of its central role in promoting investment to drive future growth. The state-owned banks were consolidated, and Development Finance Institutes that supplied directed


credit were abolished or converted into commercial banks. This paved the way for increased private competition, and the entry of foreign banks. Foreign investment in India was encouraged as a result of more conducive laws, lower barriers to entry, and the convertible Rupee. For example, foreign controlling interest of businesses in India was allowed, for the first time, in high priority industries and export driven companies. In November 1992, the National Stock Exchange (NSE) was incorporated in order to implement international best practices in secondary markets. The NSE provided investors exposure to Capital Markets (Equity) and Wholesale Debt Markets. The Narasimham committee recommended that the Reserve Bank of India be made the sole monetary and banking authority, independent of government intervention. In order to ensure well-rounded reforms, a recently set up regulatory body was given full statutory power under the Securities and Exchange Board of India (SEBI) Act of 1992. SEBI’s role was modeled on the United States’ SEC, with a function to “protect the interests of investors in securities and to promote the development of, and to regulate the securities market.”

Since the effort to introduce free market policies in India, there have been incremental changes in the structure of the financial sector. Today it is a curious contradiction between international best practices and archaic rules. Although India is still an emerging market, some ascribe its step-by-step growth strategy to its resilience against global financial crises. On the other hand, the continuing lack of transparency in certain peculiar financial instruments has served as a conduit for political corruption. This paper examines the effect of one such opaque instrument, Participatory Notes. The next section discusses the prime users of these instruments, Foreign Institutional Investors.

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Foreign Institutional Investor (FII)

After the collapse of the “Licence Raj”, India realized that it was time to globalize. In his 1991 interim budget speech, Finance Minister Dr. Manmohan Singh said, “we have now reached a stage in development where we should welcome, rather than fear, foreign investment.”

Although the official commencement date was 14th September 1992, FII inflows began in January 1993.

Today, there are multiple avenues for foreigners to invest in India. These can be categorized as Direct Investment, Portfolio Investment, Depository Receipts, External Commercial Borrowing (ECB), and External Assistance.

Direct Investment is defined as equity investments in Indian companies without using the stock markets. It is divided into investments in listed companies, called Foreign Direct Investment (FDI), and unlisted companies called Foreign Venture Capital Investment (FVCI). FDI can be subdivided into two investment routes, the Automatic Route and the Government Route. As one can infer from their names, the latter requires approval from the Government whereas the former has pre-existing procedures for investment. Depository Receipts are derivatives that map the movement of Indian stocks on foreign stock exchanges. Indian companies issue these receipts, which do not have any end-user restrictions. ECB is method of investment that allows Indian companies, both private and public, to raise money internationally. This includes bank loans, trade credit, and other securitized instruments. External Assistance is aid that India receives from foreign governments. Portfolio Investment is defined as investments in India through the stock market or mutual funds. There are three classifications of portfolio investors. The first, and

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http://www.indiabudget.nic.in/bspeech/bs199192.pdf
newest is a Qualified Foreign Investor (QFI). QFIs are defined as non-Indians who are residents of Financial Action Task Force countries, and are required to have a Memorandum of Understanding (MoU) with SEBI through their country.\textsuperscript{13} This is a recently introduced catchall category for individuals who are not registered through other routes, but can accept Indian tax obligations.\textsuperscript{14} The second type of investor is a Non-Resident Indian (NRI) or a Person of Indian Origin (PIO). The Indian government officially assigns these self-explanatory terms to people who possess NRI or PIO identification cards. People from both these categories are allowed to own a maximum of 5\% of an Indian company.\textsuperscript{15} They are also allowed to invest in government securities and corporate debt.

The third, and biggest category by Assets Under Custody (AuC), is the Foreign Institutional Investor (FII). In order to be considered as an FII, applicants need to have a proven track record and be overseen by their respective regulatory authority. Although there are exceptions to that rule, FII’s are generally one of the following institutions: university funds, endowments, foundations, charitable trusts, pension funds, mutual funds, investment trusts, insurance firms, reinsurance firms, international or multilateral organizations or one of its agencies, or a Foreign Governmental Agency. It could also be “an asset management company, investment manager or advisor, bank or institutional portfolio manager, established or incorporated outside India and proposing to make investments in India on behalf of broad based funds\textsuperscript{16} and its proprietary funds, if any.”\textsuperscript{17} As of the 30\textsuperscript{th} of November 2012, 1752 FII’s are

\textsuperscript{14} ibid
\textsuperscript{15} ibid
\textsuperscript{16} Broad based fund is defined as one with a minimum of 20 investors, in which the majority shareholder owns less than 49\%
\textsuperscript{17} Securities And Exchange Board Of India (Foreign Institutional Investors) Regulations, 1995. www.sebi.gov.in/acts/act07a.html
registered with SEBI.\textsuperscript{18} Not only do FIIs trade for themselves, but they also trade for their clients, who are known as sub-accounts. These sub-accounts do not have to be regulated to be able to register with SEBI. On the contrary, High Net Worth (over $50 mil)\textsuperscript{19} Individuals can register as sub-accounts. On November 30\textsuperscript{th} 2012, SEBI had 6306 sub-accounts registered.

