



# Tight credit policy versus currency depreciation: Simulations from a trade and inflation model of India<sup>☆</sup>

Sushanta K. Mallick

*Department of Economics, Loughborough University, Ashby Road, Loughborough,  
Leicestershire LE11 3TU, UK*

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## Abstract

Using a small macroeconomic model that examines the determinants of India's trade and inflation, this paper addresses the effects of a reform policy package similar to those implemented in 1991. Policy simulations using dynamic simulation method compare the responses to devaluation with the responses to tight credit policy. It is shown that the trade balance effects of tight credit policy are more enduring than that of devaluation, conditional on inflation being modelled in an open economy context. The simulations demonstrate that the devaluation actually worsens trade balance and hence devaluation cannot be an option in response to a negative trade shock, whereas the reduction in domestic credit reflecting demand contraction can produce a desirable improvement in the trade balance.

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*E-mail address:* [s.k.mallick@lboro.ac.uk](mailto:s.k.mallick@lboro.ac.uk).

## 1. Introduction

The macroeconomic scenario in the Indian economy in the summer of 1991 was characterised by severe fiscal and external imbalances, contributing to the balance of payments (BOP) crisis.<sup>1</sup> The crisis was mainly due to a shortage of external liquidity rather than an insolvency problem. To get over the BOP difficulty, in July 1991, the government of India accepted the IMF credit, conditional on a set of policies, that is, by announcing a significant devaluation and monetary squeeze, aimed to reduce fiscal- and current-account deficits. The two standard policy instruments – namely reducing the central bank (henceforth RBI) credit to the government (a key source of financing fiscal deficit), and devaluing the currency – were adopted, which are broadly considered as a recipe for developing economies (DEs) when they encounter BOP crises. Despite doing so, India's combined fiscal deficit in 1990s remained at 7.8% of GDP, barely changed from 8.1% of GDP in 1980s (same is the case for the central government deficit alone, which just declined to 5.9% from 6.8% of GDP, respectively). But the rate of growth of net RBI credit to the central government that creates monetized deficit has substantially slowed down from 20% on average in 1980s to 7.1% in 1990s, while the growth of other banks' credit to the government has increased from an annual average rate of 19.2% in 1980s to 21.2% in 1990s, reflecting the government's increased market borrowing to finance its deficit. Thus on the fiscal front, imprudence remains the government's biggest problem, while on the monetary side, tighter prudential norms following liberalisation have tightened credit standards,<sup>2</sup> weakening small businesses' access to the credit market.

In this paper controlling aggregate domestic credit as a stabilisation strategy, is examined in line with the standard monetary approach to the BOP, which remains the mainstay of the IMF-supported stabilisation packages. Regarding the exchange rate, the value of the rupee has depreciated by 63.6% to INR45.68/\$ in 2000–2001 (which happens to coincide with the current level in 2004 on the back of US dollar weakness) compared to 1989–1990, amounting to an average depreciation of 8.4% a year. This suggests that the RBI prefers to accommodate rupee depreciation, while aggressively preventing appreciation, as part of the RBI's intervention strategy by sterilizing major part of the capital inflows so as to target a stable real exchange rate (see Baig, Narasimhan, & Ramachandran, 2003, and Kohli, 2003). Such significant rupee depreciation partly explains why annual average inflation (based on the benchmark wholesale price index) remains so high at 8% in both 1980s and 1990s. The average broad money (M3) growth remained stable at 17.2% in both 1980s and 1990s. But in the second half of 1990s the average inflation rate being 5.3% can be in part explained by credit squeeze, as the rate of growth of domestic credit slowed to an average of 14.4% in 1990s from 18.1% in 1980s. Naastepad (2003) finds that whenever fiscal reform leads to a squeeze on available working capital credit, deficit reduction will lead to only a limited decline in inflation and a modest BOP improvement.

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<sup>1</sup> The typical explanation for the India's 1991 BOP crisis has been to attribute it either to current account deficits or currency overvaluation (see for example Cerra & Saxena, 2002).

<sup>2</sup> Credit standard, developed in Basu (2002), reflects some form of collateral by the lender as an alternative means to recoup the loan in addition to the interest rate charged, should the borrowers' projects fail.

The basic questions that arise in this context are: (1) whether the reduction in domestic credit or devaluation is the better solution than the other to BOP problem, irrespective of the exchange rate regime? (2) By how much should domestic credit be reduced so as to reduce fiscal deficit by a given amount? (3) By how much should the currency be devalued; or can we evaluate alternative devaluation strategies? To answer these quantitative policy questions, a new model of trade and inflation is developed, based on Sundararajan (1986) [henceforth VS], although VS did not model the price formation process and paid no attention to the question of non-stationarity in the time series.<sup>3</sup> This paper models trade and inflation using a modelling strategy that develops a structural model via the single-equation error correction approach following Phillips–Hansen’s method of cointegration. The paper then evaluates the comparative performance of the dynamic responses to devaluation and tight credit policy. A distinctive feature of this study is that it provides a supply side model of inflation in addition to the treatment of the demand factor. Contrary to VS’s claim of the superiority of devaluation over tight credit policy, policy simulations in this paper show that the trade balance effects of tight credit policy are more enduring than that of devaluation. The devaluation actually worsens the trade balance with no J-curve effect,<sup>4</sup> whereas the reduction in domestic credit produces a desirable improvement in the trade balance, as it squeezes domestic demand, and is more effective in reducing inflation, while devaluation generates higher inflation.<sup>5</sup> In this paper, the level of real output is left exogenous as in VS, since the focus is on short-run stabilisation, but the long-run adverse effect of credit contraction on output is already well established (for example, see Mallick, 1999a). The plan of this paper is as follows. The next section presents a model of trade and inflation, with estimation results discussed in Section 3, policy simulations and concluding remarks in Sections 4 and 5, respectively.

## 2. A policy model of macroeconomic stabilisation

The official quantitative modelling approaches to support the government policies on macroeconomic adjustment and development strategy are known to be based on the IMF’s financial programming, and the World Bank’s Revised Minimum Standard [Computable General Equilibrium (CGE)] model respectively,<sup>6</sup> developed on global stabilisation and structural adjustment experiences. This paper therefore derives its analytical starting point

<sup>3</sup> This comment also applies to the subsequent studies following VS (Murty & Prasuna, 1994; Paul, 1994; Varma, 1994). Krishnamurty and Pandit (1996) although based on a different framework, suffer from the same criticism by paying no attention to the new econometrics literature; instead use the conventional lagged dependent variables in long-run equations to reflect dynamics.

