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22

*The “Trilemma of the
International Financial
System” in India*

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Summary

1. This paper provides an analysis of the situation in India where the country faces the so-called “trilemma of the international financial system” as a result of its integration with the global economy. India’s pursuit of “capital movement deregulation” and “forex market stabilization” are leading to distortions of the conduct of “independent monetary policy”.
2. Given the deregulation of capital movements from the 1990s, India’s capital balance has been following an uninterrupted rise of net capital inflows (capital inflow minus capital outflow) in recent years. In the Jul–Sep quarter of 2007, net inflows reached INR1.3 trillion, ballooning to nearly double the amount in the previous quarter. However, net capital inflows started to subside from the Oct–Dec quarter of 2007, turning to a net outflow from the Oct–Dec quarter of 2008. Such sharp fluctuations were caused mainly by the volatility of portfolio investment.
3. India’s foreign exchange rate regime is a managed float exchange regime. When there are sharp fluctuations of the rupee exchange rate, India stabilizes the exchange rate through forex market interventions. During the period from 2007 to the beginning of 2008, massive rupee–selling interventions were conducted in a bid to quell the dramatic surge of the rupee reflecting the expansion of capital inflows. In a sharp turnaround, massive rupee–buying interventions were conducted from the Apr–Jun quarter of 2008 to stem the sharp fall of the rupee reflecting the contraction of capital inflows.
4. While India’s monetary policy places emphasis upon the relationship between money and prices, the massive forex interventions in recent years are leading to the fluctuation of India’s money supply. For example, during the period from 2007 to the beginning of 2008, India’s liquidity provision surged along with its rupee–selling interventions. However, since India took an inflation–curbing stance at the time, it was conducting a repo rate

hike campaign. As shown by this episode, fluctuations in liquidity stemming from foreign exchange policy are giving rise to phenomena which are inconsistent with the prevailing monetary policy stance.

5. There are various views regarding the relationship between money supply and economic activity. An analysis of the Indian economy using the Vector Error Correction (VEC) model suggested that the expansion of money supply leads to the rise of wholesale prices and industrial production. In India, it was indicated that changes in money supply accompanying forex interventions may distort the independent conduct of monetary policy through their impact upon prices and the real economy.
6. Despite expectations toward India's medium- to long-term economic growth, the maintenance of the current framework regarding capital movements, foreign exchange and monetary policy will serve as a risk toward medium- to long-run macroeconomic stability. The independent conduct of monetary policy is indispensable for India's medium- to long-term macroeconomic stability. Thus, assuming that the deregulation of capital flows is a requisite condition, it will be necessary for India to review its foreign exchange policy and gradually increase the flexibility of the rupee exchange rate.

As a result of India's economic integration with the global economy in recent years, India is facing a broad set of problems referred to as the "trilemma of the international financial system" (note 1). Despite high expectations toward the medium- to long-term growth of the Indian economy, the trilemma may serve as destabilizing risks. Should India continue to pursue its current policy oriented to the deregulation of capital movements and exchange rate stability, it would eventually lead to the distortion of the independence of monetary policy management whose primary purpose is the maintenance of domestic equilibrium. In Sections 1 to 3 of this paper, the current situation in India shall be examined from the perspective of the trilemma, upon an overview of the institutional framework of India's capital movements, exchange rate and monetary policy. Finally, an empirical analysis of the impact of the changes in money supply stemming from forex market interventions upon prices (the object of monetary policy) and various macroeconomic variables shall be conducted in Section 4.

1. Capital movements and rupee supply-demand

India's economic deregulation started in the 1990s. In the course of deregulation, India eased its restrictions on capital movements. Since its independence in 1947, India's economic policy rested mainly upon self-reliance and import substitution, in essence pursuing a closed system of self-sufficiency. This stems from Jawaharlal Nehru's – India's first prime minister – emulation of the Fabian socialist movement which was spreading in the UK at the time and the Soviet-style of state planning and control over the economy. More precisely, it included state-led industrial policies (the exclusion of private enterprises from major industrial sectors and the industrial licensing policy), state intervention in the financial

sector (nationalization of banks and credit rationing etc.) and foreign exchange restrictions (note 2).

In 1991, India fell into a state of economic crisis accompanied by the rise of inflation and depletion of foreign reserves. India's inflation rate soared to double-digit highs and its foreign currency reserves dwindled to levels only enough to cover two weeks worth of the value of imports.

To address the economic crisis, the government of India commenced a program of reform and deregulation known as the "Structural Adjustment Program". In a dramatic reversal of its state-controlled economic policy pursued since its independence, the government started to promote economic deregulation including, among others, the entry of private enterprises in to major industries and the partial abolishment of the industrial licensing policy (note 3).

In terms of the deregulation of capital movements among the economic deregulation measures, India started to gradually deregulate its foreign exchange controls in the following chronological order: the deregulation of foreign direct investment (FDI) in 1991, approval of foreign institutional investors (FII) to engage in portfolio investment in 1992, and the deregulation of forex trading in the current account in 1994. Since then, the gradual deregulation of FDI and portfolio investment ensued. In particular, with respect to FDI, 100% shareholdings by nonresidents were granted automatic approval in most industrial sectors. Today, restrictions upon investment only remain in certain industrial sectors such as energy, mass media, finance, transportation, communication and retail sales from the perspective of national security and protection of domestic industries.

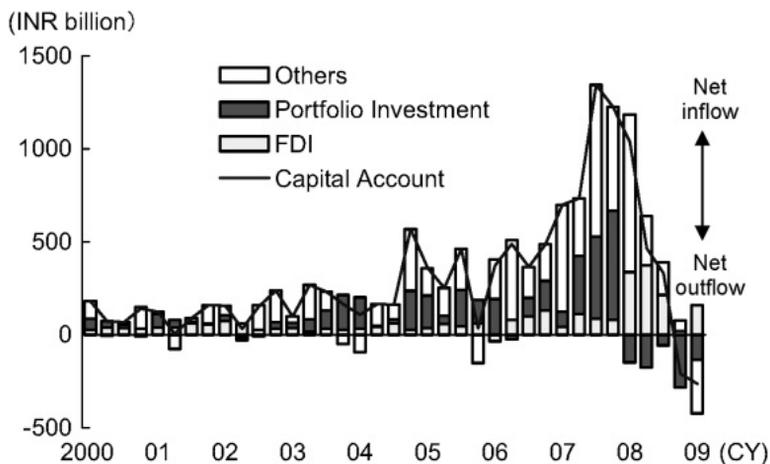
As the foregoing illustrates, foreign direct investment with the potential to generate stable inflows was deregulated first, followed by the deregulation of portfolio investment. In contrast, the government took a more cautious stance toward the deregulation of external loans (in particular short-term external loans) which entail the risks of a balance of payments crisis. Even today, the ceiling for trade credits and external commercial borrowings (ECB) are lower in

shorter maturities.

