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The effect of oil shocks and cyclicality in hiding Indian twin deficits

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Abstract

The paper estimates the relationship between the current account and fiscal deficit, and the real exchange rate, in a structural vector autoregression, with Indian data for the managed float period 1996Q2 to 2015 Q4, after controlling for output growth and oil shocks. It also examines the cyclicality of the current account, the size of each shock, and assesses whether aggregate demand, forward-looking smoothing, or supply shocks dominate outcomes. The current account deficit (CAD) is found to be countercyclical. A fiscal deficit shock raises the CAD, but high impact growth shocks and large variance oil shocks lead to overall divergence of the deficits. There is some support for the aggregate demand channel, but it is moderated by supply shocks and compositional effects. Consumption is sticky rather than forward-looking.

Keywords: Twin deficits, real exchange rate, growth, oil shocks, SVAR, cyclicality

JEL Code: H62, F32, D91, C22

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1. Introduction

The paper estimates the relationship between the current account and fiscal deficit for India after controlling for output growth and for oil shocks in a structural vector autoregression (SVAR) that also includes the real effective exchange rate. We are able to assess whether aggregate demand, forward-looking behaviour, or supply shocks dominate outcomes, since a minimal identification is used that does not impose a theoretical framework favouring one or the other channel. We also examine the cyclicality of the current account and the size of each shock.

A fiscal and a current account deficit can occur together but need not. A fiscal deficit creates excess demand some of which could spill over into imports thus widening the current account deficit through the aggregate demand channel. But this is not essential since private demand could be low, or the fiscal deficit could be creating demand mainly for non-tradable goods.

To the extent households are forward-looking, household savings could rise to smooth consumption against the expected future taxation that would be required to finance a permanent rise in government spending. Then a fiscal deficit need not affect the current account. This is the Ricardian equivalence hypothesis (REH). In emerging markets (EMs) especially, the issue is complicated by changes in the composition of expenditure and other supply shocks. Therefore it needs to be empirically established for different countries and time periods[1].

Both deficits rose sharply in India after the Global Financial Crisis (GFC) suggesting a fiscal deficit (FD) tends to worsen the current account or vice versa. But the current account deficit (CAD) corrected sharply after 2013 as oil prices fell, while the FD corrected only mildly. Oil shocks affect both deficits, as do GDP growth rates, so the effect of one deficit on the other can only be determined by controlling for these variables, thus removing sources of endogeneity in the deficits.

[1] The large empirical literature is surveyed in Section 2.3. Kim and Roubini (2008) is a careful pioneering study for the US, which we largely follow.

The FD can rise with oil shocks if subsidies to consumers rise or it can fall if taxes on petroleum products rise relatively more. The CAD would tend to rise with oil shocks in an oil importing country with inelastic demand for oil. The FD would tend to fall with growth if taxes rise more than expenditure. What happens to the CAD with growth depends on if investment or if savings rise more in relatively high growth periods.

The paper also seeks to comprehend better the causes of sharp fluctuations in the Indian CAD. The cyclicality of the CAD, or its relationship with the growth cycle, is also not well understood. In most EMs the CAD tends to be highly pro-cyclical as imports rise with output and raise the CAD. This would be the case if the CAD was driven by excess demand. If consumption smoothing dominates, it would be acyclical, as it is in most advanced economies (AEs). In India, however, the CAD tends to be countercyclical pointing to external shocks.

There are many specific instances of countercyclical or inverse movements between the CAD and GDP growth. As the CAD widened in 2011-12, India's GDP growth rate fell to 6.5 per cent, compared to 8.4 per cent in the previous year. Further widening of the CAD in the next year accompanied even lower growth of 5 per cent. Growth in aggregate demand categories like consumption and fixed investment also fell. As against this, the CAD was only 1.3 per cent in 2007-08, a year of high consumption and investment when output grew at above 9 per cent. Even so, the cyclical pattern also needs to be established after controlling for other shocks.

The real exchange rate appreciated even as the FD fell over 2013-15. A rise in the fiscal deficit should raise the CAD and appreciate the real exchange rate in a floating regime as higher government demand raises prices—but does this hold in India after taking out the effect of endogenous variables? Moreover, the central bank intervenes to reduce excess volatility driven by changing global risks. Therefore it is worth asking if, despite India's managed float, an FD shock appreciated the real exchange rate.

We use several SVAR variants, implemented with quarterly Indian data, to control for effects of oil prices, and the output cycle, and then see how fiscal deficit shocks affect the CAD and the real exchange rate. The cyclicality issue is addressed by examining the effect of growth shocks. The relative size of each shock is assessed through co-movement decompositions of the forecast errors. Responses to shocks help identify dominant influences on India's CAD.

The paper contributes to the literature by including supply shocks, compositional effects, cyclicality, real interest and exchange rate in a theoretically and empirically consistent way for the analysis of twin deficits. The large empirical literature on twin deficits in EMs (see Section 2.3) has not yet done this. Some studies support the aggregate demand channel, others the REH; some find unidirectional causality from the FD to the CAD and vice versa, others bi-directional. There is no study using quarterly data in a SVAR allowing the dynamic relationship between the variables to be explored. For example, in quarterly data fiscal delays imply the FD affects the CAD but not vice versa in the same quarter, with implications for the SVAR identification. Our extensions qualify the working of both the channels, with empirical exercises supporting theoretical predictions. Supply shocks and compositional effects moderate the aggregate demand channel. Consumption is sticky rather than forward-looking so the REH is not supported. We find a FD raises the CAD while the reverse relationship is weaker. But oil and growth shocks qualify this convergence of the deficits.

The large oil shocks, variations in the CAD and growth in India in the period of analysis help to estimate the interactions between the shocks and to assess the different theoretical channels. Results should also be relevant for other oil importing EMs with structural rigidities.

The remainder of the paper is structured as follows: Section 2 briefly draws out implications of theory for the relationships between the variables of interest and surveys the empirical literature; Section 3 presents the data and methodology used and discusses some stylized facts; Section 4 analyzes the results, while Section 5 concludes with policy implications. Tables and graphs are in an Appendix.

2. Theoretical frameworks

The short-run aggregate demand and long-run Ricardian equivalence frameworks that predict the relationship between the twin deficits are well known, we bring out how supply-side sectoral and compositional effects influence each, and draw out their implications for the cyclicality of the CAD.

2.1 Qualifying the aggregate demand channel

Apart from giving the excess of goods and services imports over exports, the CAD is also the excess of investment (I) over national (both public and private) savings (S). A CAD may therefore occur if national savings are low relative to investment, or if investment is high—or both. A static derivation from basic macroeconomic identities gives the CAD as the excess of investment over private savings plus the excess of government expenditure over taxes, that is, the FD[2].

So if government expenditure exceeds taxes, unless I falls or S rise, the CAD will widen. This basic identity underlies the twin deficits argument, which posits that one deficit is more likely to be found in the presence of another. But an identity needs to be supplemented by a behavioral analysis of the constituent variables before any conclusion can be drawn. For example, a FD need not imply a CAD if private savings are high.

In the short-run Mundell-Fleming model of an open economy subject to large capital flows, fiscal policy has no effect on output under a float because appreciation removes the demand stimulus from fiscal policy. Appreciation may increase the CAD, however—some demand switches abroad.

Sectoral relationships, relative price and terms of trade effects can be important in EMs. So the Mundell-Fleming demand side output determination is tempered by these supply side shocks. Section 2.4 shows how effects of C and I shocks can be expected to differ, and lead to different types of adjustments. The composition of demand matters since I also reduces supply-side bottlenecks.

2.2 Qualifying forward-looking optimization

In general the effects of temporary and permanent shocks differ under forward-looking behaviour. For example, Ricardian equivalence implies domestic savings will rise to offset a permanent fiscal stimulus. In EMs, however, the distinction between permanent and temporary shocks is not clear-cut since the steady-state is not so well defined.

[2] Adding and subtracting taxes, T, to the GDP identity as follows, GDP-T-C+T-G-I = X-M we get CAD = I-S^P+FD, which shows that private or government excess spending can imply a CAD, where aggregate S is now the sum of private, S^P, and government savings (dis-saving if there is a fiscal deficit), and foreign savings (equal to and financing the CAD).

Under simplifying assumptions of low international wealth holdings of domestic residents, a one good economy, and a rate of discount equal to the international interest rate, the theory of the dynamic current account (CA) implies (Obstfeld and Rogoff, 1995):

$$CA_t = (Y_t - \overline{Y}) - (G_t - \overline{G}) - (I_t - \overline{I}) \qquad (1)$$

Bars over the variables denote average values. There is a CAD if the expenditure components rise above average values, but a surplus if output rises above its average value. Thus when government expenditure (G) is above its average level the CA should go into deficit (become negative) as citizens borrow abroad to smooth their consumption during the period of higher than average government expenditure. But if the increase in government expenditure is regarded as permanent, smoothed consumption should fall, so that the CA is not affected as G and $\overline{G}$ both rise.