<sup>4</sup> In a recent econometric study by Buluswar, Thompson, and Upadhyaya (1996), it was shown that there has been no J-curve in India, and devaluation has had no significant long-run effect on the trade balance. Also, in a simulation exercise for India within a standard macroeconomic adjustment model, similar result was found with regard to the impact of devaluation (see Mallick, 2001).

<sup>5</sup> This has also been observed in other DEs. For example, in the context of three African DEs, Green and Murinde (1993) find that these economies show vulnerability to supply-side inflation generated by competitive depreciation of the exchange rate.

<sup>6</sup> For a summary of the CGE model, see World Bank (1996): 133–134. The recently developed econometric model of the IMF is called MULTIMOD, which is a modern dynamic multi-country macro model of the world

from VS as the benchmark, as VS is the earliest policy simulation model of India's trade and inflation employing the IMF's monetary approach to BOP. Further, VS compared the dynamic responses to devaluation with the responses to tight credit policy,<sup>7</sup> which are re-examined in this paper, but had little or no role for supply-side factors and did not model the price formation process<sup>8</sup> in India. The best way to examine the determinants of inflation is to bring together both the demand and supply factors in an open economy framework.

### 2.1. Monetary dynamics

Unlike the partial adjustment mechanism in VS, the money demand equation here includes the interest rate as an additional argument<sup>9</sup> that makes excess money demand a stationary process justifying it as disequilibrium variable in statistical terms. The error correction term resulting from this money demand relation acts as the adjusting variable. The desired stock of real money balances  $(M/P)^d$  is related to marketed output  $(YM)^{10}$  rather than real national income, interest rate  $(IR)$ , and expected inflation  $(\pi^e)$  that follows a distributed lagged process:

$$\ln\left(\frac{M}{P}\right)_t^d = \alpha_0 + \alpha_1 \ln(YM_t) - \alpha_2 \ln(IR_t) - \alpha_3 \pi_t^e \quad (2.1)$$

where  $P$  is the price level represented by WPI,  $\pi$  the inflation,  $M$  the money supply ( $M_3$ ).

The current expected inflation  $(\pi^e)$  is hypothesized to be a weighted average of the expected and actual inflation of the previous period:  $\pi_t^e = \sigma\pi_{t-1}^e + (1 - \sigma)\pi_{t-1}$  or  $\pi_t^e - \pi_{t-1}^e = (1 - \sigma)(\pi_{t-1} - \pi_{t-1}^e)$ , which is a first-order adaptive expectations model. Here  $\pi^e$  is numerically generated with the optimal estimate of  $\sigma$  obtained by Rao (1997):  $\pi^e = 0.617\pi_{t-1}^e + 0.383\pi_{t-1}$ . The expected inflation, which seems to follow the actual inflation with a lag, is shown in Fig. 1.

The money supply definition links the reserve or high-powered money through the money multiplier. The excess flow demand for real money balances  $(ED)$  can be defined as  $ED_t = (M/P)_t^d - (M/P)_{t-1} - \Delta(D \times K/P)_t$ , where  $D$  is net domestic assets of the banking sector, and  $K$  the money multiplier.  $ED$  is a measure of the excess flow demand for money in which  $(M/P)_t^d - (M/P)_{t-1}$  measures the gap between desired real balances at period  $t$  and the

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economy designed to study the transmission of shocks across countries as well as the short-run and medium-run consequences of alternative monetary and fiscal policies.

<sup>7</sup> VS considered only temporary shocks to evaluate the dynamics of devaluation and tight credit policy, what actually happens during an economic crisis is a permanent shock; hence there is a need to consider both temporary and permanent shocks.

<sup>8</sup> VS derives a model of price determination by simply inverting the real money balances equation, which is indeed ambiguous as to what explains inflation except money. Thus a model of price determination is inevitable following the literature on India's inflation.

<sup>9</sup> It has been found in the Indian literature that interest rate is a significant determinant of the demand for real money balances (see, for example, Kumar & Mallick, 2001).

<sup>10</sup> The currently marketed output derives its source mainly from the current non-agricultural output and the lagged agricultural output. Although there are other ways to define marketed output, we have derived marketed output following the same procedure as in VS.

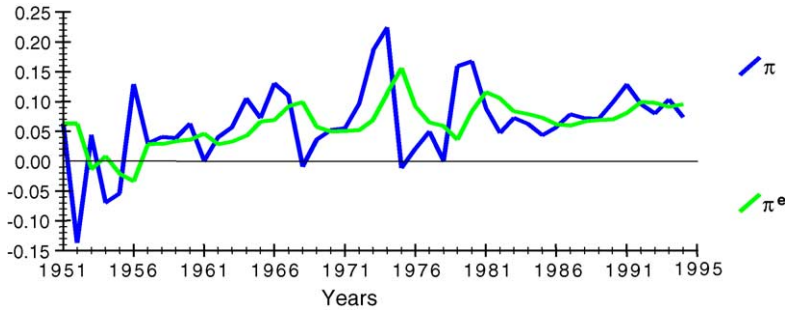


Fig. 1. Expected and actual rate of inflation.

existing stock of real balances at period  $t - 1$ , while  $\Delta(D \times K/P)_t$  measures the stock of real balances supplied domestically during the period  $t - 1$  to  $t$ .

## 2.2. Export function

The volume of exports ( $X$ ) depends on the relative price of exports [ $PX(E + S)/P$ ], which exhibits the profitability of producing and selling exports [captured by the ratio of export prices (inclusive of export subsidies) to domestic prices], real output ( $Y$ ) and ED:

$$\ln X_t^s = \varphi_0 + \varphi_1 \ln(PX(E + S)/P)_t + \varphi_2 \ln Y_t + \varphi_3 ED_t \quad (2.2)$$

where  $PX$  is the unit value of exports in US dollars (US\$),  $E$  the nominal exchange rate (INR/US\$),  $S$  the unit export subsidies, and  $Y$  the aggregate output.