While the deregulation of capital movements led to the inflow of capital necessary for economic growth from outside the country, it also led to the vulnerability of the forex market to short-term fluctuations of capital flows. During the period from 2007 to 2008 in particular, capital inflows to India swung back from expansion to contraction mode in reflection of the sharp swing of the pendulum from a global liquidity glut to financial turmoil. The value of the rupee surged in 2007 along with the expansion of capital inflows and plunged in 2008 along with the contraction of capital inflows.

Indeed, a look at India's capital account reveals that net inflows (inflows minus outflows) expanded in 2007 (**Chart 1**). Note that in the Jul-Sep quarter, net inflows almost doubled from the previous quarter to INR1.3 trillion. However, net inflows started to contract from the Oct-Dec quarter of 2007, turning to a net outflow from the Oct-Dec quarter of 2008. Such sharp fluctuations may be attributed primarily to fluctuations in "portfolio investment".

Chart 1: Trends in India's capital account



Source: CEIC

Portfolio investment Net inflows continued to expand until the Oct–Dec quarter of 2007. In addition to the deregulation of capital movements, it appears that there were more capital inflows from outside the country in pursuit of India’s high growth opportunities (Shah and Patnaik (2008)). However, “portfolio investment” has registered net outflows for five consecutive quarters since the Jan–Mar quarter of 2008, reflecting the rising global aversion to risk along with the deepening financial crisis.

Foreign direct investment (FDI) Inflows remained sluggish until around 2007 despite deregulations including those regarding equity caps. In India, the lag in development of industrial infrastructure such as electrical power and transportation networks and the lack of preferential treatment for foreign corporations (note 4) which is commonplace in China and the ASEAN are said to be serving as obstacles to corporate expansion into India.

Others Other investments continued to expand – most notably with respect to ECB – up to the beginning of 2008. Despite the slow and cautious pace of deregulation regarding ECB (in particular short–term ECBs), Indian companies continued to increase their dependence upon foreign money. Among the plausible reasons are as follows: (1) Indian companies are expanding their funding to foreign (as well as domestic) sources in a bid to meet India’s voracious capital investment demand (note 5), and (2) India’s interest rates as a whole are higher than those of developed countries. At the moment, however, the lending stance toward Indian companies appears to be turning cautious for the same reasons set forth under “portfolio investment”. Net inflows have been contracting from the Apr–Jun quarter of 2008, turning into a net outflow in the Jan–Mar quarter of 2009.

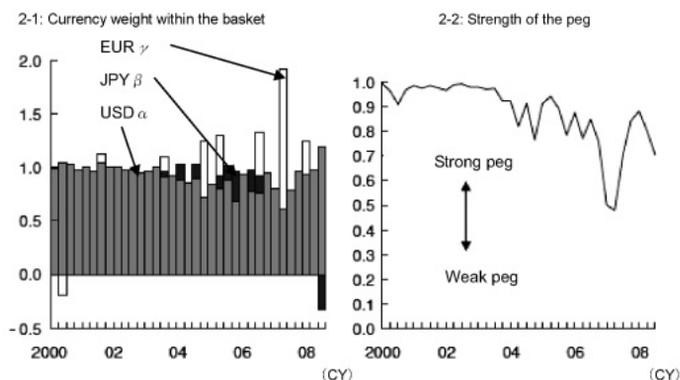
2. Market intervention by the Reserve Bank of India for foreign exchange stability and trends in money supply

The Reserve Bank of India (RBI), India's central bank, intervened aggressively in the forex market from 2007 to 2008 to address the sharp fluctuation of the rupee.

The RBI's stance toward currency intervention also underwent reform as part of the Structural Adjustment Program. According to the RBI, India is currently adopting a managed float exchange regime starting from 1993, after going through a fixed peg regime (up to 1990) and a period of currency devaluation and dual exchange rate regime (1991 to 1992) (Mohan (2006)). The managed float exchange regime tolerates free market fluctuations to a certain degree by letting the rupee exchange rate move according to demand and supply forces in the forex market. At the same time, the government also intervenes in the event of excessive fluctuations. According to the RBI's official position, the rupee exchange rate is managed for the maintenance of external competitiveness and the stabilization of foreign transactions and the domestic financial system (note 6).

In order to verify whether India's foreign currency policy is managed in accordance with the RBI's official position, the Frankel-Wei regression model was used in this paper, considering the model's wide usage as a tool for such analysis (**Chart 2**) (note 7). The results revealed that India's foreign exchange rate regime (1) possessed strong characteristics of a pegged regime from 2000 to mid-2003, and (2) the peg started to weaken from mid-2003, moving closer to a managed float exchange regime according to the RBI (note 8).