According to this theory, consumption should rise in a country well established on a transitional higher growth path that raises average growth. Under credible reform and a permanent productivity shock, both C and I should rise and S may rise or fall, depending on the size of the productivity shock and the degree of incompleteness of markets. But in the Indian case, after reforms that put it on such a path, the ratio of consumption fell steeply as the savings ratio rose from around 20 per cent to nearly 40 per cent.

The theory, however, only provides a benchmark that holds under extreme assumptions. Inability to borrow, uncertainty regarding the persistence of growth, and failures in the provision of public goods such as health, education and social security, all suggest domestic savings could rise on a higher growth path. Even if the rise in output is regarded as permanent, borrowing constraints limit consumption smoothing[3]. The distinction between temporary and permanent shocks, changes in taxes and subsidies, moving beyond the one-good assumption to bring in non-traded goods (Baxter, 1995), and incomplete markets, can all moderate twin deficits. For example, even if government net spending rises but falls largely on non-traded goods, it would not affect the current account.

[3] Ghatak and Ghatak (1996) could find no evidence to support the REH in India.

Since EM aspects that include financial constraints, sectoral effects and supply shocks temper predictions of intertemporal optimization theory consumption smoothing may not be observed.

2.3 Cyclicality

Intertemporal optimization also suggests the current account should be acyclical, as savings absorb temporary shocks. This is the stylized fact for most AEs, where the CA is acyclical or mildly procyclical. But in most EMs optimal consumption is more volatile and the CA is strongly counter-cyclical. NX falls in good times as consumption and imports rise with income. An explanation given (Aguiar and Gopinath, 2007) is shocks are regarded as permanent since trend growth, driven by policy instability, is more volatile. As expected future income also rises, optimal consumption varies more than income.

In India, however, the trade surplus (net exports, NX) is procyclical rather than countercyclical as it would be if it was driven by domestic demand. Correlation of GDP with NX normalized by GDP (GDP with NX/GDP) is a high positive compared to a high negative for the emerging and developing economy group and low negative for AEs. NX/GDP tends to fall in periods of low growth, associated with low external demand, rather than falling when rising growth and domestic demand raise imports (Goyal, 2011).

A pro-cyclical CA implies a counter-cyclical CAD. An inverse relationship between the CAD and growth can occur if as exports rise they raise growth and NX. Or a sudden collapse of export markets, due to a global shock, reduces growth and decreases NX.

Terms of trade shocks are an alternative explanation. If a deflationary oil price shock raises the import bill for inelastic oil demand, NX would fall as growth falls. This effect may dominate the fall in quantity of oil imports as growth falls, which would tend to make NX countercyclical. Moreover, if oil shocks raise costs, and as a result growth falls, the CAD would rise along with falling growth. The CA then is a source of shocks, rather than serving to smooth domestic demand. Other explanations include repeated transient supply shocks with limits on borrowing for consumption. Policy that magnified the negative effect of supply shocks on growth would make NX more pro-cyclical.

For example, 2011-12, the year of the sharp rise in Indian CAD to 4.2 per cent of GDP, saw both a sharp rise in oil prices and fall in growth. The trade deficit was large and negative over 2011-2013, but changes to a surplus if oil and gold imports are subtracted from it. If higher C, I volatility does not drive income volatility, but follows it, it is supply shocks not demand shocks from C, I that are the source of variation.

Over the longer-period, despite high fiscal deficits the Indian CAD averaged about 1 per cent of GDP, and there was a brief period when it was in surplus. Private savings were normally high enough to compensate for government dissaving. But high inflation could reduce financial savings, as happened in 2011. In 2011-12 the CAD rose to 4.2 per cent of GDP, from 2.7 per cent the previous year – that is, by 1.5 percentage points. Investment fell from 36.8 to 35 per cent, or by 1.8 percentage points, while savings fell more from 34 to 30.8 or by 3.2. The largest fall in a savings component was in household financial savings from 10.4 to 8 per cent, or by 2.4 percentage points. This, together with fall in corporate saving of 0.7, itself almost entirely covered the rise in CAD and fall in investment. Household physical savings actually increased by 1.2 almost covering the fall in public sector saving of 1.3.

Physical savings largely equal household investment. The latter creates demand for non-traded goods such as construction activity (Goyal, 2015). Since corporate investment has a large share of traded goods, it should require a widening of the CAD. Government consumption or subsidies also fall more on non-tradables.

2.4 Empirical literature

Some papers find support for the twin deficit hypothesis (Cavallo 2007, Erceg et al 2005) others do not (Kim and Roubini, 2008, Kaufman, 2002). Even so, Cavallo finds government spending on non-traded goods moderates the effect of the FD on the CAD, while Erceg et al (2005) get a similar moderation from a low response of trade to induced real appreciation following a FD. Kim and Roubini (2008), who also survey the large literature on AEs, find a FD actually reduces a CAD in the US and depreciates the REER. Both are difficult to reconcile with the effect of an FD on demand. Reasons they identify for the first are a Ricardian rise in savings, and a fall in investment; for the second a nominal depreciation following a rise in risk with higher FDs combined with sticky prices.

Early studies on the relationship between the two deficits in EMs tested for bi-directional Granger causality between the FD and the CAD in a VAR estimated with annual data. Kulkarni and Ericsson (2001) found causality from the FD to the trade deficit, supporting the aggregate demand channel for India, Pakistan, and Mexico, in a bi-variate VAR estimated with 30 years data ending in the mid-nineties. Kouassi, et al (2004), however, indicate the REH may hold. A bi-variate analysis, however, has limitations. Moreover, these studies were for a period when the exchange rate was fixed. Banday and Aneja (2016) find bilateral causality in a multivariable VAR estimated over 1990-2013 for India. Ratha (2015) includes the real exchange rate and incomes in a cointegration and error correction test of the two hypotheses for the Indian post reform period 1998-2009 using bounds testing. He finds support for the aggregate demand channel in the short-run and for REH in the long-run. But Anoruo and Ramchander (1998) in a multi-variate study of 5 Southeast Asian countries find causality running from the CAD to the FD. They estimate a full information maximum likelihood VAR with normalized stationary deficits, including control variables. Their data set ending in 1993, varied from 66 to 33 years. These studies include inflation but not oil prices that directly affect the CAD.

Kim and Roubini (2008) applied an SVAR approach with quarterly data following Blanchard and Perotti’s (2002) strategy of estimating the effects of a fiscal shock after controlling for endogeneity from output. Suresh and Tiwari (2014) followed a similar methodology for India, in a four variable VAR and SVAR including the real exchange rate and income, and found support for twin deficits for the period 1978-2011. They used annual data, however, and did not control for oil shocks, or examine the cyclicality of the CAD and compositional effects as we do.

3. Data and Methodology

3.1 Data

We use quarterly data from 1996 Q2 to 2015 Q4 for FD, primary deficit (PD), revenue deficit (RD), government capital expenditure (CE), government revenue expenditure (RE), government total expenditure (TE), CAD, trade deficit (TD), constant price private final consumption expenditure (PFCE), constant price gross fixed capital formation (GFCF), current price gross domestic product (GDP) at factor cost, constant price gross domestic product at factor cost (GDPFC), oil price in USD per barrel, 15-91 days treasury bill rate, call money rate, consumer price inflation, wholesale price inflation and 36 currency trade based real (REER) and nominal (NEER) exchange rate. *Ex-post* expected real interest rate (RIR) was calculated as: call money rate in period t - wholesale price inflation in period $t + 1$.

Apart from oil prices and fiscal variables, all other variables are from the RBI database. Quarterly data series from 1998 Q2 to 2015 Q4 on fiscal variables from the comptroller general of accounts website were supplemented by fiscal deficit from the RBI website where the series starts from 1996Q2. Brent crude oil price in US$ per barrel were from Quandl[4]. For the REER only monthly series is available, so we took the value at the end of the previous quarter. Consumer price inflation and wholesale price inflation are year on year inflation calculated from their respective price indices. All variables except prices, interest rates and exchange rate were seasonally adjusted by X-13ARIMA-SEATS using R Seasonal Package.

We require real variables since they are relevant for aggregate demand. To calculate ratios of variables to output, we used values in current prices divided by current price gross domestic product at factor cost, since the prices in the numerator and denominator would cancel out. Rates of growth were used for dollar oil prices, constant price output, consumption and investment. These ratios and growth rates are listed in Table 1, with REER given in logs. Our benchmark SVAR model consists of the five variables: first difference of log of oil price (OIL$G), growth rate of constant price gross domestic product at factor cost (GDPG), fiscal deficit to GDP ratio (FDR), current account deficit to GDP ratio (CADR) and log of trade based real exchange rate (REER).