The export demand is specified as a function of a trade-weighted average of real output in other countries ( $YW$ ) and the real exchange rate or the competitiveness, defined as the ratio of prices of Indian exports relative to foreign prices ( $PW$  (US\$)).

$$\ln(X_t^d) = \delta_0 - \delta_1 \ln(PX/PW)_t + \delta_2 \ln(YW)_t + \delta_3 \ln(E)_t \quad (2.3)$$

Equating export supply with export demand, the reduced form for  $PX$  is derived as follows:

$$\begin{aligned} \ln PX_t = & \beta_0 + \beta_1 [\ln P_t - \ln(E_t + S_t)] - \beta_2 \ln PW_t - \beta_3 \ln Y_t + \beta_4 \ln YW_t \\ & + \beta_5 ED_t + \beta_6 \ln E_t \end{aligned} \quad (2.4)$$

This export function incorporates both monetary factors and relative price factors including export subsidies. The presence of  $ED^{11}$  is expected to reduce real expenditures on both tradables and non-tradables, which would then reduce domestic demand for exportables and hence the export supply will increase.

## 2.3. Import equation

The import demand ( $I$ ) is influenced by means of competitiveness or the relative price of imports, real national income, and the excess flow demand for real-balances. Actual

<sup>11</sup> In order to avoid difficulties with the logarithm of a negative number, ED is included without taking its logarithm in the model.

imports in India were subject to a considerable degree of control and the volume of imports permitted by the authorities was through the import licensing system.<sup>12</sup> The actual imports were assumed in VS as a distributed lag function of the permitted level of imports with Koyck type geometrically declining lag coefficients. With trade liberalisation, the permitted level is equal to the actual imports. The import function in VS model is linear, while other equations are log-linear. For consistency, the import demand here is estimated in log-linear form as follows:

$$\ln I_t = \phi_0 - \phi_1 \ln \left( \frac{PM_t(E_t + T_t)}{P_t} \right) + \phi_2 \ln Y_t + \phi_3 \ln EI_t - \phi_4 ED_t + \phi_5 \ln \left[ \frac{KI_t}{PM_t} \right] + \phi_6 \ln \left( \frac{R_t}{PM_t} \right) \quad (2.5)$$

where PM is the import unit value in US\$,  $T$  the unit import duties (INR/US\$), EI the essential imports,  $R$  represents the foreign exchange reserves in Indian Rupees (INR), KI refers to net foreign assets of the non-banking sector (US\$).

#### 2.4. Price formation model

Research on the nature and sources of Indian inflation has been guided by competing theoretical explanations,<sup>13</sup> making it inconclusive as to which variables determine prices at the macroeconomic level. It has been argued and well established that cost-push phenomena play a more vital role in determining the course of price movements than the demand-pull factors. Nevertheless, it has been observed that the studies incorporating structural factors in causing inflation have not taken due note of the demand-pull factors, and studies, which emphasise monetary factors, have not given adequate attention to the cost-push factors (Mallick & Kumar, 1995). Hence there is difference of opinion and evidence regarding price formation in the Indian economy. A more complete model explaining inflation should incorporate both demand and supply side factors. To the extent that these two types of studies do not incorporate adequately both these factors, each one of them may be overstating the influence of either the demand-pull or the cost-push factors. It is possible that certain prices are affected more by one type of factor than the other. There is thus a need for a detail price formation model before considering its stabilisation through possible policy strategies.

A monetary squeeze may not reduce rates of inflation, as claimed by the monetarist school, if price formation is determined by structural rigidities or real disproportionalities, and based on mark-ups, administered-pricing and cost-indexation (Nayyar, 1995). Among non-monetary factors, food supply and government buffer stock operation through public

<sup>12</sup> Krishnamurty and Pandit (1996) claim that under the new policy environment in India the stock of foreign currency reserves deflated by import unit value index cannot be taken as a determinant of the volume of imports. Because during the erstwhile policy regime, imports were rationed according to priorities and in doing so foreign currency reserves served as a resource constraint. Since the sample used in this study spans from 1950 onwards, we keep this variable as a determinant of import demand.

<sup>13</sup> The Monetarist proposition on the acceleration of inflation stresses the quantum and cost of money, whereas the Structuralist explanation of inflation stresses wage cost, raw material cost, and capacity utilisation (see Jha, 2003; for an earlier survey, see Bhattacharya & Lodh, 1990).

distribution system and import price are other determinants of the inflation rate. In view of the opening up of the Indian economy, the external component has been important in domestic price formation via the effect of exchange rate variations. Hence to analyse the dynamics of inflation in the Indian economy, a model is needed that incorporates the tradable/non-tradable distinction and allows for differentiated tradables. This decomposition into domestic (non-tradable) and external (tradable) components in price formation has not been dealt with in the existing models of inflation [for example, Ghatak and Deadman (1989), Balakrishnan (1991), Ghani (1991), Joshi and Little (1994), and Sen and Vaidya (1995), Rao (1997), Pradhan and Subramanian (1998)].<sup>14</sup> The existing models may fail to forecast the future inflation satisfactorily. In line with Corbo (1985), the tradable/non-tradable distinctions are incorporated in the price specifications, partly to reflect exchange rate pass-through effect.

The price index ( $P$ ) is decomposed into a weighted average of the prices of tradables,  $P^T$ , and non-tradables,  $P^N$ . This distinction is important since a large proportion of goods in India are non-tradables. With weights  $\theta$  and  $(1 - \theta)$  for  $P^T$  and  $P^N$ , respectively,  $P$  is written in logs as:

$$\ln P_t = \theta \ln P_t^T + (1 - \theta) \ln P_t^N$$

$P^T$  is defined as the weighted-average of the prices of homogeneous (agricultural,  $P^A$ ) and differentiated (industrial,  $P^I$ ) tradables:

$$\ln P_t^T = \mu \ln P_t^A + (1 - \mu) \ln P_t^I$$

For  $P^A$ , the law of one price is assumed, which states that in the absence of transport costs and market imperfections, free trade delivers a unique market-clearing price for a homogeneous commodity, such that further arbitrage is uneconomical. Typically, agricultural price is visualised to be a flexible price, though for some commodities, such as rice, wheat, sugar and edible oils, the government used to fix prices. Thus the  $P^A$  equation is written as follows:

$$\ln P_t^A = \ln IPA_t + \ln E_t$$

where  $IPA_t$  refers to international price of domestically consumed agricultural tradables expressed in foreign currency.  $P^I$  is assumed to be a function of the unit labour costs, price of imported raw materials (IPRM), and excess demand:

$$\ln P_t^I = \tau_0 + \tau_1(\ln WM_t - \ln QM_t) + (1 - \tau_1)(\ln IPRM_t + \ln E_t) + \tau_2 ED_t$$

where  $QM$  is average labour productivity in the industrial sector (defined as industrial output over persons employed in the sector<sup>15</sup>), and  $WM$  the nominal wage in the industrial sector.