SEBI limits and regulations on FIIs have been amended and relaxed over time. In 1998 FIIs were first allowed access to the debt market. There are also some restrictions on the investments that FIIs, and their sub-accounts, can make. Foreign Corporates and Foreign Individuals are allowed to invest up to 5% of a company’s paid-up capital. FIIs are allowed to invest 10% for themselves, and for all the other types of sub-accounts. Including all their sub-accounts, FIIs are not allowed to hold more than 24% of the total firm capital.\textsuperscript{20} This limit can be lifted up to the statutory limit, on the behest of the Board of Directors of the company in question. As of today, there are over 290 Indian companies in which FIIs own over 30% of the paid-up capital.\textsuperscript{21}

\textsuperscript{18} http://www.sebi.gov.in/sebiweb/investment/FIITrendsNew.jsp
\textsuperscript{19} Securities And Exchange Board Of India (Foreign Institutional Investors) Regulations, 1995. www.sebi.gov.in/acts/act07a.html
\textsuperscript{21} List of Foreign Investment in Indian Companies. RBI. http://www.rbi.org.in/scripts/BS_FiiUSer.aspx
Figure 1: Net Investments by, and Number of FIIs Registered from 2000-2010

Participatory Notes (PN)

In December 2007, Assets under Management of FIIs nearly doubled year-over-year. Although this would normally be a reason to rejoice, almost 50% of FII flows in the previous two years were through an opaque financial instrument known as a Participatory Note. This section introduces and defines this instrument, and weighs its advantages against its disadvantages. 23

PNs are a type of Offshore Derivative Instrument (ODI), and are unique to a few Asian countries, including India. The SEBI (FII) Regulations defines an ODI as an instrument “which is issued overseas by a foreign institutional investor against securities held by it that are listed or proposed to be listed on any recognised stock exchange in India.” 24 These ODIs can also be issued against derivatives, resulting in leveraged exposure to the Indian Stock Market. 25 Although there are other ODIs like equity-linked notes and capped return notes, PNs are the most common type of ODI. 26

PNs became a conduit for international investment in India since their inception around 1992. 27 In spite of the fact that the official rules on FIIs were released in 1995, these instruments were attractive for investors who were apprehensive, yet interested to enter the emerging Indian market. Theses instruments provide easy access to the Indian market. If an investor would like to

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buy securities or derivatives, he sends his order to the FII. This FII then conveys that order to his broker in India, who actually buys the securities. In return, PNs are issued to the FII, who then passes them on to its clients. Apart from its ease of use, there are other factors that made a case for the creation of PNs. These instruments were freely tradable, which provided liquidity in the market. This liquidity was much required in the recently and partially liberalized Indian market. Participatory Notes provided a method for Mauritian individuals and companies to take advantage of the zero Capital Gains Tax accorded by the Double Taxation Avoidance Agreement (DTAA). Investing through this instrument also significantly lowered the cost of entry into the Indian markets. Some of these costs include, the money required to establish broker or bank relations, costs associated with FII registration and subsequent disclosures, and costs associated with foreign exchange.

In the context of the aforementioned cost advantages over FIIs, one can deduce the higher premium of an individual transaction through PNs versus FIIs. Similarly, some of the other advantages of PNs are just one side of a double-edged sword.

The first issue with PNs was the capital gains tax arbitrage opportunities that were created as a result of the DTAA. Onshore investors had to pay taxes up to 40% on short-term capital gains, compared to 0% in Mauritius. This led to an increase in the number of offshore investors.

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28 N., Nikhil Kumar, Implications of Hedge Funds on the Indian Capital Market (August 20, 2007)
29 “White Paper on Black Money.” Ministry of Finance, Department of Revenue, India. 2012, pg 27
32 N., Nikhil Kumar, Implications of Hedge Funds on the Indian Capital Market (August 20, 2007)
firms that registered in the country. Additionally, certified residents of Mauritius also had to pay minimal corporate tax, and therefore companies began routing their investments in India through Mauritius.\textsuperscript{33} Between April 2000 and March 2011, Mauritius (41.8\%) and Singapore (9.17\%) accounted for over half of the cumulative FDI in India.\textsuperscript{34} These disproportionate inflows occur even though 8 years of the data set is cut out, and some arbitrage opportunities were nullified by 2004, through the decrease in the tax rate on Indian onshore Capital Gains and the increase in the cost of setting up an establishment in Mauritius.\textsuperscript{35}

An organization that was against PNs from the start was the RBI. In its dissent of the Expert Group on FIIs, the RBI suggested winding down all PNs and ceasing further issues. They said that the suspicious and anonymous nature of the cash flows should be reason enough to shut PNs down. The anonymity could get further magnified once PNs are traded between foreign investors through a process they call “multi-layering.”\textsuperscript{36} This made it almost impossible to monitor entry into the Indian Market. In 2004, SEBI passed directives to curb these issues. They decreed that PNs could only be issued to regulated bodies. However, it was downplayed as a mere strengthening of Know Your Client (KYC) norms.\textsuperscript{37} SEBI rejected RBI’s proposal to ban PNs because they believed the financial community would have seen it as a recessive measure.\textsuperscript{38}

One problem that the government did not fix during the 2004 amendment was the plausibility of “Round-tripping.” Round-tripping is the process by which tax-free illicit or black

\begin{itemize}
\item \textsuperscript{33} Singh, Manmohan. Use of Participatory Notes in Indian Equity Markets and Recent Regulatory Changes. Vol. 7. International Monetary Fund, 2007.
\item \textsuperscript{34} “White Paper on Black Money.” Ministry of Finance, Department of Revenue, India. 2012.
\item \textsuperscript{35} Singh, Manmohan. Use of Participatory Notes in Indian Equity Markets and Recent Regulatory Changes. Vol. 7. International Monetary Fund, 2007.
\item \textsuperscript{36} RBIs dissent to EG. “White Paper on Black Money.” Ministry of Finance, Department of Revenue, India. 2012. Annex IV
\item \textsuperscript{37} Press Release, Securities and Exchange Board of India, January 23\textsuperscript{rd}, 2004
\end{itemize}
money leaves India through illegal routes, and is then repatriated to the country with minimal fees. Since the official definition of regulated bodies includes an “individual or entity” whose investment advisory is regulated, PNs provide a perfect path to bring prodigal money back into the country. The least probable issue, although still plausible, is the use of PNs by terrorists. High net worth terrorists could purchase PNs through their asset managers, and then gift the notes as payment, without paying any tax on the transfer. In spite of a longitudinal cross-section of society raising concerns about Participatory Notes, they are still traded in the market today. Therefore, to completely understand the situation today, it is important to be cognizant of the regulatory past.