Chart 2: Verification of India's foreign exchange policy



Notes: The co-movement of the Indian rupee (INR) to fluctuations of the US dollar (USD), yen (JPY) and the euro (EUR), with the Swiss franc (CHF) as the benchmark (given its confidence as an international currency and its relatively stable market fluctuation) was calibrated by the least squares method. The Frankel-Wei function in the calibration equation is as follows. Each of the variables are first differences of logarithms of daily data and are calibrated on a quarterly basis.

$$INR/CHF = \alpha(USD/CHF) + \beta(JPY/CHF) + \gamma(EUR/CHF)$$

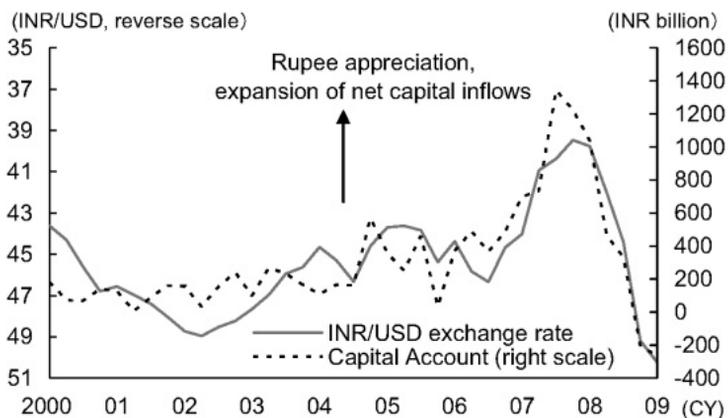
The values of α , β and γ obtained may be interpreted as the weight of the currency basket comprised of the US dollar, yen and Euro. Chart 2-1 plots quarterly calibration results for α , β and γ which are statistically significant (5% significance level). Even though there are cases which are difficult to interpret – such as negative weights and the total of the three weights surpassing a level of 1, the results more or less confirm that the weight of the US dollar is close to 1. Furthermore, Chart 2-2 represents the coefficient of determination adjusted for the degrees of freedom of the calibration results and indicates the degree of peg to the currency basket in 2-1.

Source: Datastream

The rupee exchange rate has fluctuated in reflection of capital movements confirmed under Section 1. In recent years, the rupee strengthened against the dollar along with massive capital inflows from 2004 to 2005 and from 2007 to early-2008 and subsequently lost ground to the dollar from early-2008 due to the contraction of the capital inflow (**Chart 3**). In particular, note that the rupee was subject to exceptionally volatile swings in 2007 to 2008. The rupee climbed from INR44.26/USD at the beginning of 2007 to a 10-year high of INR39.42/USD at the end of 2007 (surging at the rate of +12.3% since the beginning of the year). However, the rupee plunged from the beginning of 2008, renewing a historical-low for the first time in six years on October 22nd (INR49.31/USD) and fell further to INR50.28/USD on December 1st. Even at the end of the year 2008,

the rupee stood at a low of INR48.72/USD, recording a year-to-date rate of decline of -19.1%.

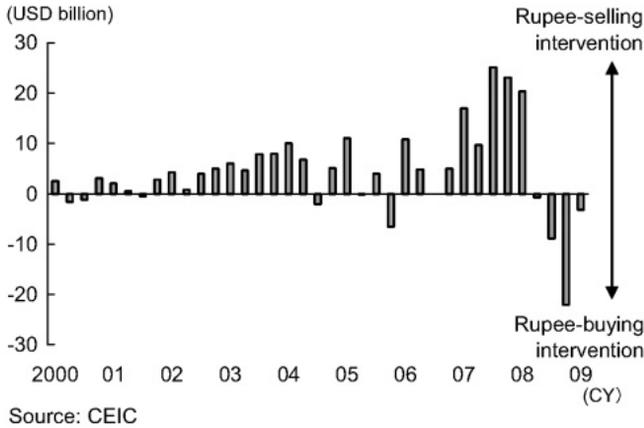
Chart 3: India's capital account and the INR/USD exchange rate



Source: CEIC

Under the current foreign exchange rate regime, currency market stabilization is provided for by market intervention in the face of sharp fluctuations of the rupee. In fact, intermittent rupee-selling interventions of approximately USD10 billion per quarter were conducted when the rupee strengthened in 2004 to 2005. Rupee-selling interventions surpassing USD20 billion/quarter were also conducted during the period from 2007 to the beginning of 2008. In a sharp policy reversal from the Apr-Jun quarter of 2008, the RBI started to conduct rupee-buying interventions to cope with the weakening of the rupee. The interventions totaled USD22 billion in the three months from October to December of 2008 (**Chart 4**).

Chart 4: Forex interventions by the RBI



3. Monetary policy and money supply

Before verifying the impact of foreign currency market interventions upon money supply, the following is a brief overview of India's monetary policy framework.

The RBI specifies in its internet website that its objective of monetary policy is to maintain price stability and ensure the adequate flow of credit to productive sectors. According to Y.V. Reddy, former Governor of the RBI, the decision on which objective to prioritize depends upon the prevailing circumstances.

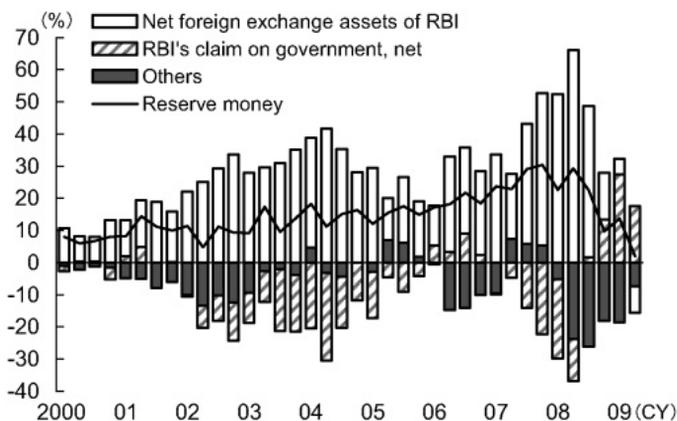
Up until the mid-1990s, the RBI used money supply (M3) as an intermediate target of monetary policy to achieve price stability. From 1998, the central bank adopted the Multiple Indicator Approach (MIA). The RBI publishes its *Annual Policy Statement* at the beginning of each fiscal year and sets forth its outlook on major macroeconomic indicators and monetary policy stance to enhance the transparency of its policy management. Among the outlooks

released are real GDP growth, wholesale price index (WPI), money supply (M3), bank credit and bank deposits. Thus, the RBI most likely keeps a close eye upon these indicators in its conduct of monetary policy (note 9).

The RBI's major policy tools include the repo rate, the reverse repo rate, and the cash reserve ratio. The repo rate is the interest rate on funds provided by the RBI to banks and the reverse repo rate is the interest rate charged when funds are absorbed in the reverse direction. The range between the repo rate (the ceiling) and the reverse repo rate (the floor) is referred to as the "corridor". It is within this range or corridor that the call rate is guided in the money market.