<sup>14</sup> Moreover, foreign influence on domestic component of price level is not entirely due to the behaviour of import prices, the transmission could also be through interest rates, where domestic nominal interest rate is given by the constant world interest rate plus the devaluation rate. High interest rates do contribute to cost-push inflation as well. This gives us another reason why we need to include flow excess demand for money as it is influenced by the interest rates and could cause inflation.

<sup>15</sup> Alternatively, average labour productivity can be measured by computing productivity by industry and then weighting it by the share of each industry output in total output (deflated by WPI in manufacturing).

The parameter for costs of intermediate inputs reflects the extent to which the country depends on imported raw materials, such as fertiliser for agriculture, petroleum for energy and so on. A unit restriction is imposed on the supply-side variables, where the coefficient  $\tau_1$  measures the importance of domestic costs.

$P^N$  is formed from three sources: (1) prices are assumed to be determined as a mark-up over unit labour costs; (2) any rise in the price of imported intermediate goods leads to a rise in non-tradable prices; (3) money market disequilibrium (ED) that reflects either cyclical variation in mark-up or the dynamic effects of monetary policy through changes in credit.

$$\ln P_t^N = \lambda_0 + \lambda_1(\ln WN_t - \ln QN_t) + (1 - \lambda_1)(\ln IPRM_t + \ln E_t) + \lambda_2 ED_t$$

where QN and WN are the average labour productivity and wage in the non-tradable sector, respectively. For wage formation, the relative wage between the tradable and non-tradable sector is assumed constant, i.e.  $WM = MN$ .<sup>16</sup> For simplicity it is assumed that  $QM = QN$  due to data problem. For the cost-push variables, the coefficients add up to unity. The above relationships can now give us the following estimable price equation:

$$\begin{aligned} \ln P_t = & \omega_0 + \omega_1(\ln IPA_t + \ln E_t) + \omega_2(\ln WM_t - \ln QM_t) \\ & + \omega_3(\ln IPRM_t + \ln E_t) + \omega_4 ED_t \end{aligned} \quad (2.6)$$

where,

$$\begin{aligned} \omega_0 &= \theta(1 - \mu)\tau_0 + (1 - \theta)\lambda_0, & \omega_1 &= \theta\mu, & \omega_2 &= \theta(1 - \mu)\tau_1 + (1 - \theta)\lambda_1, \\ \omega_3 &= \theta(1 - \mu)(1 - \tau_1) + (1 - \theta)(1 - \lambda_1), & \omega_4 &= \theta(1 - \mu)\tau_2 + (1 - \theta)\lambda_2, \\ \text{and } \omega_1 &+ \omega_2 + \omega_3 = 1. \end{aligned}$$

In this model,  $\partial P/\partial E \approx 1$  which means that the model is homogeneous in prices, but the continuous depreciation of the currency would not give rise to an equal change in the permanent rate of inflation as the wage rate is exogenous. However, the idea of long-run homogeneity in the price equations has been accepted as very important in many supply-side models of inflation (for example, see Church & Wallis, 1994). The next section explores empirically both static (long-run) and dynamic (short-run) homogeneity in prices.

### 3. Estimation results of the model

It is now conventional for dynamic economic modelling to adopt an error correction mechanism (ECM) (see Banerjee, Dolado, Galbraith, & Hendry, 1993; Hendry, 1995). ECM specifications are interpreted as modelling the short-run dynamics of the data around a long-run equilibrium. In order to avoid flaws in modelling non-stationarity, a representation is needed that captures the trend and dynamics of the series. The univariate cointegration

<sup>16</sup> Though the rate of change of wages in the tradeable sector can take the form of an expectations-augmented Phillips curve, since wages are indexed to previous period inflation, this is ignored in the present model because output is exogenous.

approach<sup>17</sup> of Phillips and Hansen (1990) employing fully modified OLS (FM-OLS) method provides an ideal framework for this representation,<sup>18</sup> uncovering consistent parameter estimates.

The stylised model consists of a price, a money demand, export price, export and import demand equations. Estimation is carried out on the basis of a sample of 46 annual observations pertaining to the period 1950–1995. The basic data are compiled from various sources.<sup>19</sup> The time series properties of the variables were examined using the graphs of the series (both in levels and first differences) and the Augmented Dickey-Fuller (ADF) tests (with/without trend), which confirm the presence of non-stationarity in the time series or integrated of order  $I(1)$ .<sup>20</sup> When the series are  $I(1)$  and some of the regressors are endogenous, the OLS estimator is asymptotically second order biased and hence instrumental variable (IV) methods are used. However, IV approaches, although better than OLS in term of efficiency, do not provide asymptotically efficient estimators. The FM-OLS method is asymptotically efficient (i.e. the best for estimation and inference) and it specifically deals with the presence of endogeneity in the regressors and does not require the use of instruments. The semi-parametric corrections in this method – transformations involving the long-run variance and covariance of the residuals – deal with endogeneity of the regressors and potential serial correlation in the residuals. FM-OLS is therefore the best method to estimate a single cointegrating relation, which is carried out using Microfit version 4.00 (see Pesaran & Pesaran, 1997). Table 1 presents parameter estimates of the long-run cointegrating regressions and short-run estimates along with the diagnostics statistics. The residuals (EC) from the long-run regressions interpreted as disequilibrium terms are found to be stationary and the test statistics reject the null hypothesis of no cointegration at 1 and 5% levels. Each EC term enters its own equation with negative sign supporting the EC interpretation.<sup>21</sup> The diagnostic tests indicate no evidence of serial correlation, of heteroscedasticity, of non-normality of the residuals, which broadly confirm a well-specified model of price formation and trade balance.