**Regulatory timeline**

Participatory notes have caused friction with regulators in the countries that it exists. Taiwan introduced strong disclosure requirements for PNs in December 1999, but they rescinded those regulations 6 months later. The rules on PNs in India have been shaped by the regulatory changes in the past. The idea of an offshore instrument for investment in Indian securities probably stems from the Double Taxation Avoidance Agreement with Mauritius. However, PNs first came into existence when the economy opened up in 1992. In conjunction with the Foreign Exchange Regulation Act (FERA) of 1973, the Government of India guidelines released

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on 14th September 1992 provided a framework for foreign investment in India.\textsuperscript{42} The official guidelines for PNs came out in 1995 as part of SEBI's rules on FIIs.

Since then there have been a number of amendments to the rules, but only a few of them have significantly affected PNs.

The first major amendment was probably made in January 2004. The RBI had voiced its issues with PNs in 2003. It believed that the opacity, and the ease of acquiring, of these instruments created more risk than benefit for the economic stability of India. Since the end-user of this instrument was unknown, it could be used not only for fraudulent purposes but also for malicious purposes, as detailed above. In order to alleviate these qualms, SEBI decided to install robust Know Your Customer (KYC) norms. They also stipulated that FIIs could only issue them to other “regulated”\textsuperscript{43} entities. In spite of these changes, the PN volumes continued to rise until more than half of FII assets were in the form of PNs. These high volumes proved a cause for concern because PNs were highly attractive instruments even though SEBI controlled the anonymity of the instrument. The increase in companies routing their investments through Mauritius alluded to the fact that investors were taking advantage of the tax arbitrage opportunities presented by PNs. Regulators were also worried simply about the high volumes, because a mass international exodus from the Indian stock markets could have a major impact on the market, possibly affecting domestic investor confidence. On October 26\textsuperscript{th}, 2007, SEBI issued a statement in regard to curbing PN flows. These measures were implemented in the amendment made on 22\textsuperscript{nd} May 2008. There were three fundamental changes these measures made. Firstly, sub-accounts were disallowed from issuing PNs. Secondly, PNs on derivatives had to be

completely wound up by 2009. Thirdly, there was a 40% ceiling imposed on PNs as a percent of the total AuC. Fourthly, companies that were below this ceiling were allowed to increase their percentage of PNs by a maximum of 5% each year.\textsuperscript{44} These complicated norms created a sense of unease within foreign investors, and they began to offload more than just their PNs issued on derivatives. Although this could be explained as the unraveling of derivative included strategies such as a Protective Put, SEBI decided to rectify the changes made in May. Apart from sub-accounts not being able to issue PNs, all other changes were revoked.\textsuperscript{45} In 2012 the government decided to cut down the time lag on reporting PN transactions from 6 months to 10 days.

Although PNs are not close to the levels of 2007, they have been increasing in numbers recently. In light of this fact, it is important to understand the effects of this instrument on the stability of the Indian Rupee.

\textsuperscript{44} Securities And Exchange Board Of India (Foreign Institutional Investors) Regulations amendment 22\textsuperscript{nd} May, 2008. www.sebi.gov.in/acts/act07a.html
\textsuperscript{45} Securities And Exchange Board Of India (Foreign Institutional Investors) Regulations amendment 10\textsuperscript{th} Oct, 2008. www.sebi.gov.in/acts/act07a.html
**Literature Review**

The Narasimham committee of 1991 suggested against allowing investments from NRIs because of the volatility associated with those cash flows.\(^{46}\) However, they offer no empirical evidence confirming this volatility. The Narasimham committee suggested against NRI flows out of skepticism caused by the mass outflow of NRI investments right before the 1992 Balance of Payments crisis. Ironically, instruments still exist today, which could have more volatile cash flows than the NRI flows. Before we understand the effects of those specific instruments, it is important to understand the overarching effects of FIIs on the Indian stock market. Rai and Bhanumurthy\(^{47}\) used monthly data to determine that equity returns are the main determinants of FII investment. Dhiman\(^{48}\) confirmed their findings when he concluded that the average daily returns of the NSE granger caused the daily purchase to sales ratio of FIIs. Mohan\(^{49}\) pointed out that FII flows accounted for 69% of all foreign investment in India, as compared to an average of 20% for developing countries. He predicted that FII flows were more volatile than FDI flows, thus leading to a greater relative volatility in Indian markets as compared to other emerging markets. However, using an event study methodology in his other study, Mohan\(^{50}\) found that on the contrary FII flow volatility did not systematically affect the stock market. He cited the “Black Monday” crash of May 2004 when the stock market was resilient to an eight-sigma volatility, in

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spite of FII outflows. Therefore it seems that FII outflows do not create enough instability to result in a mass sell-off in the Indian market.

The one way that FIIs create weakness in the Indian economy is through the exchange rate. According to Chandrasekhar⁵¹ large FII inflows lead to an appreciation of the Rupee, hurting the exports of the country, even though it makes imports cheaper. Conversely, large FII outflows depreciate the value of the Rupee, increasing exports and making imports more expensive. In order to mitigate the rise in Rupee, the RBI buys foreign exchange. However, this affects their ability to control domestic money supply. In order to avoid this problem, before 2006, the RBI would sell government securities equal to the value of foreign exchange purchased. The Lahiri Report⁵² raises concerns about the enhanced volatility of PN flows. It claims that individuals, who determine their own entry and exit and usually have shorter investment horizons than investment funds, are able to hold PNs. Further, Singh⁵³ states that regulators attribute the cause of the May 2004 and the May/June 2006 FII sell-offs to an initial sell-off from PN investors.

As a result of its ability to drive other FII flows, PN flows should contribute to a greater change in the Indian Rupee exchange rate than other FII inflows. Vasudevan⁵⁴ states that there has been no empirical analysis done on the vulnerability of PN cash flows, but unfortunately

doesn’t go on to do any himself. There is very little research about the effect of PNs, specifically, on the Indian Rupee.