As set forth above, the RBI places emphasis upon the relationship between money and prices. In recent years, however, forex interventions are serving as a disruptive factor upon monetary policy because of its impact upon money supply. A look at the RBI's balance sheet reveals that reserve money (the equivalent to base money) has increased by approximately 30% y-o-y from 2007 to 2008. However, the rate of increase has slowed sharply from the second half of 2008 (Chart 5).

Chart 5: Reserve money (y-o-y change, component factors)



Source: CEIC

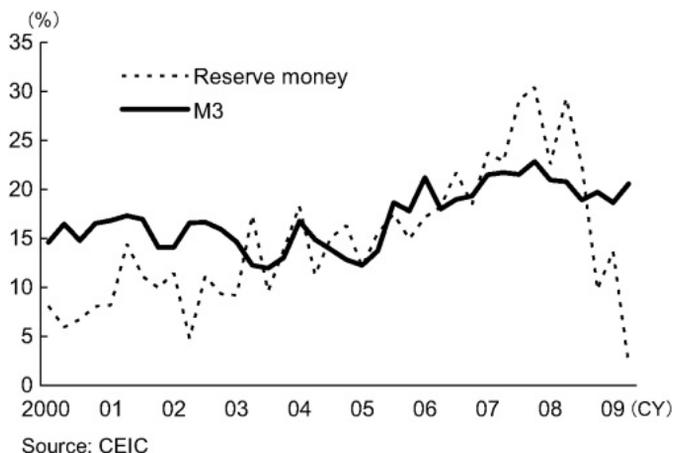
Looking closer at the year-on-year change of reserve money in terms of its component factors, it is evident that foreign currency reserves contributed to the rise of RBI's reserve money during the period around 2004 and from 2007 to mid-2008. Subsequently, the contribution by foreign currency reserves to reserve money contracted in the second half of 2008 along with the turn of market interventions from rupee-selling to rupee-buying interventions.

Even though the RBI has sterilized its interventions to neutralize the fluctuations of reserve money stemming from foreign reserve factors, the sterilizations thus far have been insufficient (note 10). Although the RBI's claim on government is deemed as a proxy variable of sterilization (Moorthy (2007)), the contribution by claim on government to reserve money is not large enough to offset the contribution by foreign currency reserves.

A comparison of 2004 with the period from 2007 to mid-2008 – both being periods when foreign currency reserves swelled sharply – shows that sterilization was insufficient in the latter period, leading to a 30% y-o-y rise of reserve money. A plausible factor to explain why the sterilizations from 2007 to mid-2008 turned out to be insufficient is the costly nature of sterilization measures (note 11). In addition, the large volume of the rupee-selling interventions may have led to difficulties for the sterilization measures to catch up with the market interventions.

The fluctuations in reserve money comprised primarily of foreign currency reserves also spread to money supply through the credit creation functions of private-sector banks. In the Oct-Dec quarter of 2007, M3 grew 22.8% y-o-y, reflecting the expansion of reserve money. Even at the end of FY2007 (March 2008), M3 growth stood at 20.9% y-o-y, surpassing RBI's outlook (+17.0 to 17.5%) at the beginning of the fiscal year (**Chart 6**) (note 12).

Chart 6: Reserve money and M3 (y-o-y change)



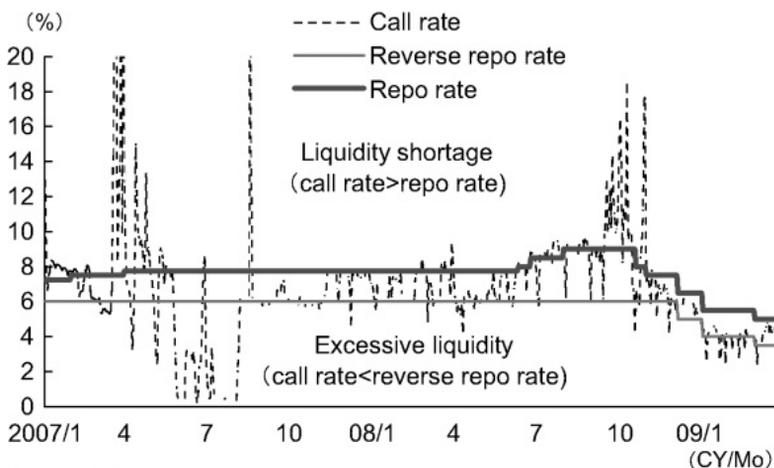
The fluctuations of money supply accompanying the forex interventions during the period from 2007 to 2008 are inconsistent with the RBI's monetary policy stance at the time.

Even though India's money supply rose along with its rupee-selling interventions during the period from 2007 to mid-2008, the RBI had placed emphasis upon curbing inflation and had been raising the repo rate (the short-term interest rate charged by the RBI when providing funds to banks) (**Chart 7**). As explained before, the range between the repo rate as the ceiling and the reverse repo rate (the short-term interest rate charged when funds are absorbed in the reverse direction) as the floor is referred to as the "corridor". The call rate is normally guided within this "corridor". Even so, the call rate frequently fell below the reverse repo rate during 2007 in reflection of excessive liquidity, with the exception of an overshoot at the end of March due to special factors (note 13).

In September to October of 2008, the global spread of the financial crisis led to tighter liquidity conditions within India, keeping the call rate higher than the repo rate. Amid such conditions, the RBI shifted its policy stance to place emphasis upon

financial stability and economic growth and stepped forward to reduce both the repo rate and the reverse repo rate. However, since the RBI also absorbed the liquidity through rupee-buying interventions, the RBI was accused of inconsistency (note 14).

Chart 7: Monetary policy rates and the call rate



4. Empirical analysis of the impact of money supply upon macroeconomic conditions

Thus far, it has been verified that capital movements affect money supply through forex interventions. Taking into consideration the various views regarding the relationship between money supply and prices (note 15), the following is an empirical analysis of whether or not the fluctuation of India's money supply actually has an impact upon prices and the real economy.

The vector autoregression (VAR) model is a widely-used

econometric model to analyze interdependencies between economic variables over multiple time series. An example of the use of the VAR model for the analysis of the relationship among macroeconomic variables such as money supply, prices and production in India is Scrimany and Samanta (1998) (Bhattacharya (2006)). More recent examples are those by Agarwal (2006) and Mitsubishi Research Institute (2006). Preceding works such as these all conclude that the increase of money supply affects the rise of prices and expansion of production in India.