The results suggest that cost-push factors are more important in determining inflation than the excess demand, possibly because of the regime of price controls and administered prices. Price level is positively and significantly affected by the domestic unit labour costs and the cost of imported inputs. The cost-push factors satisfy the unit long-run homogeneity restriction in the price equation and the parameter estimates are statistically significant with

<sup>17</sup> This procedure has the drawback that, in the case of more than two time series, more cointegrating vectors may exist. Hence, a preliminary investigation was carried out for the presence of other cointegrating vectors equation-wise via Johansen's system based estimation procedure, which does yield the presence of a single cointegrating relation. A complete VAR analysis to infer  $r=5$  cannot be done as we have too many variables with too few observations. However, the equation-wise results can be obtained from the author.

<sup>18</sup> Phillips–Hansen procedure is similar to Engle and Granger (1987) in the case of testing for cointegration as both follow residual-based tests. But for estimation of the parameters, the asymptotic distribution of the OLS estimator involves the unit-root distribution and is non-standard and hence carrying out inferences using the usual  $t$ -tests in the OLS regression will be invalid. The Phillips–Hansen FM-OLS takes account of this as opposed to standard OLS estimation method.

<sup>19</sup> All the data sources along with the detailed notes on data definitions are available in Mallick (1999b).

<sup>20</sup> All the preliminary results are available upon request.

<sup>21</sup> This one-to-one assignment of EC terms indicates that the  $\alpha$  matrix in Johansen notation is diagonal (above a block of zero).

Table 1

## The model equations

## 1. Price equation

Long-run:<sup>a</sup>

$$\ln(P) = 0.828_{(2.669)} + 0.73 \times (\ln(\text{IPA}) + \ln(E))_{(13.291)} + 0.16 \times (\ln(\text{WM}) - \ln(\text{QM}))_{(4.00)} \\ + 0.11 \times (\ln(\text{IPRM}) + \ln(E))_{(4.48)} - 0.0003 \times \text{ED}_{(-5.15)}$$

Short-run:<sup>b</sup>

$$\Delta \ln(P) = -0.002_{(1.12)} + 0.84 \times (\Delta \ln(\text{IPA}) + \Delta \ln(E))_{(21.05)} + 0.07 \times (\Delta \ln(W) - \Delta \ln(Q))_{(2.84)} \\ + (1 - 0.84 - 0.07) \times (\Delta \ln(\text{IPRM}) + \Delta \ln(E)) - 0.00003 \times \Delta \text{ED}_{(-0.78)} + 0.06 \times \Delta \ln(P(-1))_{(0.84)} \\ - 0.35 \times \text{EC1}(-1)_{(-3.05)}$$

## 2. Desired real balances:

Long-run:<sup>c</sup>

$$\ln(\text{MD}) = -14.95 + 1.96_{(-25.83)} \times \ln(\text{YM})_{(31.25)} - 1.03\pi^e_{(-2.25)} - 0.56 \times \ln(\text{IR})_{(-6.497)}$$

## Short-run:

$$\Delta \ln(\text{MD}) = 0.012_{(0.71)} + 1.45 \times \Delta \ln(\text{YM})_{(4.23)} - 0.32 \times \Delta \pi^e_{(-1.08)} - 0.34 \times \Delta \ln(\text{IR})_{(-3.93)} \\ - 0.26 \times \text{EC2}(-1)_{(-2.31)}$$

## 3. Unit value of exports:

## Long-run:

$$\ln(\text{PX}) = -11.80_{(-5.405)} + 0.03 \times (\ln(P)_{(0.504)} - \ln(E + S)) + \\ 0.657 \times \ln(\text{PW})_{(5.896)} + 1.89 \times \ln(Y)_{(6.28)} - 0.86 \times \ln(\text{YW})_{(-1.91)} + 0.0012 \times \text{ED}_{(4.75)}$$

Short-run:<sup>d</sup>

$$\Delta \ln(\text{PX}) = -0.007_{(-0.255)} + 0.048 \times (\Delta \ln(P(-1))_{(1.57)} - \Delta \ln(E(-1) + S(-1))) + \\ 0.367 \times \Delta \ln(\text{PW}(-1))_{(2.51)} + 0.55 \times \Delta \ln(Y)_{(1.94)} + 0.73 \times \Delta \ln(\text{YW}(-1))_{(1.399)} + 0.0002 \times \text{ED}_{(1.469)} \\ + 0.28 \times \Delta \ln(\text{PX}(-1))_{(1.946)} - 0.215 \times \text{EC3}(-1)_{(-2.025)}$$

## 4. Export demand:

## Long-run:

$$\ln(X) = -1.66_{(-1.19)} - 0.58 \times \ln(\text{PX}/\text{PW})_{(-2.64)} + 0.68 \times \ln(\text{YW})_{(3.96)} + 1.18 \times \ln(E)_{(4.91)}$$

Short-run:<sup>e</sup>

$$\Delta \ln(X) = 0.07_{(3.54)} - 0.12 \times \Delta \ln(\text{PX}/\text{PW})_{(-1.08)} + 0.72 \times \Delta \ln(\text{YW})_{(1.565)} + 0.18 \times \Delta \ln(X(-1))_{(1.14)} \\ - 0.298 \times \text{EC4}(-1)_{(-2.88)}$$

## 5. Imports:

## Long-run:

$$\ln(I) = -5.20_{(-7.34)} - 0.17 \times \ln((\text{PM} \times (E + T))/P)_{(-2.95)} + 1.00 \times \ln(Y)_{(11.70)} + 0.002 \times \ln(\text{ED})_{(0.102)} \\ + 0.32 \times \ln(\text{KI}/\text{PM})_{(10.65)} + 0.16 \times \ln(R/\text{PM})_{(7.11)} - 0.0003 \times \text{ED}_{(-2.56)}$$

Short-run:<sup>f</sup>

$$\Delta \ln(I) = 0.02_{(1.48)} - 0.12 \times \Delta \ln((\text{PM} \times (E + T))/P)_{(-2.74)} + 0.22 \times \Delta \ln(Y(-1))_{(0.74)} \\ + 0.06 \times \Delta \ln(\text{EI})_{(3.00)} + 0.30 \times \Delta \ln(\text{KI}/\text{PM})_{(12.39)} + 0.05 \times \Delta \ln(R(-1)/\text{PM}(-1))_{(1.32)} \\ + 0.07 \times \Delta \ln(I(-1))_{(0.96)} - 0.0003 \times \text{ED}_{(-2.92)} - 0.598 \times \text{EC5}(-1)_{(-4.53)}$$

6. Balance of payments:  $R = R(-1) + X - I + \text{KI}$ 7. Money supply:  $M = k \times (R + D)$ 

Long-run model is based on fully modified phillips-hansen regression. *t*-statistics for the individual parameters are in parenthesis. The abbreviations for the statistical tests following each equation are as follows: BG is the Breusch-Godfrey test for autocorrelation; BJ is the Bera-Jarque normality test; WHT is the white test for heteroscedasticity; ARCH is the Engle-test for autoregressive conditional heteroscedasticity; CHOW is the Chow stability test (Chow Forecast Test: Forecast from 1991 to 1995). Probability values are in square brackets.