The aim of this paper is to clarify the beliefs about PNs and verify whether it truly creates more exchange rate volatility than other FII flows.
Data and Methodology

The data used in this empirical study is monthly time-series data from September 2003 to September 2012. Monthly data was used over quarterly or yearly data because it was the highest frequency of data that was available. This high frequency of data was preferred because it maps the regulatory changes and the movement of the exchange rate as closely as possible. The variables involved in this empirical study are described below. These variables were selected to try and explain the movement of the exchange rate while controlling for confounding factors. Individual descriptions and details for the variables are stated below.

United States Dollar/Indian Rupee Exchange Rate (USDINR):

This variable is the nominal exchange rate between the US Dollar and the Indian Rupee. It was sourced from the Global Financial Database. It is the dependent variable in the regression. It would be an appropriate measure of currency strength because the performance of the Indian Rupee is practically always compared to the US Dollar. Similarly, it is also preferred to the real exchange rate because the nominal exchange rate decides transactions. It was preferred to the trade-weighted exchange rate because it is easier to isolate all other effects of just one country, and hence understand the variables that affect the strength of the INR. The change in USDINR was calculated using the following formula:

\[ ch_{USDINR} = \frac{\ln USDINR_m}{\ln USDINR_{m-1}} - 1 \]

where \( m \) is the current month. Closing values at month-end were used.
**United States Dollar Spot Index (USDXY):**

USDINR can be affected by changes in both India and the United States. Therefore, the USDXY variable is introduced to control against changes in the US Dollar. This variable represents the index that measures the strength of the US Dollar against a basket of six other major currencies, not including the Indian Rupee. The change in USDXY was calculated using the following formula:

$$c_{chUSDXY} = \frac{\ln USDXY_m}{\ln USDXY_{m-1}} - 1$$

where $m$ is the current month. Closing values at month-end were used.

**Consumer Price Index (CPI):**

CPI is the total value of the average basket of goods required by a consumer. The percent change in this number relates to the Inflation for the country. This variable is used to measure the real effects on the dependent variable, separate from inflation. Data for this was sourced from the Bureau of Labor Statistics for the United States and from the Labour Bureau for India. Inflation is given by the formula:

$$Inflation = \frac{CPI_m}{CPI_{m-1}} - 1$$

where $m$ is the current month. Closing values at month-end were used.

**Total Value of Participatory Notes (TVPN):**

This variable represents the total monetary value of PNs in Rupees Crore (10 million). It is the most important independent variable in this regression. This variable was the restricting variable in the regression, because data was only available from September 2003 onwards. This
data was derived from the SEBI website. The change in TVPN was calculated using the following formula:

\[ c_{HTVPN} = \frac{\ln TVPN_m}{\ln TVPN_{m-1}} - 1 \]

where \( m \) is the current month. This change represents the net PN flows each month.

**Assets under Custody, Foreign Institutional Investors (AUCFII):**

This variable represents the total value of Assets Under FII Custody. The data for this variable is also sourced from the SEBI website, and has the same restriction as the data for TVPN.

**AUCFII excluding PNs (AUCNPN):**

This variable is derived by the following formula: \( AUCNPN = AUCFII - TVPN \)

Since it is formed from restricting variables, AUCNPN is also restricted. It is used in this specific way in order to view all other FII investments as separate from PN investments.

The change in AUCNPN was calculated using the following formula:

\[ cHAUCNPN = \frac{\ln AUCNPN_m}{\ln AUCNPN_{m-1}} - 1 \]

where \( m \) is the current month. Similar to TVPN, the change represents the net AUCNPN flows for each month.

**Broad Money (M3):**

Broad Money is defined as the sum of currency with the public, demand deposits time deposits and other deposits with the RBI. An increase in broad money increases the Rupee
supply in the Market, and vice versa. The change in Reserve was calculated using the following formula:

\[ chM3 = \frac{\ln M3_m}{\ln M3_{m-1}} - 1 \]

where \( m \) is the current month. The data was sourced from the online RBI database.

**RBI Government Securities Turnover (RBI):**

Open Market Operations are the market operations conducted by the Reserve Bank of India by way of sale/purchase of Government securities to/from the market with an objective to adjust the rupee liquidity conditions in the market on a durable basis. 55 A sale of securities increases the Rupee liquidity in the Market, and vice versa. This variable takes into consideration the effect of sterilization mentioned in the PN section. The absolute value of turnover was used, and the data was sourced from the online RBI database.

**Note:** Broad Money and government securities turnover is reported every week and thus there is lead or lag in the time of the data by 1-2 days. However, I do not perceive this to be a big issue, because the securities are sold every Wednesday, and the data is reported every Friday.

---

Table 1: Summary Statistics - Variables of Interest

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>chUSDINR</td>
<td>109</td>
<td>0.0003673</td>
<td>0.0063485</td>
<td>-0.0172543</td>
<td>0.0177713</td>
</tr>
<tr>
<td>chUSDXY</td>
<td>109</td>
<td>-0.0002915</td>
<td>0.0058287</td>
<td>-0.0153525</td>
<td>0.0171213</td>
</tr>
<tr>
<td>chTVPN</td>
<td>109</td>
<td>0.0016573</td>
<td>0.0113841</td>
<td>-0.035618</td>
<td>0.03202</td>
</tr>
<tr>
<td>chAUCNPN</td>
<td>109</td>
<td>0.0019653</td>
<td>0.0075043</td>
<td>-0.0229478</td>
<td>0.0211312</td>
</tr>
<tr>
<td>chM3</td>
<td>109</td>
<td>0.0012645</td>
<td>0.00106061</td>
<td>-0.000453</td>
<td>0.0056467</td>
</tr>
<tr>
<td>dchM3</td>
<td>108</td>
<td>-3.85e-07</td>
<td>0.0015368</td>
<td>-0.0052324</td>
<td>0.003895</td>
</tr>
<tr>
<td>Inflation</td>
<td>109</td>
<td>0.0060322</td>
<td>0.0092756</td>
<td>-0.0389292</td>
<td>0.0457516</td>
</tr>
<tr>
<td>dInflation</td>
<td>108</td>
<td>0.0000433</td>
<td>0.0119457</td>
<td>-0.0407474</td>
<td>0.0389292</td>
</tr>
<tr>
<td>RBI</td>
<td>109</td>
<td>54.81645</td>
<td>102.3259</td>
<td>0.35</td>
<td>542.79</td>
</tr>
<tr>
<td>dRBI</td>
<td>108</td>
<td>-0.3507408</td>
<td>93.57357</td>
<td>-329</td>
<td>480.24</td>
</tr>
</tbody>
</table>
Analysis

Note: Appendix A is a STATA supplement to the analysis.