Retropolation[5], rather than interpolation between the benchmark years of successive series, was used to create a continuous series for the national accounts variables as we were going to work with growth rates. We checked for the robustness of our procedure by matching the retropolated current price GDP with simply taking its values from the latest base year and compiling.

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[4] https://www.quandl.com/data/ODA/POILBRE_USD

[5] Consider two series for an economic variable of interest X_t and Y_t. The old series X_t end at T where the new series Y_t starts. For retropolation we calculate the difference of log between the two series at T, that is, $d_t = \log Y_T - log\, X_T$ and add this difference to X_t till T to create a uniform series thus preserving the growth rate of the old series. The implicit assumption is that the "error" contained in the older series remains constant over time that is, that it already existed at time 0 and that its magnitude, measured in proportional terms, has not changed between 0 and T. Interpolation on the other hand assumes that the error has increased linearly over time and so in this case X_t is transformed as $X_t + \frac{t}{T} d_t$. In this case the starting value of X_t call it X_0 is not changed (Fuente, 2014).

3.1.1 Stylized facts

Line graphs of the variables used illustrate some of the features discussed in Section 2, and will also help understand some of the results obtained in Section 4. The FD tends to fall in periods of high growth. While the NEER depreciated quite sharply after 2008, with some spikes, this could not prevent sharp appreciations of the REER. The latter did however tend to come back to an index value of 100 after deviations lasting a few years. The trade and current account deficits have countercyclical stretches—rising when growth is low and dollar oil prices high.

The ratio of PFCE to GDP fell sharply in the boom years lasting to 2008 prior to the GFC while the ratio of GFCF rose. Both fell during the GFC and then fluctuated around previous peaks. Their dips coincided with sharps peaks in the RIR. Thus the consumption ratio fell much more in high growth periods than it rose in low growth periods, suggesting it is sticky. It also implies the savings ratio would rise in high growth periods and fall in low growth periods. Although investment rose, so did savings during the growth boom so that the CAD fell. The latter rose in the subsequent period when growth fell as oil prices rose and capital formation fell more than consumption did. Table 1 shows variable mean and variances, and that the latter were highest for oil shocks.

3.2 Methodology

Structural vector auto regressions are estimated and impulse responses (IRs), forecast error variance decompositions (FEVDs), and co-movement decompositions due to shocks obtained. We assume that one step ahead prediction $\mu_t = y_t - E(y_t|\mathcal{F}_{t-1})$ can be written as a linear function of the structural shocks ϵ_t where $\mathcal{F}_{t-1}$ is the set of information available till time $t - 1$. In its most general form a structural model is the pair of equations:

$$A\mu_t = B\epsilon_t$$

Where μ_t are reduced form shocks and ϵ_t are structural shocks. The reduced form vector auto regression given below can be estimated using ordinary least square equation by equation:

$$y_t = \theta_0 + \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + \mu_t$$

Once we have obtained μ_t we have to use the relation between structural and reduced form shocks to obtain the structural shocks of interest. We can write $\mu_t = A^{-1}B\epsilon_t$. One can write $A^{-1}B = C$ to obtain $\mu_t = C\epsilon_t$ which represents reduced form shock as a linear combination of structural shocks. Under the assumption of normality the average log-likelihood can be written as:

$$L = const - \ln|C| - 0.5 \times trace\left(\sum_{\mu}(CC')^{-1}\right)$$

As we can see the above model is not identified as we have n^2 parameters in both A and B. We know μ_t and we have we have $(n^2+n)/2$ free parameters in μ_t (Σ_μ) and thus we can identify at max $(n^2+n)/2$ parameters in A and B together. This implies we have to place at-least $n^2 + \frac{n^2-n}{2}$ restrictions to identify the model. This is a simple order condition and is necessary not sufficient. Sufficient rank conditions have been explained in Amisano-Giannini (1997). As we can see from the number of restrictions required we have to place restrictions on both A and B to identify the model. The simplest identification scheme is that A is the identity matrix and B is lower triangular. This C model is the famous Cholesky decomposition and is a type of short run restriction. Although we put restrictions on the contemporaneous relation between reduced form and structural shocks it turns out to restrict contemporaneous relation between endogenous variables as the inverse of a lower triangular matrix is lower triangular only. The same may not hold true for any arbitrary restrictions on the B matrix.

Thus since we know Σ_μ (covariance matrix of reduced form residual), we can always write $\Sigma_\mu = C\Sigma_\epsilon C' = (A^{-1}B)\Sigma_\epsilon(A^{-1}B)'$. Various kinds of normalization are possible from here. We will normalize Σ_ϵ and A as an identity matrix thus leaving the diagonal elements of B free. One can calculate $C = A^{-1}B$ as lower triangular matrix as discussed above. By construction a unit innovation in the structural shocks in this representation is an innovation of size one standard deviation, so structural impulse responses are based on one-standard deviation shocks. For post estimation analysis, once we have obtained the C matrix, we can use the moving average representation of reduced form VAR given by $y_t = E(L)\mu_t$ to obtain $y_t = E(L)C\epsilon_t$ as structural moving average representation given below in extended form to obtain impulse responses:

$$y_t = \psi_0\epsilon_t + \psi_1\epsilon_{t-1} + \cdots + \psi_p\epsilon_{t-p}$$

The variance of the s period ahead forecast of the ith element of y, y_i is given by:

$$E\left[(y_{i,t+s}-E_t y_{i,t+s})(y_{i,t+s}-E_t y_{i,t+s})'\right]=\sum_{l=1}^{k} VAR_{s,l}(y_i)=VAR_s(y_i)$$

Where $VAR_{s,l}(y_i)=\sum_{ll}\left[\psi_{0,il}^2+\psi_{1,il}^2+\cdots+\psi_{s-1,il}^2\right]$ is the contribution of lth structural shock; this is the FEVD due to a given shock. Similarly, the covariance between the s-period ahead forecast error y_i and the s-period ahead forecast error of y_j can be decomposed into a part due to each structural disturbance as follows:

$$E\left[(y_{i,t+s}-E_t y_{i,t+s})(y_{j,t+s}-E_t y_{j,t+s})'\right]=\sum_{l=1}^{k} COV_{s,l}(y_i,y_j)=COV_s(y_i,y_j)$$

Where $COV_{s,l}(y_i,y_j)=\sum_{ll}\psi_{0,il}\,\psi_{0,jl}+\psi_{1,il}\psi_{1,jl}+\cdots+\psi_{s-1,il}\psi_{s-1,jl}$ and can be called "Co-movement Decomposition". From here one can calculate the conditional correlation of y_i,y_j due to an individual shock and with respect to all shocks as given below:

$$CCORR_s=\frac{COV_s(y_i,y_j)}{\sqrt{VAR_s(y_i)VAR_s(y_j)}}$$

$$CCORR_{s,l}=\frac{COV_{s,l}(y_i,y_j)}{\sqrt{VAR_{s,l}(y_i)VAR_{s,l}(y_j)}}$$

We can also use long run restrictions to identify the model. From above structural moving average representation we define $D(L)=E(L)C$ and we can obtain $E(1)C=D(1)$ where $E(1)=\sum_{j=0}^{j=\infty}E_j$ and $D(1)=\sum_{j=0}^{j=\infty}D_j$. By restricting the element of $D(1)$ we can implement long run restrictions. For example, if we have a vector of 5 variable and we impose the restriction that long run impact of fourth variable on fifth variable is zero. This effectively means $D_{5,4}(1)=0$. One can use combination of long and short run restrictions to identify the model provided that it satisfies rank and order conditions. Once identified and estimated, IR and FEVDs can be calculated as usual.

3.2.1 Estimated models

The Cholesky identification was imposed with the order below in the benchmark model. The justification is while dollar oil prices are contemporaneously exogenous, growth affects the FD as revenues change, but lags in fiscal decisions imply other current macro variables do not contemporaneously affect the FD.