Scrimany and Samanta (1998) of RBI used the three following variables to build a structural VAR model for the period from August 1991 to March 1997 (monthly): money supply (M1), the wholesale price index (WPI) and the index of industrial production (IIP). According to Scrimany and Samanta (1998), a calibration of the impulse response functions of WPI and IIP to M1 verified that M1 growth leads to the rise of the WPI and IIP.

Agarwal (2006) built a structural VAR model for two time periods from January 1985 to December 1995 and January 1996 to March 2005 using eight variables including the following: reserve money (M0), money supply (M3), WPI, IIP and the rate of interest (call rate).

According to Agarwal (2006), the impulse response function of WPI to the expansion of M0 revealed an unexpected fall of prices with respect to the latter time period. Admittedly, the graph included in the paper indicates a fall of the WPI for approximately four months following the expansion of M0. Even so, the WPI takes an upturn in the fifth to sixth month and subsequently levels out. Even though the impulse response is not exactly clear, the interpretation still holds that the increase of money supply leads to inflationary pressures upon the lapse of time.

Meanwhile, the impulse response of IIP to the expansion of M0 also revealed ambiguous results. Despite a rise during the initial one to two months, the rise was followed by a temporary dip in the third month and subsequently leveled out from the fourth month.

Mitsubishi Research Institute (2006) built a structural VAR model

for the period from the Jan–Mar quarter of 1990 to the Jul–Sep quarter of 2005 using the five following variables: M0, money supply (M2), the consumer price index (CPI), IIP and the rate of interest (3–mo interbank rate). The impulse response functions demonstrated that the rise of M0 leads to a definite rise of the CPI and IIP.

This paper also uses the VAR as a means to analyze the impact of changes in money supply upon prices and production in India.

As a framework of analysis, this paper employs the classical Aggregate Demand–Aggregate Supply (AD–AS) model. In this model, the four following variables are endogenous variables: production (Y), prices (P), money supply (M) and interest rates (R) (note 16).

The reason for the usage of the IIP stems from the analysis of monthly data instead of quarterly data in order to stabilize the results of calibration by obtaining as many samples as possible (since GDP data is only available on a quarterly basis, the IIP was selected because of its availability on a monthly basis). Furthermore, the WPI and M3 are key indicators in the Multiple Indicator Approach (MIA) to monetary policy management. The call rate is a short–term interest rate guided by the policy interest rates. All variables other than the call rate are adjusted for seasonal factors and converted into logarithms prior to analysis.

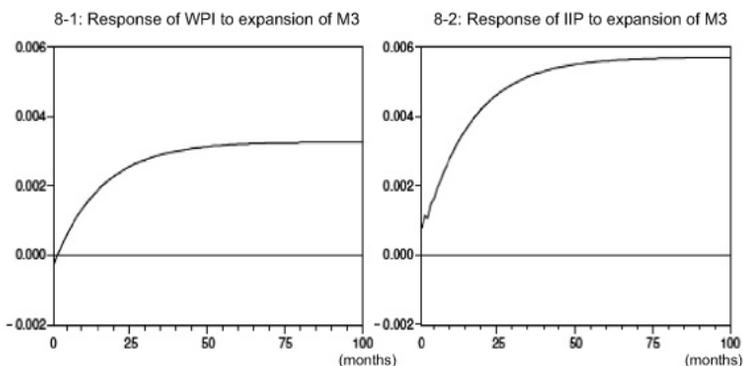
A verification of the trends in each of the variables revealed an aberrant jump of the call rate in March 2007 (note 17). Given the potential disruptive effect of outliers upon the results of analysis, the time period of analysis in this paper is limited to 72 months from January 2001 to December 2006 (note 18).

Since the type of VAR model will differ depending upon the characteristics of data sets, tests must be conducted with respect to each of the variables. Accordingly, the unit root tests and cointegration tests conducted on the four variables set forth above revealed that the variables are non–stationary and are cointegrated (note 19). In such cases, the Vector Error Correction (VEC) model is used instead of the standard VAR model.

To analyze the impact of M3 shocks upon WPI and IIP, the following calibrations were conducted: (1) a VEC model comprised of the four variables (note 20), and (2) the impulse response functions of WPI and IIP in response to M3 shocks (note 21).

As expected, the results of analysis verified that the expansion of M3 pushes up the WPI and IIP (**Chart 8**). In India, changes in money supply accompanying forex interventions have the potential to distort the conduct of independent monetary policy through its impact upon actual prices and the real economy.

Chart 8: Impulse response functions



Note: The size of the M3 shock is 1 standard deviation. Impulse responses for up to 100 months are displayed.

Source: CEIC

While the results of analysis in this paper is more or less consistent with previous works, the results possess the following characteristics: (1) the analysis spans the most recent period up to December 2006, and (2) it analyzes both M3 and WPI which are watched closely by the RBI in its conduct of monetary policy (**Chart 9**).

Chart 9: Comparison of the analysis in this paper with those of previous works

	Scrimany and Samanta (1998)	Agarwal (2006)	Mitsubishi Research Institute (2006)	This paper
Time span (end)	March 1997	March 2005	July - September 2005	December 2006
Term	Monthly	Monthly	Quarterly	Monthly
Money indicator (M)	M1	M0	M2	M3
Price Indicator (P)	WPI	WPI	CPI	WPI
Response of P to expansion of M	Rise	Unstable	Rise	Rise
Response of Y to expansion of M	Increase	Unstable	Increase	Increase

Sources: Compiled by MHRl, based upon Scrimany and Samanta (1998), Agarwal (2006) and Mitsubishi Research Institute (2006).