One of the first tests that needs to be conducted with time-series data is a test for stationary data. This kind of test is also called a unit root test. A unit root occurs when a specific event in history creates a systematic effect on the regressand. If this effect is not controlled for, a “spurious” regression could occur. This could manifest itself as a high $R^2$, even if the variables are uncorrelated.

In order to check for this problem, an Augmented Dickey-Fuller test was performed. This test is preferred to the basic Dickey-Fuller test because it takes into consideration the lagged changes in in the variable. Since the data had monthly frequency, a lag of 12 periods was used. The null hypothesis was that a unit root exists, and the alternative hypothesis stated that it didn’t exist.

Table 2: Augmented Dickey-Fuller Test Results

<table>
<thead>
<tr>
<th>Number</th>
<th>Variable</th>
<th>Test Statistic</th>
<th>MacKinnon P-Value</th>
<th>Stationary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>chUSDINR</td>
<td>-3.514</td>
<td>0.0076</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>chUSDXY</td>
<td>-4.596</td>
<td>0.0001</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>chTVPN</td>
<td>-2.703</td>
<td>0.0736</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>chAUCNPN</td>
<td>-3.167</td>
<td>0.0220</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>chM3</td>
<td>-1.990</td>
<td>0.6067</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>RBI</td>
<td>-2.666</td>
<td>0.2503</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>Inflation</td>
<td>-2.360</td>
<td>0.4013</td>
<td>No</td>
</tr>
</tbody>
</table>
The test was significant at the 5% threshold and thus I rejected the null hypothesis for variables 1-4. However, we failed to reject the null for variables 5-7, and the data was not stationary. In order to try and obtain stationary data for chM3, RBI, and Inflation, I created first differenced variables using STATA, for each one. The first difference eliminates the effect of the unit root because the persisting change between the two numbers is eliminated. The Augmented Dickey-Fuller test was run again on those differenced variables, and the results were as follows:

Table 3: Augmented Dickey-Fuller Test after First Differencing

<table>
<thead>
<tr>
<th>Number</th>
<th>Variable</th>
<th>Test Statistic</th>
<th>MacKinnon P-Value</th>
<th>Stationary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>dchM3</td>
<td>-6.988</td>
<td>0.0000</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>dRBI</td>
<td>-4.480</td>
<td>0.0002</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>dInflation</td>
<td>-5.852</td>
<td>0.0000</td>
<td>Yes</td>
</tr>
</tbody>
</table>

These first-differenced variables were significantly stationary at the 1% critical level. In order to try and decide how to proceed, one can try and examine the volatility distribution of the regressand. To meet this, chUSDINR was regressed against the other six dependent variables according to the following equation:

\[
chUSDINR = \beta_0 + \beta_1 * chUSDXY + \beta_2 * chTVPN + \beta_3 \\
* chAUCNPN + \beta_4 * dchM3 + \beta_5 * dRBI + \beta_6 \\
* dInflation + u
\]

and then u was plot against Months.
From this graph, it didn’t look like error volatility was clustered or conditionally heteroskedastic. However, this can be evaluated through a post-test. Out of the three vertical separators, the one on the left is for October 2007, which is when a PN and FII sell-off was triggered when the Indian Government announced they were going to cap the value of PNs and completely ban the sale of PNs on derivatives. The middle line represents when the government withdrew the measures in October 2008, and the one to the right represents the month after the United States “officially”\(^{56}\) came out of its recession. I expected that the exchange rate volatility would have been larger between the first two bands as a result of the fragile state of the U.S. economy and foreign inflows into India. Although there is an increase in volatility, the presence of the USDXY variable probably mitigated the clustering effect. Therefore I decided against using

\(^{56}\)According to the National Bureau of Economic Research
Autoregressive Conditional Heteroskedasticity (ARCH) or General Autoregressive Conditional Heteroskedasticity (GARCH) models to begin to fit my data.

The next logical step was to try and use the Vector Auto Regression (VAR) model. The VAR model compares each variable and its lags to all the other variables and their lags. This model is a powerful analytic tool just because it allows observation of multiple interactions. However, before running a VAR, it is important to ensure that there is no co-integration between any two series over time. Just like non-stationary data, co-integrated time series data could lead to a “spurious” regression. To prevent this from occurring, a Johansen test was administered, for which the lag had to be determined. The “varsoc” function was used in STATA to generate Akaike’s Information Criterion (AIC) and establish the lag as 1. The Johansen test was subsequently performed, with the null hypothesis stating that the time series’ were not co-integrated. The resulting trace statistic exceeded 5% for all ranks, and therefore we failed to reject the null hypothesis. The series’ were not co-integrated, and therefore the unrestricted VAR model could be implemented using a lag of 1 and 2. STATA created a system of 105 equations, in which each variable was regressed against 1 lag and 2 lags of all the other variables, and a constant. The VAR came up with several significant coefficients, some of which stood out. Four separate variables were correlated with chAUCNPN, which I thought was interesting because it alludes to the fact that the institutionalized investor develops his data from multiple sources. I also found it interesting that as expected, inflation and sometimes lagged inflation correlated with the change in USDINR and the change in M3. However, both these inferences were rendered moot by another one. All the lagged variables significantly correlated with their own variable. This reeked of autocorrelation, and hence I performed a Lagrange Multiplier test of serial correlation on the VAR. As feared, the statistic turned out to be significant at Lag 2, and I had to begin again.
Had the VAR worked without errors, there would have been some interesting relationships to analyze. The most interesting part about a VAR is that one can also observe the relationship with lagged variables. The first effect that would have been interesting to identify would be the relationship between the chTVPN and the chUSDINR variable. I would have expected the coefficient to be positive and significant at the 5% level. However, it would have been more interesting to compare the coefficients on chTVPN and chAUCNPN with respect to chUSDINR. Assuming chAUCNPN would have been significant, this comparison would have revealed whether PNs had a greater effect on the USD/INR exchange rate than all other kinds of FII flows. The lagged variable wouldn’t have revealed very much justifiable information because of the one-month frequency.