The identification scheme in terms of shocks is:

$$\begin{bmatrix} \mu_{OIL\$G,t} \\ \mu_{GDPG,t} \\ \mu_{FDR,t} \\ \mu_{CADR,t} \\ \mu_{REER,t} \end{bmatrix} = \begin{bmatrix} C_1 & 0 & 0 & 0 & 0 \\ C_2 & C_6 & 0 & 0 & 0 \\ C_3 & C_7 & C_{10} & 0 & 0 \\ C_4 & C_8 & C_{11} & C_{13} & 0 \\ C_5 & C_9 & C_{12} & C_{14} & C_{15} \end{bmatrix} \begin{bmatrix} \epsilon_{OIL\$G,t} \\ \epsilon_{GDPG,t} \\ \epsilon_{FDR,t} \\ \epsilon_{CADR,t} \\ \epsilon_{REER,t} \end{bmatrix}$$

For robustness we tried other identifications, changed variable definitions, added new variables such as the RIR, or substituted with other variables. For example, we substituted other deficits or types of government expenditure for FDR; used gross fixed capital formation (GFCF) and private final consumption expenditure (PFCE), for which quarterly data is available, as respective activity variables instead of GDPFC in order to assess compositional effects; and used bilateral RER (INR/USD using CPI) instead of REER. In order to see the effect on the components of the CAD, GFCF is used as an additional variable in a six variable SVAR. RIR was added in another six variable SVAR to assess the monetary stance. An alternative identification where the FD is allowed to contemporaneously affect GDP was also used. Estimation periods for these models were 1998 Q2 to 2015 Q4.

We estimate the vector auto regression models with four lags and then select optimal number of lags. Lag length selection criterion such as FPE, AIC, HQIC and SBIC suggest one lag and so we estimate the model with one lag (Table 2). OLS is used except for the last model with long-run restrictions where maximum likelihood estimation was done. Maximum eigenvalue[6] estimated is 0.885055 < 1 and therefore moving average representation for estimating IR, FEVD and comovement decomposition can be obtained. Augmented Dickey Fuller tests with lag one show all variables are stationary except the REER. Stability of the VAR models implies that the system of variables is covariance stationary. Confidence bands were created using. Using the 16th percentile and 84th percentile of the Kilian (1998) small-sample bias corrected bootstrap as lower and upper bound gives roughly one standard deviation (68%) confidence intervals.

The model with RIR is:

[6] Estimated model is $y_t = c + \phi_1 y_{t-1} + \epsilon_t$. Eigenvalues $\lambda_1, \lambda_2, \dots, \lambda_n$ are solutions of the characteristic equation $|\phi_1 - \lambda I_n|$.

$$\begin{bmatrix} \mu_{OIL\$G,t} \\ \mu_{GDPG,t} \\ \mu_{FDR,t} \\ \mu_{CADR,t} \\ \mu_{RIR,t} \\ \mu_{REER}, t \end{bmatrix} = \begin{bmatrix} C_1 & 0 & 0 & 0 & 0 & 0 \\ C_2 & C_7 & 0 & 0 & 0 & 0 \\ C_3 & C_8 & C_{12} & 0 & 0 & 0 \\ C_4 & C_9 & C_{13} & C_{16} & 0 & 0 \\ C_5 & C_{10} & C_{14} & C_{17} & C_{19} & 0 \\ C_6 & C_{11} & C_{15} & C_{18} & C_{20} & C_{21} \end{bmatrix} \begin{bmatrix} \epsilon_{OIL\$G,t} \\ \epsilon_{GDPG,t} \\ \epsilon_{FDR,t} \\ \epsilon_{CADR,t} \\ \epsilon_{RIR,t} \\ \epsilon_{REER,t} \end{bmatrix}$$

With a contemporaneous relation between the FDR and GDPG our model becomes:

$$\begin{bmatrix} \mu_{OIL\$G,t} \\ \mu_{GDPG,t} \\ \mu_{FDR,t} \\ \mu_{CADR,t} \\ \mu_{REER,t} \end{bmatrix} = \begin{bmatrix} C_1 & 0 & 0 & 0 & 0 \\ C_2 & C_6 & C_{16} & 0 & 0 \\ C_3 & C_7 & C_{10} & 0 & 0 \\ C_4 & C_8 & C_{11} & C_{13} & 0 \\ C_5 & C_9 & C_{12} & C_{14} & C_{15} \end{bmatrix} \begin{bmatrix} \epsilon_{OIL\$G,t} \\ \epsilon_{GDPG,t} \\ \epsilon_{FDR,t} \\ \epsilon_{CADR,t} \\ \epsilon_{REER,t} \end{bmatrix}$$

We complete the identification by putting one long run restriction that fiscal deficit does not affect growth in the long run. This implies $D_{2,3}(1) = 0$, and makes it possible to estimate the model using the likelihood given above**.**

4. Results

The IRs are reported in panels where the shocks are given on top and variable responses on the left. The benchmark model (Figure 2 and Table 3) shows an FD raises the CAD, supporting twin deficits; but oil and growth shocks have opposite effects on the two deficits explaining periods of divergence in the deficits (Figure 2).

The correlations between CAD and FD under different shocks are shown in Table 4. The comovements between the two deficits under the same shocks are shown in Table 5. They are positive under CAD and FD shocks but negative under the other three shocks. The FD shock has the largest impact on the comovement of CAD and FD. Both shocks are of the same sign. Table 1 shows the standard deviation of the oil shock to be the largest at 9.5. This therefore dominates, explaining the divergence between the CAD and FD observed in the data (Figure 1). The impact of the FD on the CAD is larger than that of the latter on the FD.

A positive growth shock turns the CAD into a surplus, which gradually reduces and becomes a deficit as growth falls. This is consistent with the observed counter-cyclicality of the

CAD—it being higher in low growth periods. A growth shock turns the FD into a surplus[7]. An oil shock also has this effect. We work with dollar oil prices. Prior to an oil shock growth is normally at a peak, explaining the immediate rise in growth, fall in FD, and CAD, in the IRs to an oil shock (Figure 2). Institutional arrangements delayed pass through in the estimation period. But all three trends reverse over time. An FD shock reduces growth, but the IR is insignificant in a few initial quarters.

The confidence intervals, shown in the figures, are adequate for the first three shocks, but are wide for the CAD and REER shocks, but IRs are still significant in some stretches. A CAD and an oil shock lead to a real appreciation, which significantly worsens the CAD[8]. Inflation following cost shocks may be further appreciating the real exchange rate. A CAD shock itself mildly increases growth although the IR is not significant in some initial quarters. It also mildly raises the FD and appreciates the REER.

The FEVDs for the benchmark model, reported in Table 3, show that while own shocks dominate, upto 12.5 per cent of the variation in FD is explained by GDP growth with oil shocks accounting for half of that. The second largest immediate impact on the CAD comes from oil shocks, although REER shocks overtake these by the 10th quarter reaching 6 per cent. GDPG has the second largest impact on REER variance, after own shocks, reaching 13 per cent by 10 quarters while the share of FD is only 5 per cent.

Our several robustness exercises support the trends identified, give further detail on causal mechanisms, and check the validity of the identification used. Substituting GFCF growth for output growth shows some differences in the IRs (Figure 3). A positive FD shock raises GFCF, possibly since it allows more investment to be financed. But a rise in the CAD reduces GFCF, suggesting it is more vulnerable to external risks that limit external financing. Under a positive GFCF shock the current account is always in surplus, suggesting expansion in domestic supply or lower dependence of investment on imports. The first is more likely since the sensitivity of GFCF to a CAD suggests investment requires imports.

The impact of FD, CAD and REER shocks on PFCE is like that for GDP growth (Figure 4), and the opposite of GFCF. A REER depreciation raises PFCE pointing perhaps to inelastic

[7] Although the confidence interval is wide in the first few quarters, it lies mostly in the negative quadrant.
[8] The IR of the REER on the CAD shock is insignificant.

imports such as oil. But under a PFCE shock the CAD is always in deficit, and the fiscal deficit does not become a surplus.

Substituting the primary or revenue deficit for FD gives the same pattern as for FD. Using the trade deficit instead of the CAD—shows it to be always a deficit[9]. If TE, RE and CE are substituted for FD, similar patterns are obtained for all three. The IRs for TE are reported in Figure 5. As in the benchmark model, any kind of government expenditure shock reduces growth, but the growth reduction is least with CE. The only difference from the IRs with FD is that a government expenditure shock leads to an initial current account surplus (CAS), and a CAD shock reduces government expenditure although it increases the FD. The CAS suggests government expenditure falls more on non-tradables, while a tax cut raises imports. Although expenditure falls, revenues may be falling or subsidies rising more than the fall in expenditure under a CAD shock, explaining the rise in FD.

Introducing RIR in the model does not change any of the impulse response patterns (Figure 6), supporting their robustness. A RIR shock (rise) decreases growth, raises the FD, turns the CAD into a surplus, and appreciates the RER. But the RIR falls in response to a rise in oil prices, growth and FD. Monetary policy accommodates all three. It is possible that expected inflation, used to calculate the RIR in the period of estimation, exceeds any rise in nominal rates explaining the RIR fall. The RIR only rises in response to a CAD shock. It does not show much response to a REER shock.