5. Conclusion

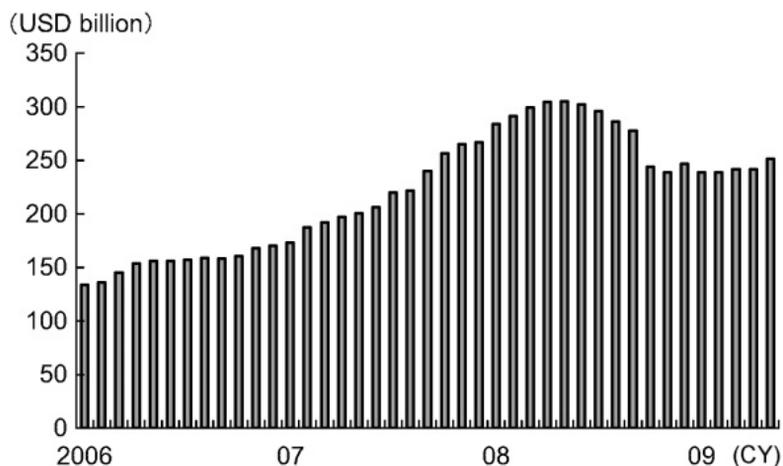
During the period from 2007 to 2008, the world experienced a sharp turn of events from a global excess of money to a global financial crisis, which led to a reversal in direction of global money which had been flowing into the emerging economies. Capital inflows to India rose in 2007 and fell in 2008. Accordingly, the value of the rupee surged in 2007 and plunged in 2008.

This paper verified the “trilemma of the international financial system”, referring to the phenomenon where changes in capital flows into India affect India’s money supply through market interventions to stabilize the forex market and ultimately distort the RBI’s conduct of monetary policy. Empirical analysis verified that money supply affects prices and the real economy.

Judging from the foregoing, even though the Indian economy faces the risks of a growing external debt repayment burden due to the fall of the rupee in 2008, the risks of India falling into a balance of payments crisis are subdued. This stems from the fact that the expansion of foreign currency reserves through the rupee-selling

interventions in 2007 is serving as “insurance” toward a balance of payments crisis (**Chart 10**). Thus, there is only a remote possibility that India will fall into an economic crisis comparable to the crisis in 1991.

Chart 10: Trends in India’s foreign currency reserves



Source: CEIC

Nevertheless, the contraction of capital inflows in the background to the sharp fall of the rupee may be perceived as a constraint upon India’s economic growth. Considering the recent trend among Indian companies to tap the capital flows into India for their robust capital investment within the country, the decline of capital inflows would serve as constraints upon investment. Amid the lingering ramifications of the global financial and economic crisis, the Indian economy may be subject to adverse effects not only from the perspective of trade but also from international finance.

Looking forward on a medium- to long-term time span, expectations toward India’s economic growth still run high due mainly to demographic factors. Thus, if global economic and financial conditions regain stability, there is the possibility that

capital flows into India would expand and reignite a rupee–strengthening scenario. If conventional rupee–selling interventions are conducted at this time, this would generate excessive liquidity as experienced in 2007, leading to concerns regarding the distortion of monetary policy which seeks to achieve price stability (note 22).

Despite the expectations toward India’s medium– to long–term economic growth, the maintenance of the current framework regarding capital movements, foreign exchange and monetary policy will serve as a risk toward medium– to long–run macroeconomic stability.

To achieve India’s medium to long–term economic growth, India faces the task to solve the “trilemma of the international financial system” and ensure the independent conduct of monetary policy. Given the deregulation of capital flows, India’s foreign exchange policy must come under review. While the maintenance of India’s global competitiveness is purportedly one of the underlying reasons for the stabilization of the rupee exchange rate, what matters in external competitiveness is not the nominal exchange rate but the real exchange rate which is adjusted for price levels. In order to maintain external competitiveness through price stability, forex interventions which jeopardize the independence of monetary policy should also be held in check.

In the medium– to long–run, it is desirable for India to review its managed float exchange regime and gradually increase the flexibility of the rupee exchange rate.

Appendix 1: the AD–AS Model in this paper

Drawing upon the works of Sugihara, Mihira, Takahashi and Takeda (2000) which analyzes the impact of monetary policy in Japan using the structural VAR model, the following classical AD–AS

model is employed.

$$Y = f_c(Y) + f_i(Y, R - \bar{P}^e) + \bar{G}$$

... (1) demand for goods (f_c is a consumption function, f_i is an investment function)

$$Y^s = f_s(\bar{W} - P, \bar{K}, \bar{A})$$

... (2) supply of goods (f_s is a production function)

$$R = f_r(Y - \bar{Y}^*, P)$$

... (3) response function of monetary policy

$$M - P = f_m(Y, R)$$

... (4) currency supply and demand (f_m is a currency demand function)

Exogenous variables are indicated by the notation $\bar{\quad}$, and \bar{P}^e is the expected rate of inflation, \bar{G} is government spending, \bar{W} is nominal wages, \bar{K} is capital stock, \bar{A} is total factor productivity, and \bar{Y}^* is potential GDP.

By abbreviating the exogenous variables, the model may be rewritten as the following probability model.

$$Y = f(Y, R) + \varepsilon_Y \quad \dots(1)'$$

$$P = f(Y) + \varepsilon_P \Leftrightarrow Y = f(P) + \varepsilon_{YS} \quad \dots(2)'$$

$$R = f(Y, P) + \varepsilon_R \quad \dots(3)'$$

$$M = f(Y, R, P) + \varepsilon_M \quad \dots(4)'$$

(1)' to (4)' are static models, which will be used as a basis to calibrate the VAR/VEC models which possess lags (note 23).

Appendix 2: the results of unit root test and cointegration test

(1) Unit root test

A unit root test was conducted to determine whether the data is non-stationary. As a result of testing in various patterns of equations and lag criterion to avoid any possible arbitrariness, the results revealed the existence of a unit root (indicating that the data is non-stationary) in all four variables in most of the patterns (**Chart 11**).

Chart 11: Results of unit root tests

(Equation)	(Lag criterion)	IIP	WPI	Call rate	M3
Including intercept	AIC	Non-stationary	Non-stationary	Non-stationary	Non-stationary
Including intercept, trend	AIC	Non-stationary	Non-stationary	Non-stationary	Non-stationary
Including intercept	SIC	Non-stationary	Non-stationary	Stationary**	Non-stationary
Including intercept, trend	SIC	Non-stationary	Non-stationary	Non-stationary	Non-stationary

Note: ADF test. ** 5% significance level.
Source: CEIC

(2) Cointegration test

Since the results suggested that the data series are non-stationary, tests were then conducted to verify cointegration. Again, to avoid any possible arbitrariness, we conducted cointegration tests over a number of lags (12 patterns from 1 to 12 months). The majority of the results indicated that there are two cointegrated relations among the four variables (**Chart 12**).