The lagged relationship between Inflation and chUSDINR, as well as RBI and chUSDINR would have been interesting to note. Assuming the relationships were significant, it would have been useful to make sure that both the lagged regressors affected the regressand with a positive coefficient.
Discussion

One of the limitations that this study had was the monthly frequency of the data. Exchange rates tend to fluctuate every day. In fact, in Balance of Trade crises, countries like India have devalued their currencies by over 20% in day. However, the fact that the data was monthly, helped keep out some of the potential outliers from the daily data.

Probably the biggest flaw in the paper is the serial or autocorrelation, notorious to time-series data. A simple Breusch-Godfrey statistic brought to light the issue that had existed right after the first regression was modeled.

Table 4: The Breusch-Godfrey LM Statistic for the Initial Linear Regression

<table>
<thead>
<tr>
<th>lags(p)</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.636</td>
<td>1</td>
<td>0.0565</td>
</tr>
</tbody>
</table>

H0: no serial correlation

After I realized my mistake, I went back and rejected the null hypothesis, and then in order to account for the serial correlation, I first-differenced the other variables. These variables were then regressed again, and another Breusch-Godfrey Statistic was found. However, this time the p-value was even greater than the initial statistic, all of which can be seen in Appendix A. I believe this effect may have occurred because of three possible reasons: the first could have been because some of the variables were already in percent changes. The second reason could have...
been the lower bound on the TVPN and AUCNPN data caused a problem to differencing. Another possible reason could have been the existence of multicollinearity between the dependent variables. If it was strong enough, and in a specific direction, it could have thrown off the standard errors by enough to make the test statistics insignificant.
Conclusion

Although my VAR test failed to provide conclusive data on the experiment, from all the data and information I have come across, PNs do not seem to have as big as an impact on the exchange rate as the Indian Media makes it out to have. Initially there was definitely a big reason to be concerned about PNs. Since the end-user was not known, there were many possible illegal uses of the instrument, as mentioned in this thesis. Let’s look at the question of illegal money re-entering the country. Although the government ends up loosing tax gains in the short term, it repatriates money back into India in the long term. In any case the government of India has set up charity schemes, through which people can begin to convert their illegal money into legal money by paying a small fee.

From the many non-empirical analyses that I had to go through before I could write this thesis, I would like to straw man two of the prominent volatility-related arguments that people make against PNs. The first is the belief that when PN investors buy stocks, they do it as speculators and not investors. This means they have an approximate investment horizon of less than a year and bet on the market moving in a certain direction in that short horizon, instead of expecting the company they invest in to do well in either case. I have two issues with that. For the sake of argument, lets assume that all PN users are speculators, the speculation can only be dangerous to the Rupee in the situation of a fear-driven, or irrational dumping of PNs. This is still no reason to bar a financial instrument. In the worlds largest democracy (by population) I pity the people who ascribe to cowardly politics instead of welcoming international competition. The second problem I have with that claim is the fact that foreigners are stereotyped as speculators. In some situations, firms may want to increase their risk exposure to India, or they may want to hedge against their currency. Either way for the most part, these decisions are well
thought of investment strategies, in riskier countries with higher costs of Capital. The second and probably biggest problem I have with PN critics is this belief of ‘Herd Mentality’ in foreign investors. There has been some scientific work linking emotionally driven economic decision-making being linked to information asymmetry, which many foreign investors in India experience. Although there might be a financial basis for this potential sell-off in the future, it does not warrant prejudice against the foreign investment community, or one of its vehicles in India today. In spite of this, in a follow-up study, if it were found that the PNs do have an adverse effect on the INR, it would be wise for the Indian government’s finance ministry to pass laws better limiting the sale and trade of PNs.
Works Cited


Position Paper on External Assistance Received by India, Government of India, Ministry of Finance, Department of Economic Affairs, New Delhi, March 2008

N., Nikhil Kumar, Implications of Hedge Funds on the Indian Capital Market (August 20, 2007)


Appendix A: STATA OUTPUT and SOME MANIPULATIONS

1.

. dfuller chUSDINR, lags(12)
Augmented Dickey-Fuller test for unit root Number of obs = 95

-------- Interpolated Dickey-Fuller --------
Test 1% Critical 5% Critical 10% Critical
Statistic Value Value Value
Z(t) -3.514 -3.517 -2.894 -2.582

MacKinnon approximate p-value for Z(t) = 0.0076

. dfuller chUSDXY, lags(12)
Augmented Dickey-Fuller test for unit root Number of obs = 95

-------- Interpolated Dickey-Fuller --------
Test 1% Critical 5% Critical 10% Critical
Statistic Value Value Value
Z(t) -4.596 -3.517 -2.894 -2.582

MacKinnon approximate p-value for Z(t) = 0.0001

. dfuller chTVPN, lags(12)
Augmented Dickey-Fuller test for unit root Number of obs = 95

-------- Interpolated Dickey-Fuller --------
Test 1% Critical 5% Critical 10% Critical
Statistic Value Value Value
Z(t) -2.703 -3.517 -2.894 -2.582

MacKinnon approximate p-value for Z(t) = 0.0736

. dfuller chAUCNPN, lags(12)
Augmented Dickey-Fuller test for unit root Number of obs = 95
### Interpolated Dickey-Fuller Test

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-3.167</td>
<td>-3.517</td>
<td>-2.894</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.0220