Both an FD and a RIR shock (rise) depreciate the REER. The first is counter to the aggregate demand channel whereby an FD as a manifestation of excess demand should raise prices and appreciate the rupee, and the second is counter to uncovered interest parity whereby a rise in domestic rates should attract more inflows. These results suggest growth is a more powerful attractor of inflows. Both an FD and a RIR rise decrease growth, and therefore reduce inflows and depreciate the rupee. That a FD shock depreciates the REER may also point to excess capacity so that a FD does not raise inflation. But precision is lowest in the IRs due to REER shocks. This may be because the Indian managed float reduced variation in the REER.

[9] These IRs are not reported to save space, but are available on request.

When contemporaneous correlation is allowed between the FD and growth, since it is possible that an FD stimulates growth in the same quarter, the IRs (Figure 7) are the same as in the benchmark model with the recursive structure except that growth rises on impact under an FD shock before it falls as in the benchmark. Thus even with the alternative identification any impact of the FD on growth is short-run and transient. An FD shock still significantly depreciates the REER.

When GFCF is added after CAD, in order to see how the components of the CAD adjust to a CAD shock (Figure 8) GFCF falls. Results (available on request) using PFCE instead of GFCF show it rises implying savings also fall[10]. Thus consumption is sticky to external shocks while GFCF and savings adjust. Consumption which does not rise or fall with persistent shocks supports habit formation rather than the Ricardian hypothesis of forward-looking consumption smoothing. It implies savings volatility would exceed that of consumption. We saw this also in the stylized facts (Section 3).

GFCF expands supply but is sensitive to financing and to the CAD. Increase in GFCF reduces the FD while a rise in PFCE raises it. An FD does not lead to real appreciation but real appreciation significantly raises the CAD after a two year period. A shock appreciating the REER mildly and insignificantly raises growth and turns the FD into a surplus.

The results imply twin deficits can be expected to occur except in the presence of large oil shocks, when the FD and CAD move in opposite directions. The results are robust since they hold in a variety of models. Standard aggregate demand effects are there: The FD does raise the CAD and has transient effects on growth. But these shocks are dominated by supply shocks and composition effects. As activity and as adjusting variables C and I have differential effects. Inefficiencies in government expenditure vitiate its effect on demand. Under demand shocks both deficits move together, so the observed divergence in the two deficits points to the dominance of supply shocks in the estimation period.

REH is not supported. Consumption is sticky, implying consumption smoothing is absent with savings adjusting more. Relative price affects, such as through oil shocks, affect consumption and the CAD, while the supply-side effects of GFCF dominate its effect on

[10] Quarterly data is not available on savings itself.

demand. For example, a PFCE shock raises CAD and FD, but GFCF decreases both. If aggregate demand affects, or a rise in investment to smooth consumption following a productivity shock, were dominating, a rise in GFCF should also raise the CAD.

The literature explores the relationship between the two deficits and if the aggregate demand channel is supported or REH, and gets mixed results. We find more support for aggregate demand than for REH—the two deficits do move together but oil shocks and effects of output can create the divergence observed in the data.

6. Conclusions and policy implications

The estimations suggest answers to the questions raised in the introduction. Even controlling for output growth and oil shocks a fiscal deficit does tend to raise the current account deficit, and it explains the largest part of their co-movement. But income and oil shocks themselves cause the two deficits to diverge, and since oil shocks had the highest variance in the period of estimation, they explain the observed divergence between the FD and the CAD.

The CAD rises with oil shocks pointing to inelastic demand for oil. But the FD falls with oil shocks suggesting that taxes on oil products and profits of public sector oil producers dominate subsidies. Government expenditure falls more on non-traded goods.

The CAD first falls with a growth shock and then rises as growth falls so it is countercyclical. Supply shocks and compositional effects explain this. Both investment and savings rise under growth shocks, but a CAD decreases investment. Consumption is sticky. The FD falls with growth, implying taxes rise more than expenditure.

The effect of oil shocks and the differential impact of consumption and investment suggest compositional effects and supply shocks dominate the behavior of India's CAD, moderating the aggregate demand channel. Ricardian equivalence is not supported. For example, the supply side impact of investment dominates its impact on demand.

There are a number of implications for policy. First, an FD and a RIR shock both depreciate the REER. One reason maybe both decrease growth, which reduces foreign inflows. Therefore an interest rate defense of the exchange rate must not be used in India. Exchange rate adjustment is preferable to use of the interest rate defense.

Second, a CAD shock appreciates the real exchange rate which worsens the CAD. Since the effects on CAD become substantial after about 8 quarters it implies over-valuation should not be allowed to persist beyond 2 years.

Third, from the point of view of minimizing its impact on the CAD a FD should take the form of a rise in capital expenditure rather than a cut in taxes. But the efficiency of public expenditure has to improve. Investment decreases the fiscal deficit but is vulnerable to financing and CAD shocks, therefore measures should be taken to protect investment expenditure, while making consumption of oil products more price elastic.

The compositional effects can be more carefully explored in further research, and supply-side factors included in studies for other EMs

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Appendix:

Table 1: Data summary

Variable	**Mean**	**Median**	**Std. Deviation**
Oil $ Price Growth	0.93	3.95	9.05
GDPFC Growth	1.68	1.68	0.65
Consumption Growth	1.55	1.58	2.07
Investment Growth	2.08	2.08	3.38
FD ratio to GDP	5.43	5.54	1.64
CAD ratio to GDP	1.40	1.36	2.07
TD ratio to GDP	6.41	6.95	3.05
Log REER	4.62	4.61	0.06
Real Interest Rate	1.76	2.11	3.85
RD ratio to GDP	3.79	4.21	1.46
PD ratio to GDP	1.29	1.14	1.58
RE ratio to GDP	13.88	13.70	1.85
CE ratio to GDP	2.68	2.11	1.81
TE ratio to GDP	16.45	16.14	2.57