**Chart 12: Results of Johansen cointegration test
(number of cointegration relations identified)**

No. of lags	Trace test	Maximum eigenvalue test
1 month	0	0
2 months	2	0
3 months	2	0
4 months	2	0
5 months	2	1
6 months	1	1
7 months	3	1
8 months	2	2
9 months	2	1
10 months	1	1
11 months	2	2
12 months	3	3

Source: CEIC

Appendix 3: the VEC model calibrations and impulse response function

(1) The VEC model

In this paper, we calibrated the following VEC model. In accordance to the results of the cointegration tests in Appendix 2, the error correction term – indicating the number of cointegration relations – is 2. Furthermore, both the Schwarz Information Criterion (SIC) and the Akaike Information Criterion (AIC) suggest that the number of time lag is one (note 24).

$$\begin{bmatrix} dY \\ dP \\ dR \\ dM \end{bmatrix} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \end{bmatrix} \underbrace{\begin{bmatrix} (\beta_{11}Y_{t-1} + \beta_{12}P_{t-1} + \beta_{13}R_{t-1} + \beta_{14}M_{t-1}) \\ (\beta_{21}Y_{t-1} + \beta_{22}P_{t-1} + \beta_{23}R_{t-1} + \beta_{24}M_{t-1}) \end{bmatrix}}_{\text{Error correction term}} + A_{t-1} \underbrace{\begin{bmatrix} dY_{t-1} \\ dP_{t-1} \\ dR_{t-1} \\ dM_{t-1} \end{bmatrix}}_{\text{Lag term}} + \begin{bmatrix} e_{Yt} \\ e_{Pt} \\ e_{Rt} \\ e_{Mt} \end{bmatrix}$$

(2) Impulse response function

In calibrating impulse response functions, we must take note of the problem of identification (Kitaoka, Yano and Takahashi (2008) and others). In conventional VAR/VEC models, various economic shocks among variables become intermixed with each other, making it difficult to extract shocks which occur to individual variables.

Thus, the Cholesky decomposition was used to identify the shocks which are unique to each of the variables. To avoid arbitrary identifications, we used the framework of the AD–AS model referred to in Appendix 1. Namely, given (1)' to (4)' of Appendix 1, each of the variables would be subject to the following restrictions at the same time.

$Y \leftarrow y, r:$

Y is affected by shocks of Y itself and R at the same point in time

$P \leftarrow y, p:$

P is affected by shocks of P itself and Y at the same point in time

$R \leftarrow y, p, r:$

R is affected by shocks of R itself and Y and P at the same point in time

$M \leftarrow y, p, r, m:$

M is affected by shocks of M itself and Y, P and R at the same point in time

(The lower case letters refer to shocks unique to each of the variables)

Furthermore, as in Sugihara, Mihira, Takahashi and Takeda (2000), we imposed the constraint that “investment does not respond simultaneously to the rate of interest” (note 25). As a result, we obtained a recursive–structure Cholesky decomposition as follows.

$Y \leftarrow y$

$P \leftarrow y, p$

$R \leftarrow y, p, r$

$M \leftarrow y, p, r, m$

Chart 8 of the main text is a graphic demonstration of the responses of P(WPI) and Y(IIP) to an M(M3) shock under the foregoing constraint.

Note that the results of impulse response functions may change when the order of the recursive structure is changed in Cholesky decompositions. To check the robustness of the results of analysis in this paper, an opposite ordering Cholesky decomposition was conducted as follows (note 26).

$M \leftarrow m$

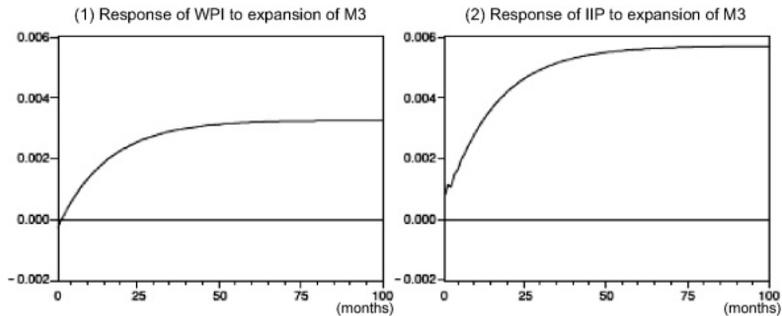
$R \leftarrow m, r$

$P \leftarrow m, r, p$

$Y \leftarrow m, r, p, y$

The results turned out to be very similar to **Chart 8 (Chart 13)**.

Chart 13: Impulse response functions



Note: The size of the M3 shock is 1 standard deviation. Impulse responses for up to 100 months are displayed.

Source: CEIC

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Notes

- 1 The “trilemma of the international financial system” refers to the quandary that it is impossible to achieve “free capital movements”, “stabilization of the foreign exchange rate” and “independent monetary policy” at the same time.
- 2 In particular, the outflow of capital was regulated because of the shortage of foreign currency. Restrictions upon imports stemming from the foregoing led to restraints upon imports necessary for the expansion of corporate capabilities for exports and domestic businesses. Thus, in view of these shortcomings, state-led industrial policies are perceived as hampering foreign investment and sound competition among domestic corporate enterprises, thus serving as a drag upon India’s economic progress.
- 3 India’s strong economic growth in recent years is attributed to India’s successive economic deregulation measures (Mizuho Research Institute (2006)). A look at long-term trends in India’s real GDP growth reveals that growth was stagnant at around +3 to 5% per annum subsequent to its independence in 1947 and rose to +6% in the 1990s and +8% from 2000 onward.
- 4 The Indian government stands upon a principle of nondiscrimination between domestic and foreign enterprises with respect to the attraction of business enterprises and does not possess the notion of providing exclusive preferential treatment to foreign enterprises as in China and the countries of the ASEAN.
- 5 Such a view is set forth by Mohan (2008a) of the Reserve Bank of India. Furthermore, according to Arvind Subramanian of the Peterson Institute for International Economics, 40% of funding by Indian companies in FY2007 depends upon the ECB and issuance of new stocks (*Business Standard*, November 5, 2008).
- 6 Planning Commission (2008).
- 7 Based upon Frankel and Wei (1992). This paper draws upon the works of Patnaik (2007) and Shah and Patnaik (2008) which analyzes India’s foreign exchange policy using a Frankel–Wei regression model. This paper also draws upon Kawai and Motonishi (2004) in the preparation of Chart 2.
- 8 Similar conclusions are drawn in Shah and Patnaik (2008).
- 9 However, these outlooks are not deemed as the RBI’s policy targets. The outlook on WPI also differs from the “inflation target”.
- 10 Up to 2004, the RBI used open market operations of government bonds as its principal tool for sterilization. However, as a result of the RBI’s successive outright selling operations of its government bondholdings to cope with the rupee-selling market interventions at the time, the RBI’s government bondholdings in its balance sheet was depleted. Since the RBI itself is prohibited by law to issue bonds, the