---

 augmented Dickey-Fuller test for unit root  

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-1.990</td>
<td>-4.051</td>
<td>-3.455</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.6067

---

 augmented Dickey-Fuller test for unit root  

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-2.666</td>
<td>-4.051</td>
<td>-3.455</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.2503

---

 augmented Dickey-Fuller test for unit root  

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-2.360</td>
<td>-4.051</td>
<td>-3.455</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.4013
. dfuller dchM3, lags(12)

Augmented Dickey-Fuller test for unit root
Number of obs = 94

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-6.988</td>
<td>-3.518</td>
<td>-2.895</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller dRBI, lags(12)

Augmented Dickey-Fuller test for unit root
Number of obs = 94

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-4.480</td>
<td>-3.518</td>
<td>-2.895</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.0002

. dfuller dInflation, lags(12)

Augmented Dickey-Fuller test for unit root
Number of obs = 94

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-5.852</td>
<td>-3.518</td>
<td>-2.895</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.0000
2.

```
. reg chUSDINR chUSDXY chTVPN chAUCNPN dchM3 dInflation dRBI

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 108</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>0.002116969</td>
<td>6</td>
<td>0.000352828</td>
<td>F(  6, 101) = 15.94</td>
</tr>
<tr>
<td>Residual</td>
<td>0.002235628</td>
<td>101</td>
<td>0.00022135</td>
<td>Prob &gt; F = 0.0000</td>
</tr>
<tr>
<td>Total</td>
<td>0.004352597</td>
<td>107</td>
<td>0.000040678</td>
<td>Adj R-squared = 0.4559</td>
</tr>
</tbody>
</table>

| Coef.             | Std. Err. | t    | P>|t|  | [95% Conf. Interval] |
|-------------------|-----------|------|------|----------------------|
| chUSDINR          | 0.4747286 | 0.0832284 | 5.70 | 0.000 | 0.3096259    | 0.6398313 |
| chUSDXY           | -0.1123166| 0.0447407 | -2.51| 0.014 | -0.2010701   | -0.0235631 |
| chTVPN            | -0.2260905| 0.0698298 | -3.24| 0.002 | -0.364614    | -0.087567  |
| chAUCNPN          | -0.1968207| 0.3013988 | -0.65| 0.515 | -0.7947148   | 0.4010733  |
| dchM3             | -0.0549006| 0.0388463 | -1.41| 0.161 | -0.1319612   | 0.0221599  |
| dInflation        | 3.98e-07  | 4.93e-06  | 0.08| 0.936 | -9.39e-06    | 0.000102   |
| dRBI              | 0.0011491 | 0.0004691 | 2.45| 0.016 | 0.0002185    | 0.0020796  |
| _cons             |           |       |      |        |              |             |
```

. predict res1, r
(3 missing values generated)
3.
```
graph twoway line res1 Month
```

4.
```
.var soc chUSDINR, exog(chUSDXY chVPN chAUCPN dchM3 dRBI dInflation)
```

<table>
<thead>
<tr>
<th>lag</th>
<th>LL</th>
<th>LR</th>
<th>df</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
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<tbody>
<tr>
<td>0</td>
<td>416.162</td>
<td>.000022*</td>
<td>7.86851*</td>
<td>7.7964*</td>
<td>7.69052*</td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>416.39</td>
<td>.45564</td>
<td>1</td>
<td>0.500</td>
<td>.000023</td>
<td>-7.85366</td>
<td>-7.77125</td>
<td>-7.65024</td>
</tr>
<tr>
<td>2</td>
<td>417.232</td>
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<td>0.194</td>
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<tr>
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<td>4</td>
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<td>2.5433</td>
<td>1</td>
<td>0.111</td>
<td>.000023</td>
<td>-7.83819</td>
<td>-7.72487</td>
<td>-7.55849</td>
</tr>
</tbody>
</table>

Endogenous: chUSDINR
Exogenous: chUSDXY chVPN chAUCPN dchM3 dRBI dInflation _cons
5.

```
. vecrank chUSDINR chUSDXY chTVPN chAUCNPN dchM3 dRBI dInflation, lag(1)

Johansen tests for cointegration

Number of obs = 105
Sample: Dec 2003 - Aug 2012

<table>
<thead>
<tr>
<th>rank</th>
<th>parms</th>
<th>LL</th>
<th>eigenvalue</th>
<th>statistic</th>
<th>trace</th>
<th>critical</th>
</tr>
</thead>
<tbody>
<tr>
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<td>7</td>
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<td>.</td>
<td>726.6484</td>
<td>124.24</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>1529.2217</td>
<td>0.80987</td>
<td>552.3411</td>
<td>94.15</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>1598.607</td>
<td>0.73330</td>
<td>413.5705</td>
<td>68.52</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>1655.3586</td>
<td>0.66074</td>
<td>300.0672</td>
<td>47.21</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>47</td>
<td>1707.673</td>
<td>0.63082</td>
<td>195.4384</td>
<td>29.68</td>
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</tr>
<tr>
<td>5</td>
<td>52</td>
<td>1750.8581</td>
<td>0.56070</td>
<td>109.0683</td>
<td>15.41</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>55</td>
<td>1781.8147</td>
<td>0.44548</td>
<td>47.1551</td>
<td>3.76</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>56</td>
<td>1805.3922</td>
<td>0.36180</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

6.