Figure 1: Data Graphs

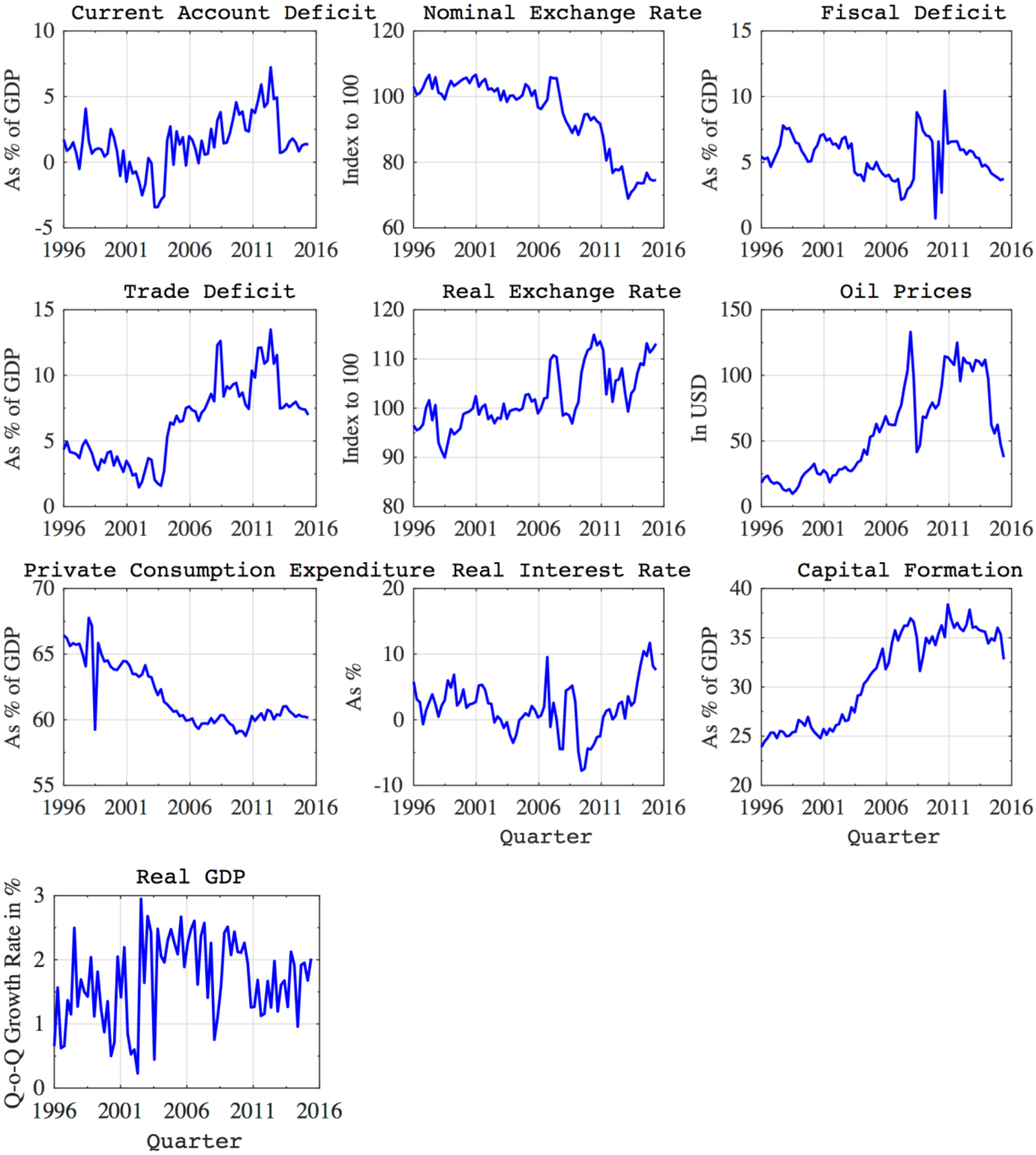


Table: 2 Lag Length Selection and VAR Stability

VAR model: variables	Lag Length Selection Criterion FPE	AIC	HQIC	SBIC	Maximum Eigenvalue
OIL$G, GDPG, FDR, CADR, REER	1	1	1	1	.885055
OIL$G, GFCFG,FDR, CADR, REER	1	1	1	1	.885056
OIL$G, PFCEG, FDR, CADR, REER	2	2	1	1	.888184
OIL$G, GDPG,TER, CADR, REER	1	4	1	1	.898914
OIL$G, GDPG, FDR, CADR, RIR, REER	1	1	1	1	.872713
OIL$G, GDPG, FDR, CADR, GFCFG, REER	1	1	1	1	.883347

Note: Numbers 1, 2 and 4 are the optimal lag for the given model in corresponding row based on the criteria in corresponding column.

Table 3: FEVD for the benchmark model

Quarter	OIL$G Shock	GDPG Shock	FDR Shock	CADR Shock	REER Shock
Variance Decomposition of FD					
1	5.74	8.07	85.03	0.59	0.58
5	6.27	11.87	77.31	1.95	2.60
10	6.35	12.29	75.51	2.48	3.37
15	6.30	12.42	74.73	2.87	3.69
20	6.27	12.49	74.44	2.99	3.81
Variance Decomposition of CAD					
Quarter	OIL$G Shock	GDPG Shock	FDR Shock	CADR Shock	REER Shock
1	5.19	2.37	3.39	88.52	0.53
5	5.81	4.88	3.92	81.22	4.17
10	5.90	5.86	4.21	77.04	6.99
15	5.92	6.26	4.38	75.33	8.11
20	5.99	6.39	4.51	74.56	8.56
Variance Decomposition of REER					
Quarter	OIL$G Shock	GDPG Shock	FDR Shock	CADR Shock	REER Shock
1	1.69	4.03	2.84	1.55	89.89
5	2.74	10.87	4.94	4.48	76.96
10	3.05	12.95	5.14	5.98	72.88
15	3.23	13.25	5.24	6.66	71.61
20	3.25	13.23	5.39	6.88	71.25

Table: 4 Conditional Correlation Between Current Account and Fiscal Deficit

Quarter	OIL$G Shock	GDPG Shock	FDR Shock	CADR Shock	REER Shock	All Shock
1	-0.25	-0.33	0.93	0.57	-1.00	0.18
	(-0.88,0.50)	(-0.94,0.72)	(0.75,0.99)	(0.45,0.62)	(-1.00,1.00)	(0.07,0.27)
5	-0.30	-0.53	0.80	0.63	-0.91	0.14
	(-0.76,0.40)	(-0.84,0.47)	(0.48,0.95)	(-0.19,0.74)	(-0.99,0.65)	(-0.02,0.28)
10	-0.28	-0.46	0.72	0.59	-0.85	0.11
	(-0.73,0.37)	(-0.80,0.38)	(0.36,0.91)	(-0.28,0.74)	(-0.98,0.69)	(-0.07,0.28)
15	-0.28	-0.44	0.69	0.57	-0.84	0.10
	(-0.73,0.36)	(-0.79,0.35)	(0.31,0.90)	(-0.28,0.74)	(-0.98,0.68)	(-0.10,0.28)
20	-0.29	-0.44	0.68	0.57	-0.83	0.10
	(-0.73,0.35	(-0.79,0.34)	(0.29,0.90)	(-0.28,0.73)	(-0.97,0.69)	(-0.11,0.28)

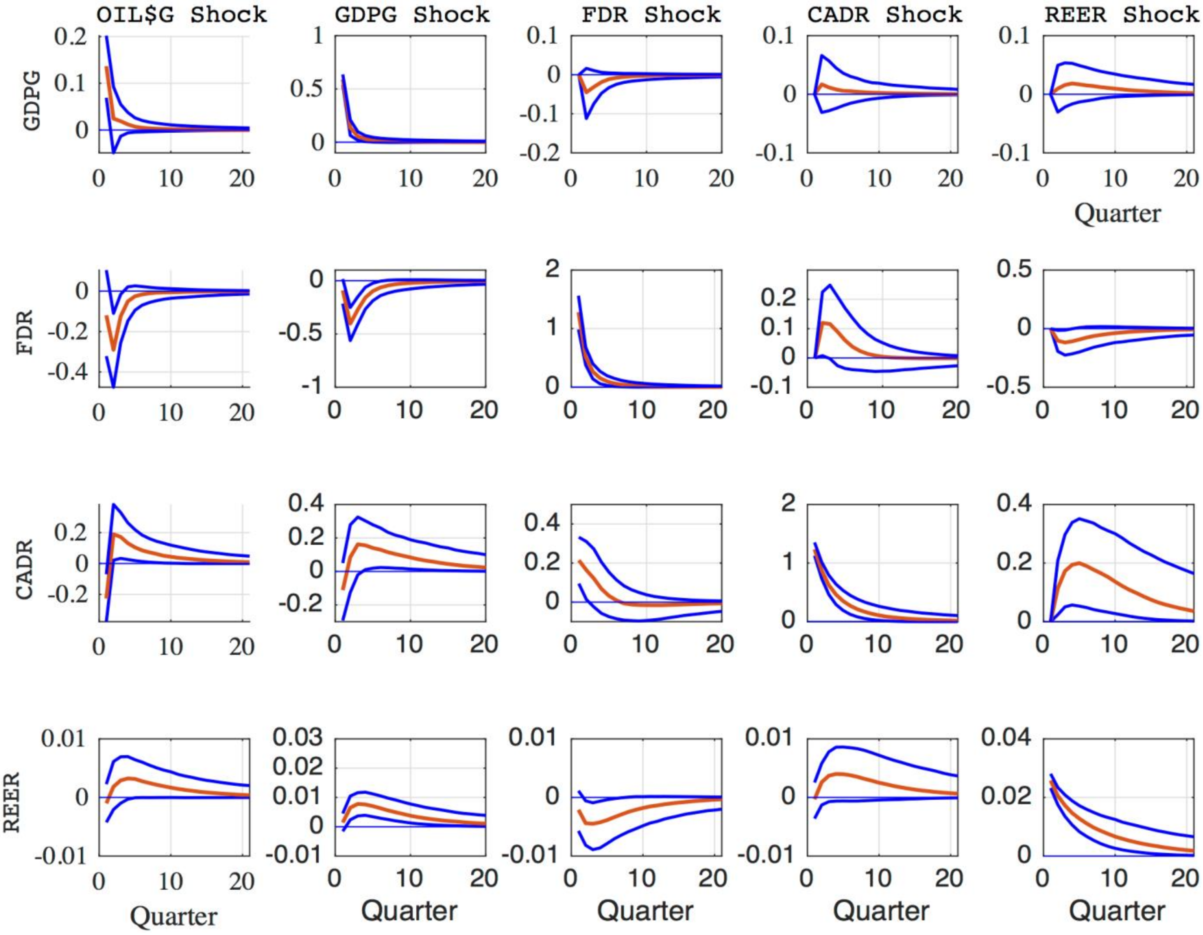
Note: Based on the shocks we obtain the conditional covariance between fiscal deficit and current account deficit (product of the respective forecast error) and conditional forecast variance with 68 per cent probability bands. Then using the correlation formulae as given in the text, we obtain conditional correlations due to each shock and all shocks in the estimated model.