<sup>a</sup> Wald test of long-run homogeneity restriction imposed on parameters  $\chi^2(1) = 0.1666\text{E-}3$  [0.990].

<sup>b</sup> Adj.  $R^2 = 0.792$ ; BG = 1.66 [0.205]; BJ = 1.108 [0.575]; ARCH = 0.048 [0.83]; Chow = 1.13 [0.367]; WHT = 31.25 [0.306].

<sup>c</sup> Adj.  $R^2 = 0.49$ ; BG = 0.288 [0.59]; ARCH = 2.14 [0.13]; JB = 1.25 [0.54]; WHT = 21.29 [0.09]; CHOW = 0.667 [0.65].

<sup>d</sup> Adj.  $R^2 = 0.26$ ; BG = 2.13 [0.135]; BJ = 1.24 [0.537]; ARCH = 1.14 [0.29]; Chow = 1.21 [0.329]; WHT = 36.45 [0.269].

<sup>e</sup> Adj.  $R^2 = 0.14$ ; BG = 2.14 [0.13]; BJ = 3.48 [0.18]; ARCH = 1.26 [0.295]; Chow = 2.72 [0.037]; WHT = 28.38 [0.20].

<sup>f</sup> Adj.  $R^2 = 0.83$ ; BG = 2.08 [0.14]; BJ = .45 [0.798]; ARCH = 0.259 [0.61]; Chow = 1.92 [0.12]; WHT = 39.33 [0.41].

correct a priori expected signs. The ED term is not significant in the price equation in the short-run, though it is so in the long-run, satisfying the monetary framework. Prices being imported supports a structuralist framework. Combining both demand and supply factors suggests a weak role of money in its influence on prices in India in the short-run. The evidence shows that the domestic costs such as wages dominate import prices in the long-run, whereas the short-run price elasticity relating to wage cost is about the same as regards foreign raw material import prices. The role of rising agricultural prices is more important, which serve as a nominal standard for other prices in India (Goyal, 1995). In the past, the role of supply shocks (rise in agricultural and import prices) has been very significant leading to periods of lower non-agricultural growth and higher inflation (Goyal, 1997). The coefficient of the EC term in the dynamic price equation is negative and significant, with 32% of the deviations from the equilibrium being reversed in the following year. The income elasticity of demand for real-balances is 1.95 in the long-run and 1.45 in the short-run, in line with many money demand functions for India, where the elasticity has always been higher than unity.<sup>22</sup>

The export price is positively influenced by domestic as well as world prices. A 10% increase in  $P$  pushes up  $PX$  by 0.5% in the short-run. The  $ED$  variable, which influences trade flows through relative prices, is highly positively significant in the export price equation. The EC term is 0.22 and significant. This low speed of adjustment explains that India is a price taker in some export goods, although a price setter in others lately. At a disaggregated level, price elasticities may vary for different export commodities. Manufactured exports in India may exhibit a demand function very different from traditional commodity exports (Lucas, 1988). The significant variables in export demand are relative prices of exports, world income and exchange rate in the long-run, but in the short-run they are insignificant. When world real income increases by 1%, the export demand increases by 0.72% in the short-run and 0.68% in the long-run. As relative price decreases by 1%, export demand increases by 0.12% in the short-run and by 0.58% in the long-run.

The major determinants of real import demand in the long-run are net national income, real foreign exchange assets, real capital inflows and excess money demand. The inelasticity of imports with respect to relative price of imports in the long-run can be explained by the fact that during most of the sample period the imported goods were mostly repressed through import restrictions such as prohibition of imports, quotas, and prohibitively high import duties. The short-run elasticity of imports is negatively significant with respect to relative price of imports. Both the foreign reserve and capital flows are also highly significant. An increase in ED depresses imports as it has the statistically significant negative coefficient.

The empirical evidence presented here suggests that the cointegrating regressions implied by the model are an adequate specification of long-run behaviour. Overall, a reasonable speed of adjustment towards the long-run equilibrium is strongly indicated for all the endogenous

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<sup>22</sup> It is however worth-noting that in the past decade there may have been a process of increasing financial intermediation through the shift from the traditional economy to greater monetization as well as technical progress in the financial sector (as has been found for other countries), thereby reducing income elasticity. In the 1990s, average income velocity (GDP/M3) has indeed come down to 2.1% from 2.6 to 3.7% in the 1980s and 1970s, respectively.

variables. The short-run dynamic model derived from the long-run behaviour is used to perform policy simulations in Section 4.

#### 4. Policy simulations

To evaluate the overall performance of the complete model, simulation techniques are used, particularly the deterministic dynamic simulation method. First, for each period, actual values of all the exogenous data are imposed on the estimated model, yielding baseline series for the simulated variables. Second, the model is simulated via adding shocks to the exogenous variables. The model solutions have been obtained using *WINSOLVE* (Pierse, 1997).

Policy simulations focus on the dynamic effects of devaluation and how they contrast with the effects of tight credit policy—mainly the point emphasised by the VS model. The magnitudes of these shocks are: a temporary depreciation of the exchange rate by 10% in the first year, and a temporary reduction in domestic credit by 1%. The percentage change of the deviation of dynamically simulated values from the base for inflation and trade balance are exhibited in Fig. 2. Dynamic simulations indicate that the model is stable. The way the model is set up, a 10% devaluation influences price level by 9% as it has a direct impact through traded goods prices and prices of imported raw materials.<sup>23</sup> VS had modelled price level in terms of only demand variables such as money without exchange rate or cost factors. The price level does not behave in the same way here as VS, because price will increase more due to devaluation in view of the direct effect of the exchange rate. In the next period the excess demand for money declines 2.61% due to decline in money demand by 1.08% because of rise in expected inflation. Such fall in ED gives rise to an increase in price by 0.05% as the price elasticity with respect to ED is 0.00003. Following a temporary devaluation shock, price does rise in the first year, but dies out in the second period.