```
. var chUSDINR chUSDXY chTVPN chAUCNPN dchM3 dRBI dInflation dRBI, lag(1 2)

Vector autoregression

Sample: Dec 2003 - Sep 2012
No. of obs = 106
Log likelihood = 1859.864
AIC = -33.11065
FPE = 9.97e-24
HQIC = -32.04133
SBIC = -30.47234

<table>
<thead>
<tr>
<th>Equation</th>
<th>Parms</th>
<th>RMSE</th>
<th>R-sq</th>
<th>chi2</th>
<th>P&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>chUSDINR</td>
<td>15</td>
<td>.006171</td>
<td>0.2023</td>
<td>26.88937</td>
<td>0.0199</td>
</tr>
<tr>
<td>chUSDXY</td>
<td>15</td>
<td>.006102</td>
<td>0.0680</td>
<td>7.730514</td>
<td>0.9029</td>
</tr>
<tr>
<td>chTVPN</td>
<td>15</td>
<td>.010849</td>
<td>0.2323</td>
<td>32.07855</td>
<td>0.0039</td>
</tr>
<tr>
<td>chAUCNPN</td>
<td>15</td>
<td>.007423</td>
<td>0.1434</td>
<td>17.74913</td>
<td>0.2184</td>
</tr>
<tr>
<td>dchM3</td>
<td>15</td>
<td>.001276</td>
<td>0.4019</td>
<td>71.22096</td>
<td>0.0000</td>
</tr>
<tr>
<td>dInflation</td>
<td>15</td>
<td>.010497</td>
<td>0.3389</td>
<td>54.34967</td>
<td>0.0000</td>
</tr>
<tr>
<td>dRBI</td>
<td>15</td>
<td>86.062</td>
<td>0.2591</td>
<td>37.06522</td>
<td>0.0007</td>
</tr>
</tbody>
</table>
```
| chUSDINR | Coef. | Std. Err. | z    | P>|z| | [95% Conf. Interval] |
|----------|-------|-----------|------|------|----------------------|
| chUSDINR |       |           |      |      |                      |
| L1.      | .2460982 | .1312475 | 1.88 | 0.061 | -.0111422 -.5033386 |
| dInflation | .1772865 | .0546875 | 3.24 | 0.001 | .0701011 .284472   |
| chUSDXY  |       |           |      |      |                      |
| chTVVPN  |       |           |      |      |                      |
| L1.      | -.1132866 | .0606831 | -1.87 | 0.062 | -.2322233 .00565   |
| chTVVPN  |       |           |      |      |                      |
| chUSDINR |       |           |      |      |                      |
| L1.      | -.7192643 | .2307454 | -3.12 | 0.002 | -1.171517 -.2670116 |
| _cons    | .0019712 | .0011028 | 1.79 | 0.074 | -.0001902 .0041326 |
| chAUCNPN |       |           |      |      |                      |
| chUSDINR |       |           |      |      |                      |
| L2.      | .3280637 | .1669265 | 1.97 | 0.049 | .0008939 .6552336  |
| chUSDXY  |       |           |      |      |                      |
| L2.      | -.2620619 | .1433322 | -1.83 | 0.067 | -.5429878 .0188639 |
| chTVVPN  |       |           |      |      |                      |
| L1.      | .1743466 | .0738202 | 2.36 | 0.018 | .0296617 .3190316  |
| _cons    | .0016634 | .0007545 | 2.20 | 0.027 | .0001846 .0031422  |
| dchM3    |       |           |      |      |                      |
| dchM3    |       |           |      |      |                      |
| L1.      | -.6366976 | .092386 | -6.89 | 0.000 | -.8177709 -.4556243 |
| L2.      | -.260749 | .0883822 | -2.95 | 0.003 | -.4339745 -.0875236 |
| dInflation |       |           |      |      |                      |
| L1.      | -.0382377 | .0113071 | -3.38 | 0.001 | -.0603992 -.0160763 |
| L2.      | -.0293989 | .0121867 | -2.41 | 0.016 | -.0532844 -.0055133 |
| dInflation |       |           |      |      |                      |
| dInflation |       |           |      |      |                      |
| L1.      | -.5587198 | .0930255 | -6.01 | 0.000 | -.7410464 -.3763932 |
| L2.      | -.2799954 | .1002627 | -2.79 | 0.005 | -.4765067 -.083484  |
7.

**. varlmar**

Lagrange-multiplier test

<table>
<thead>
<tr>
<th>lag</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>58.6423</td>
<td>49</td>
<td>0.16281</td>
</tr>
<tr>
<td>2</td>
<td>64.5057</td>
<td>49</td>
<td>0.06785</td>
</tr>
</tbody>
</table>

H0: no autocorrelation at lag order

8.

**. bgodfrey**

Breusch-Godfrey LM test for autocorrelation

<table>
<thead>
<tr>
<th>lags(p)</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.636</td>
<td>1</td>
<td>0.0565</td>
</tr>
</tbody>
</table>

H0: no serial correlation
9.

```
. reg dchUSDINR dchUSDXY dchTVPN dchAUCNPN d2M3 d2Inf d2RBI, noc

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 107</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>.003496127</td>
<td>6</td>
<td>.000582688</td>
<td>F( 6, 101) = 16.71</td>
</tr>
<tr>
<td>Residual</td>
<td>.003521833</td>
<td>101</td>
<td>.00003487</td>
<td>Prob &gt; F = 0.0000</td>
</tr>
<tr>
<td>Total</td>
<td>.00701796</td>
<td>107</td>
<td>.00065588</td>
<td>Adj R-squared = 0.4684</td>
</tr>
</tbody>
</table>

|          | Coef.   | Std. Err. | t    | P>|t|    | [95% Conf. Interval] |
|----------|---------|-----------|------|--------|----------------------|
| dchUSDINR|         |           |      |        |                      |
| dchUSDXY | .4866393| .0715082  | 6.81 | 0.000  | .3447863 -.6284922   |
| dchTVPN  | -.0565114| .0399012 | -1.42| 0.160  | -.1356646 .0226419   |
| dchAUCNPN| -.235586 | .0591257  | -3.98| 0.000  | -.3528755 -.1182965  |
| d2M3     | -.1614567| .2231376  | -0.72| 0.471  | -.6041018 .2811884   |
| d2Inf    | -.0662863| .0291876  | -2.27| 0.025  | -.1241866 -.008386   |
| d2RBI    | -2.44e-06| 3.95e-06  | -0.62| 0.538  | -.0000103 5.39e-06   |

. bgodfrey

Breusch–Godfrey LM test for autocorrelation

<table>
<thead>
<tr>
<th>lags(p)</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.004</td>
<td>1</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

H0: no serial correlation
```