Table: 5 Co-movement Decomposition of Current Account and Fiscal Deficit

Quarter	OIL$G Shock	GDPG Shock	FDR Shock	CADR Shock	REER Shock
1	-5.57	-2.19	86.72	23.12	-2.09
	(-22.15,16.06)	(-23.66,24.08)	(34.76,137.25)	(0.88,49.80)	(-6.42,0.26)
5	-9.37	-18.40	91.00	50.35	-13.59
	(-38.42,14.63)	(-64.99,21.85)	(30.70,159.97)	(-9.82,129.49)	(-44.56,2.97)
10	-11.01	-27.13	103.27	57.67	-22.80
	(-50.14,17.24)	(-85.70,24.90)	(31.59,188.92)	(-21.94,162.64)	(-90.18,6.37)
15	-11.81	-28.96	106.97	59.00	-25.21
	(-54.46,18.36)	(-97.09,25.27)	(30.85,196.34)	(-26.09,168.45)	(-113.18,9.34)
20	-12.24	-29.58	109.10	59.20	-26.47
	(56.44,18.63	(-103.86,25.89)	(31.13,201.56)	(-30.30,172.52)	(-129.16,10.33)

Note: These values give proportion of covariance attributed to each shock. This is similar to forecast error variance decomposition and can be called forecast error covariance decomposition. We attribute covariance to the respective shocks as forecast error variance is attributed to the shocks. The brackets give the 16th and 84th percentile of 1000 co-movements created using bootstrap.

Figure 2: Benchmark model



Notes: The LHS shows variables responding to one s.d. shocks listed on the column heads. The Cholesky identification uses the variables in the order shown.