With regard to the impact on trade balance, a 10% devaluation gives rise to a phenomenon where the price increase leads to a rise in export price by 0.36% having no significant impact on exports demand, while imports decline marginally despite higher relative price, producing a trade deficit. In the subsequent year due to the negative liquidity effect as a result of price effect, export price declines leading to an improvement in trade balance. This effect remains cyclical until the trade balance improves due to the positive relative price effect being relatively stronger than the liquidity effect. Devaluation leads to an increase in the relative price of tradables, and thereby a decline in aggregate expenditures (Dornbusch, 1980),<sup>24</sup> leading to a decline in prices and an increase in ED. Export price being positively related to ED with a short-run coefficient of 0.002, an increase in ED raises export price and hence export demand declines (see Table 1, Eqs. (3) and (4)). Since such price decline

<sup>23</sup> Devaluation in the context of this model has two distinct effects. First, there is a change in the relative prices; second, it creates a liquidity effect through the increase in domestic prices leading to changes in the excess demand for real-balances.

<sup>24</sup> Nominal domestic absorption ( $A$ ) is given by  $A = C + I + G$ ; defining national income ( $Y$ ) as  $Y = C + I + G + X - M$ , we have  $A = Y - (X - M) = Y - TB$ , where  $TB$  refers to trade balance.

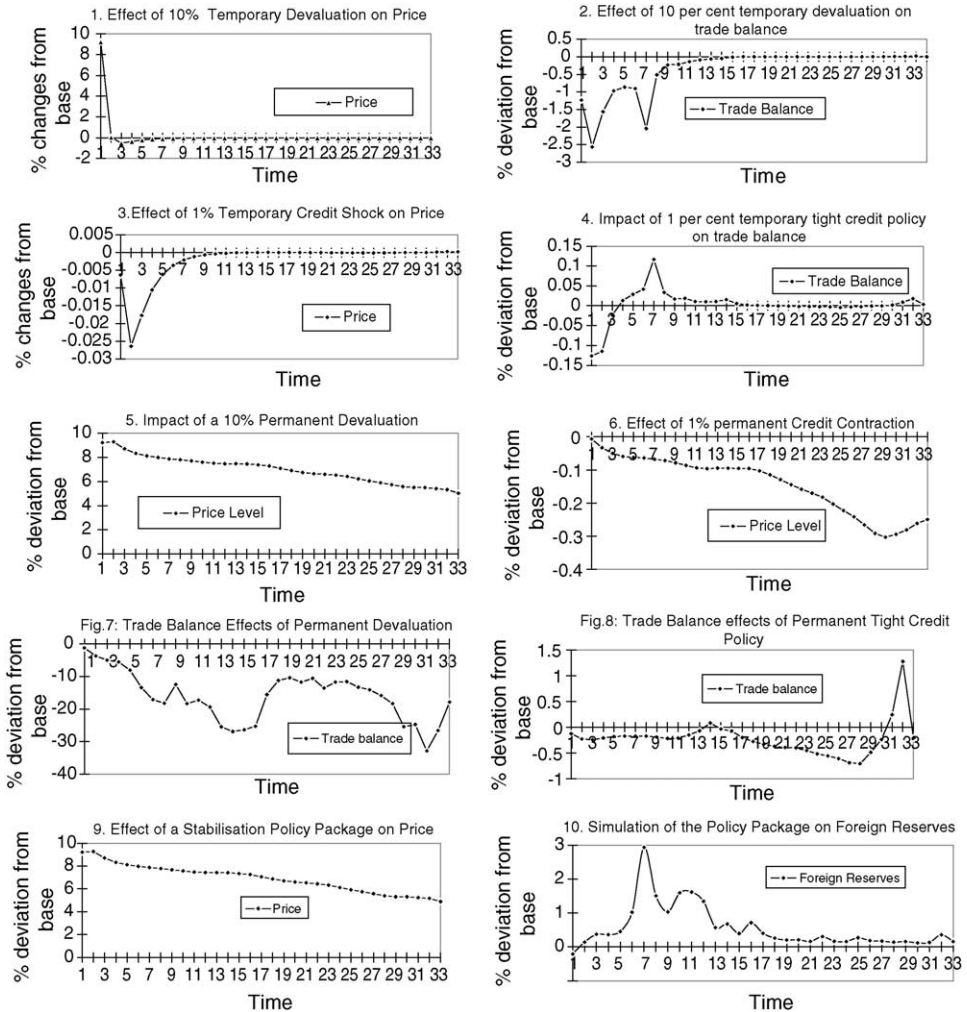


Fig. 2. Model simulations.

leads to an increase in import demand (see Table 1, Eq. (5)), trade balance deteriorates temporarily until it goes to steady state through the relative price effect [Fig. 2(2)].

When the credit policy is tightened by 1%, price declines in the same period by 0.01% due to decline in money supply by 0.89%, thereby increasing real money balances and reducing ED that has a relative price effect (via export price decline) in improving the trade balance. Subsequently, the price level increases by such a small magnitude that trade balance will not deteriorate. Though in the case of credit shock, there is no direct relative price effect, an indirect effect comes through the liquidity effect via price change, making trade balance positive. Since devaluation is resorted to as an immediate solution to BOP crisis, it worsens trade balance, not tight credit policy [see Fig. 2(2 and 4)]. Despite the short-run effects of

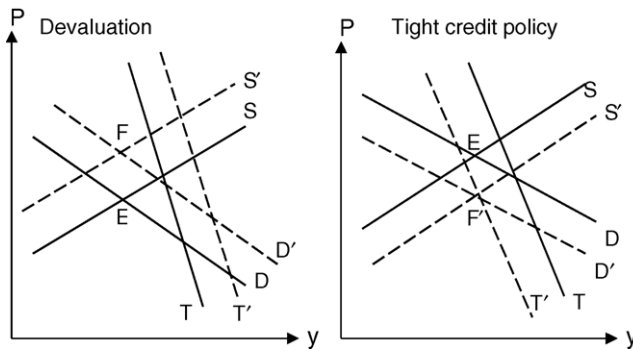


Fig. 3. Comparing devaluation and tight credit policy.