Market Stabilization Scheme (MSS) bonds were introduced in 2004 as government bonds which may be issued by the RBI on behalf of the government. For example, in the event there is an over-supply of rupees as a result of rupee-selling market interventions, the RBI issues MSS bonds on behalf of the government. The rupee currency absorbed in this way is separated from the RBI's balance sheet and pooled in the MSS cash account, to be used solely for the redemption or buyback of MSS bonds. However, interest-payments on MSS bonds are paid from the account of the Union Government of India and not from the MSS account.

- 11 In India, the amount of interest payments on MSS bonds issued as a tool for sterilization is stated explicitly in the budget of the Union Government of India. According to Mohan (2008b), outstanding issues of MSS bonds in FY2007 increased 167.4% y-o-y and interest payments rose 219.9%, serving to squeeze India's fiscal conditions. According to comments by an RBI official interviewed by the author, these costs served as one of the factors which made the sterilizations insufficient.
- 12 The ripple effect of reserve money to M3 may be eased by the RBI raising the cash reserve ratio, which in turn curbs private-sector credit creation. In fact, M3 did not rise as much as reserve money due to frequent cash reserve ratio hikes in 2007. Even so, M3 still increased at a +20% -level pace on a year-on-year basis. On the contrary, from October 2008 onward, M3 growth is not slowing as much as reserve money because of cash reserve ratio cuts to cope with the global financial crisis.
- 13 In March 2007, the call rate surged as a result of an acute liquidity crunch in the short-term money market because of a higher-than-usual demand for cash among corporate enterprises to meet corporate tax payments.
- 14 *Business Standard*, October 27, 2008 editorial.

- 15 As for the relationship between money supply and economic activity, major central banks of Europe and the US conducted monetary policy with money supply as the intermediate target in the 1970s. However, money supply ceased to be an intermediate target in the 1980s and 1990s.

The US Federal Reserve Board (FRB) started to treat money supply in the same way as other economic indicators, citing the unstable relationship between money supply and economic activity. The Bank of Japan (BOJ) is also of the view that the relationship between Japan's money supply and economic activity is growing unstable and hence it is difficult to interpret information on the future course of the economy and prices from money supply trends. That said, the BOJ takes the stance that it will continue to analyze movements in money supply given its attributes as a comprehensive gauge of overall economic activity.

In contrast, major central banks of Europe take the view that money supply reflects fund transactions in the background to economic transactions and that it includes important information on future price movements. Therefore, even though money supply is no longer an intermediate target, it is still watched closely as one of the factors in the formation of monetary policy decisions (Bank of Japan (2002)).

Although the RBI amended its monetary policy with M3 as the intermediate target in the latter half of the 1990s, it is still conducting monetary policy with a close eye

- upon M3 as a key indicator in the Multiple Indicator Approach (MIA) (refer to Section 3 of this paper).
- 16 This paper draws upon the works of Sugihara, Mihira, Takahashi and Takeda (2000) which analyze the impact of monetary policy in Japan (for more details, refer to Appendix 1).
- 17 Refer to Chart 7 and Note 13.
- 18 The period of analysis starts in January 2001 because data on the call rate is only available from the CEIC Database from February 2000 onward. In time series analysis, analyses of extremely long time spans are inappropriate because of the prerequisite that relations between variables are stable – namely that there are no structural changes – during the relevant time period.
- 19 Refer to Appendix 2 for the results of unit root tests and the cointegration tests.
- 20 Refer to Appendix 3 for the VEC model calibrated in this paper.
- 21 In calibrations of impulse response functions, it is necessary to take note of the problem regarding identification. (Kitaoka, Yano, Takahashi (2008) and others) In conventional VAR/VEC models, various economic shocks among variables become intermixed with each other, making it difficult to extract shocks which occur only on M3. In this paper, we used the Cholesky decomposition to cope with the problem of identification (for details, refer to Appendix 3).
- 22 Since the risks of inflation stemming from India's fiscal deficit are already a source of concern, capital inflows and the resurgence of forex market interventions may serve to fan the inflation risks. India's fiscal deficit grew from 2.5% of nominal GDP in FY2007 to 6.2% of nominal GDP in FY2008 (preliminary estimate), reflecting the expansion of government expenditures to cope with the global economic crisis. According to the Ministry of Finance of India, the fiscal deficit is projected to rise to 6.8% of nominal GDP in the FY2009 budget proposal and remain high at 5.5% of nominal GDP in FY2010. While the government is issuing more government bonds to finance India's fiscal deficit, the RBI is purchasing existing government bonds through open market operations in a bid to facilitate the smooth market absorption of the newly-issued government bonds. According to a high-ranking Ministry of Finance official, half of the government bond issues in FY2009 will be underwritten by the RBI (*Business Standard*, July 17, 2009). If the RBI engages in rupee-selling interventions at the same time when it issues more banknotes through the purchase of government bonds, this would spur the provision of liquidity.
- 23 Refer to Appendix 3.
- 24 There are four time lags in the structural VAR model in Scrimany and Samanta (1998) and two time lags in the structural VAR model in Agarwal (2006). The number of time lags is not specified in Mitsubishi Research Institute (2006).
- 25 This is based upon the notion that in investment, there are lags in each stage as follows "acknowledgment of change in interest rate → decision making → implementation".
- 26 In this case, we would step away from the initial AD-AS model and the assumption that "investment does not respond simultaneously to the rate of interest".



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