Figure 3: Capital formation as the activity variable

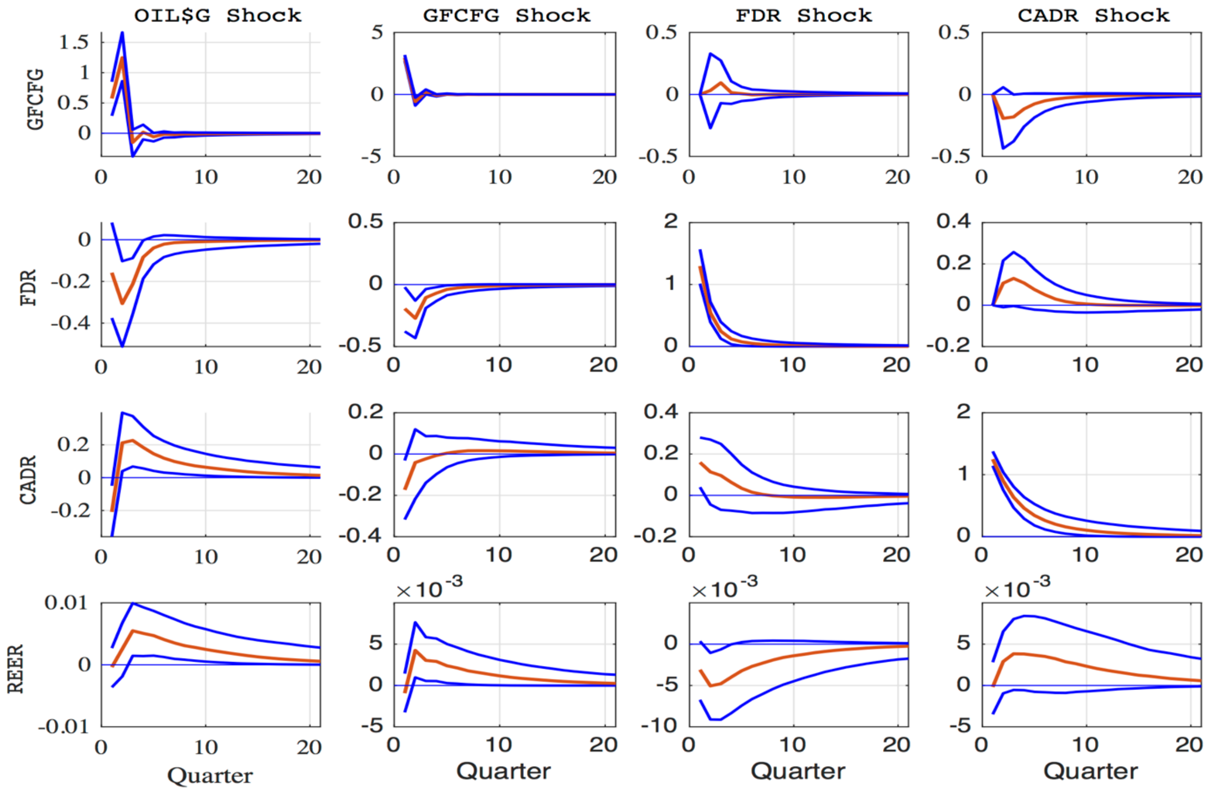


Figure 4: Consumption as the activity variable

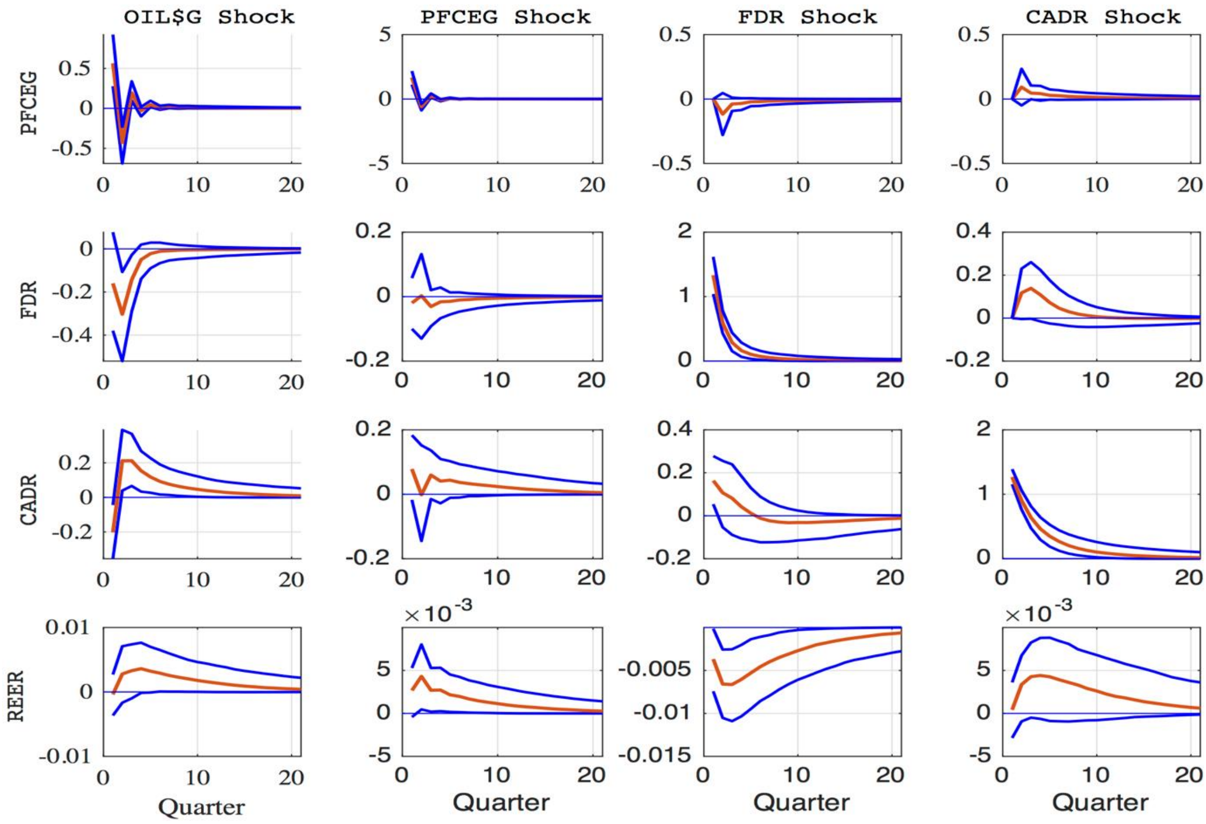


Figure 5: Using government total expenditure instead of deficit

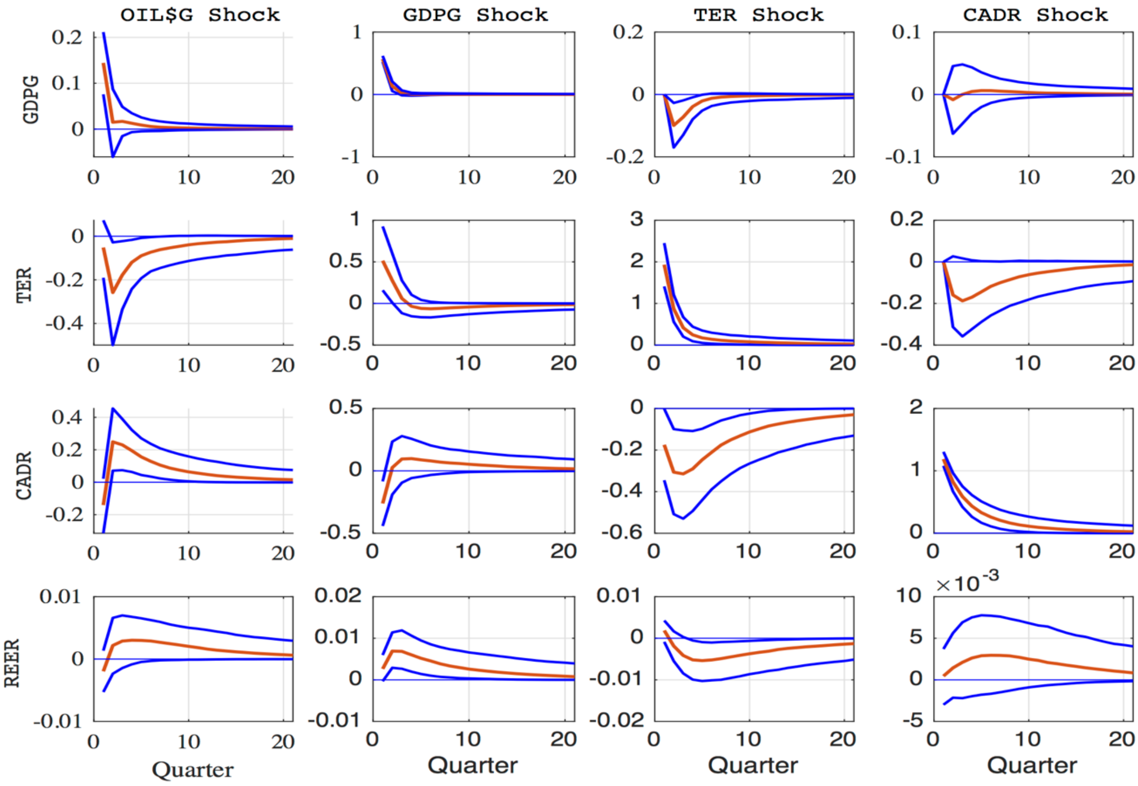


Figure 6: Adding the real interest rate

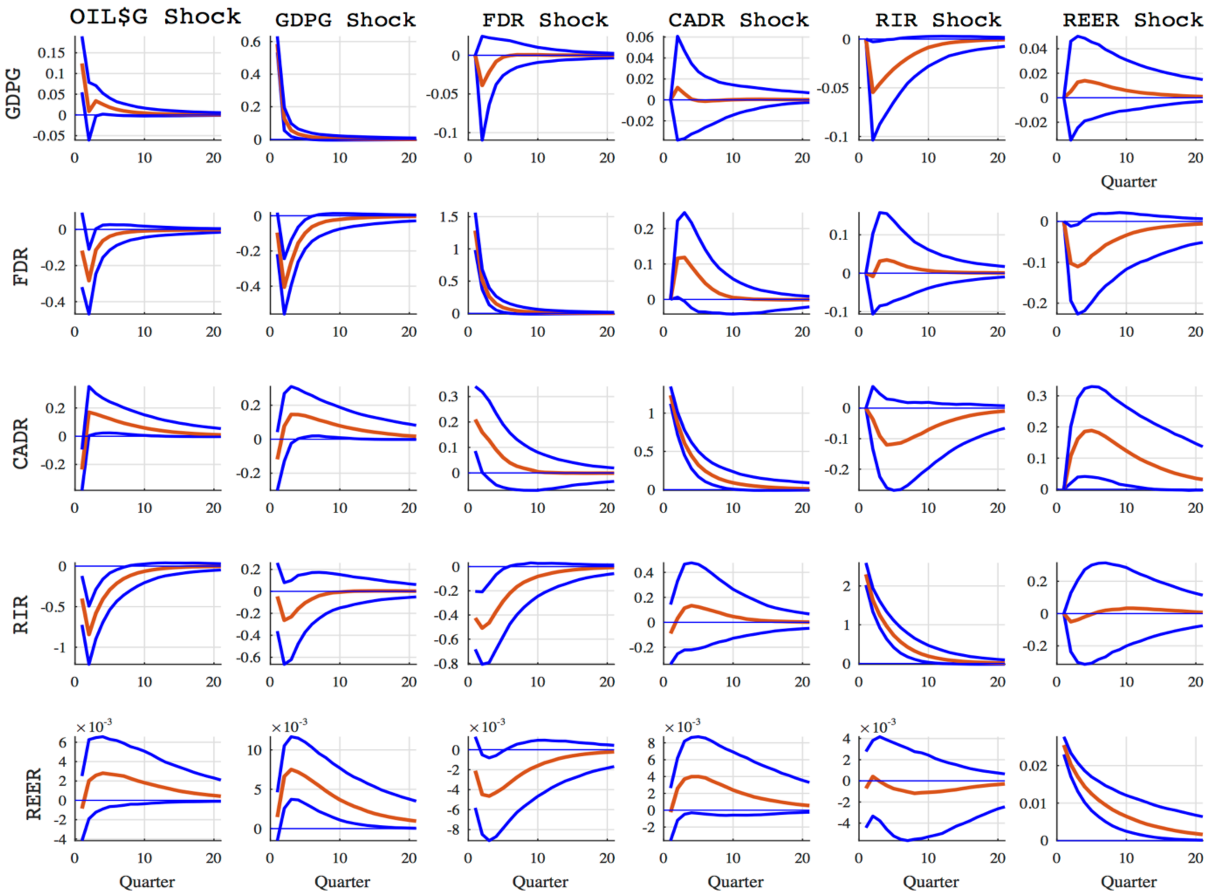


Figure 7: Alternative identification: contemporaneous relation between FD and GDP and no long run effect of FD on GDP

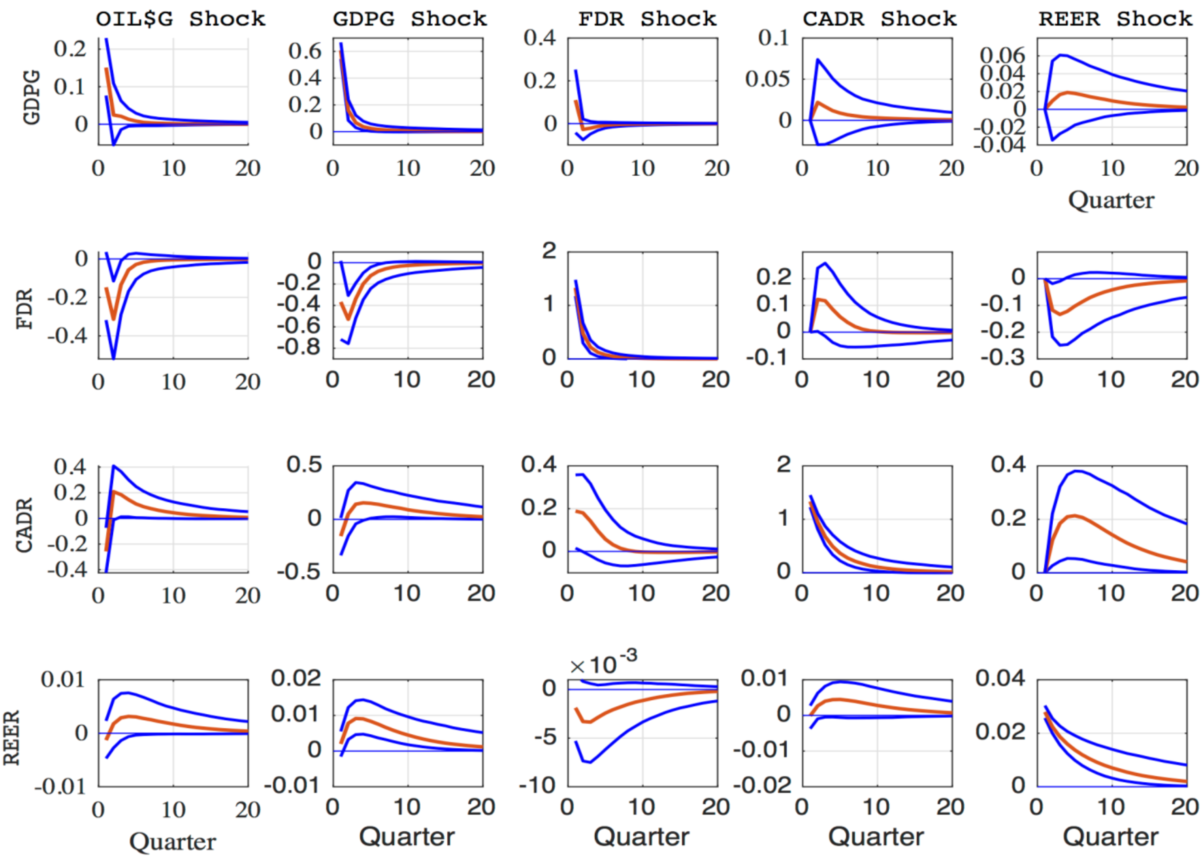


Figure 8: Including GFCF as one adjusting component of CAD