the two policies being different, the trade balance improvement due to tight credit policy is more enduring than the improvement resulting from devaluation, as devaluation leads to sizeable increase in prices. As the actual devaluation is a permanent<sup>25</sup> one, the permanent shocks are simulated with 10% devaluation and 1% credit contraction [see Fig. 2(5–8)]. In case of temporary shock, the model goes back to the original steady state the next period following the shock. Clearly, the temporary shock dies out rather quickly and the long-run cumulative effect is zero, but a 10% permanent devaluation initially results in about the same percentage change which gradually converges to the steady state of 5%, whereas a 1% change in domestic credit leads to a decline in the price level by 0.3% in the long-run. A permanent devaluation and credit shock shows trade balance an oscillatory pattern [Fig. 2 (7 and 8)]. The deterioration in trade balance can be explained via the adjustment mechanism of price response as shown in Fig. 3. At equilibrium  $E$ , the trade deficit ( $T'$ ) in the first panel gets wider following the devaluation shock, which has a stronger effect on an increase in absolute prices than the relative price effect, whereas in case of credit shock there is decline in absorption thereby reducing absolute prices. Both the short-run policies do not affect real output, but they do influence the nominal income via changes in prices.

As shown by  $T'$  in the diagram, the devaluation (1st panel) gives rise to a huge deterioration in trade deficit as compared to a tight credit policy (2nd panel). Further, the simulations demonstrate that the permanent effects dominate in the long-run whereas the temporary shocks prevail only in the short-run. Thus it is worth examining whether the permanent heavy devaluation policy chosen by the government under pressure from IMF is an ideal one relative to a 10% devaluation as simulated above or a do-nothing option would have seemed better. If we evaluate alternative devaluation strategies such as 20, 30%, or the actual scenario of about 39% devaluation in 1991, we would get a very high deterioration in trade balance.<sup>26</sup> In addition to the devaluation and credit shocks, the tariffs and export subsidies

<sup>25</sup> Although devaluation occurs at a point in time, its effect on further currency depreciation makes it a permanent shock. As noted earlier, Indian rupee depreciated 8.4% a year on average during the 1990s.

<sup>26</sup> This result is not surprising in an economy with a small external sector, where the response of trade balance to exchange rate changes can be marginal. For example, Upadhyaya and Dhakal (1997) tested the effectiveness of devaluation on the trade balance in eight DEs from Asia, Europe, Africa and Latin America, and found that

are simulated as part of a structural reform policy package comprising: (1) a 10% permanent devaluation; (2) 1% permanent reduction in credit; (3) permanent reduction of tariffs by 10%; (4) permanent reduction of export subsidies by 10%. The results are presented in Fig. 2(9 and 10). In this joint simulation, the devaluation impact on price dominates (see Fig. 2(9)), with little effect on trade balance.

Despite substantial currency depreciation, India's export performance has not been significant enough to pay for its imports, whereas China with a fixed currency continues to generate vast current account surpluses. This suggests that there is something wrong with tweaking the value of the currency to gain international competitive advantage. The fact of the matter is devaluation can increase currency instability and thereby raise the risk and cost of export finance. The lack of credit and working capital needs to finance their exports may restrict the exporters from taking the cost advantage from devaluation. With currency depreciation, India's exports have just increased to 8% of GDP in 1990s from 4.7% of GDP in 1980s, whereas imports have increased to 10.9% of GDP from 8% of GDP, with net services balance at 1.6% of GDP barely changed from 1.4% of GDP over the same period. Current account deficit however has improved to an average 1.3% of GDP in 1990s, from 1.8% of GDP in 1980s. It is worth mentioning here that the current account deficit was 0.1% in 1970s with a fixed exchange rate regime, and the central government fiscal deficit was much lower at 3.8% of GDP. It appears that import liberalisation has created the higher current account deficit in the 1980s. Even with higher external liquidity in 1990s, why currency depreciation continued along with the current account deficit. Thus it is worsening trade balance that causes increased government spending and thereby higher fiscal deficit.<sup>27</sup> This paper shows that devaluation has not helped eliminating trade deficit rather it has increased domestic inflation, whereas a tight credit policy could have helped to bridge the trade gap by reducing domestic demand for imported goods in the short-run and would have also capped inflation. Besides, in the long-run, trade deficits do not necessarily reflect excess demand in the context of DEs. It is rather due to their weaker ability to export and greater propensity to import. This can be addressed via structural policies to improve export earnings and hence meet their foreign exchange requirement.

## 5. Concluding remarks

This paper focused on the inflationary and the trade balance impacts of the devaluation and the tight credit policy associated with India's 1991 crisis. A supply-side model of inflation determination in addition to the standard demand framework was estimated. Price inflation responds not only to the movement of international prices, but also more to other cost components than the excess demand. The model has then been simulated to evaluate the dynamic responses to devaluation and tight credit policy. The paper argued that devaluation is not the most efficient policy instrument, whereas short-run solutions like credit control

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devaluation, in general, does not improve the trade balance in the long-run, in some cases it even had a perverse effect.

<sup>27</sup> This can in part be due to the impact of oil imports on trade deficit, causing higher government spending and thereby fiscal deficit. Anoruo and Ramchander (1998) find trade deficits to cause fiscal deficits and not vice versa.

would be a better solution for temporary and exogenously generated disequilibria. Although the rupee continuously depreciated with respect to the dollar throughout the 1990s, exports did not respond to the falling rupee correspondingly, even with several export-related incentive schemes. This suggests that nominal currency devaluation does not improve overall export performance significantly, and consequently deficit on the trade account continues. Thus, for short-run stabilisation, controlling credit flow to reduce demand can be a better policy strategy than devaluing the currency to improve external balance. On the contrary such currency devaluation adds to higher inflation, leading to further depreciation and so on.

A clear distinction between temporary and permanent responses was made in this paper, as the overall effect of the temporary policy shock is neutral in the long-run. Evidence showed that devaluation was not a temporary shock, as the currency depreciation continued throughout the 1990s. In this model output was considered exogenous to highlight the complex dynamic interactions between inflation and trade balance. However, output exogeneity is clearly restrictive because of likely output effects of devaluation and the effects of credit conditions on investment. An explicit link between monetary, external, and output sector is essential for the model to be useful in studying the effects of medium and long-term trade policy choices on the economy.

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