Resource dependence, commodity shocks and the exchange rate: An empirical study of Papua New Guinea

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“A flexible exchange rate is important, and it shouldn’t be artificially restrained because of the needs of the economy.”

- **Elvira Nabiullina**, Governor, Bank of Russia

Outline

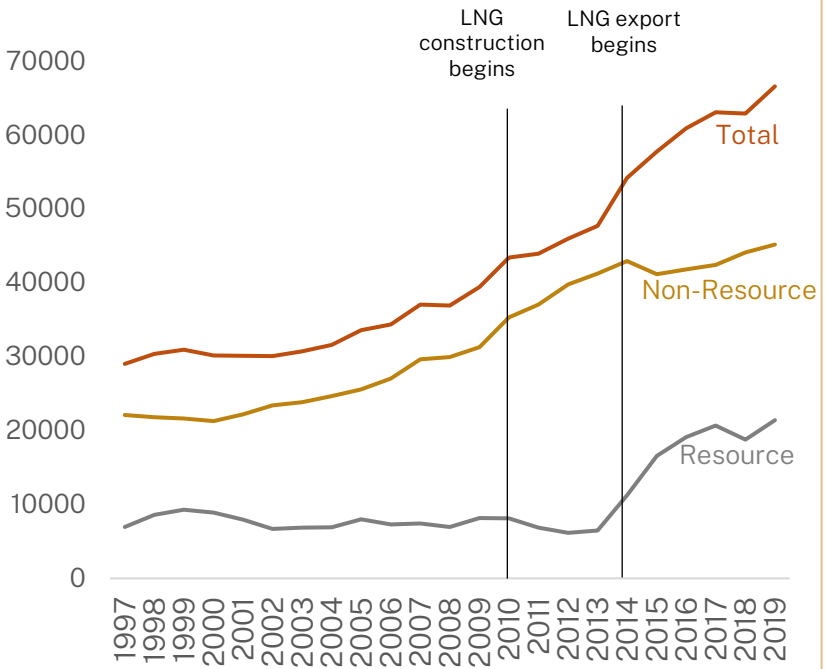
1. Background
2. Literature
3. Empirical framework
4. Results
5. Robustness
6. Conclusion & policy implications

1. Background

Resource boom and lost promises

- PNG is a commodity exporter - 98% of its exports are commodities.
- High reliance on resource exports and strong import dependence.
- While the largest resource project (PNG-LNG) made huge economic promises, progress in the non-resource economy has been slow since 2014.

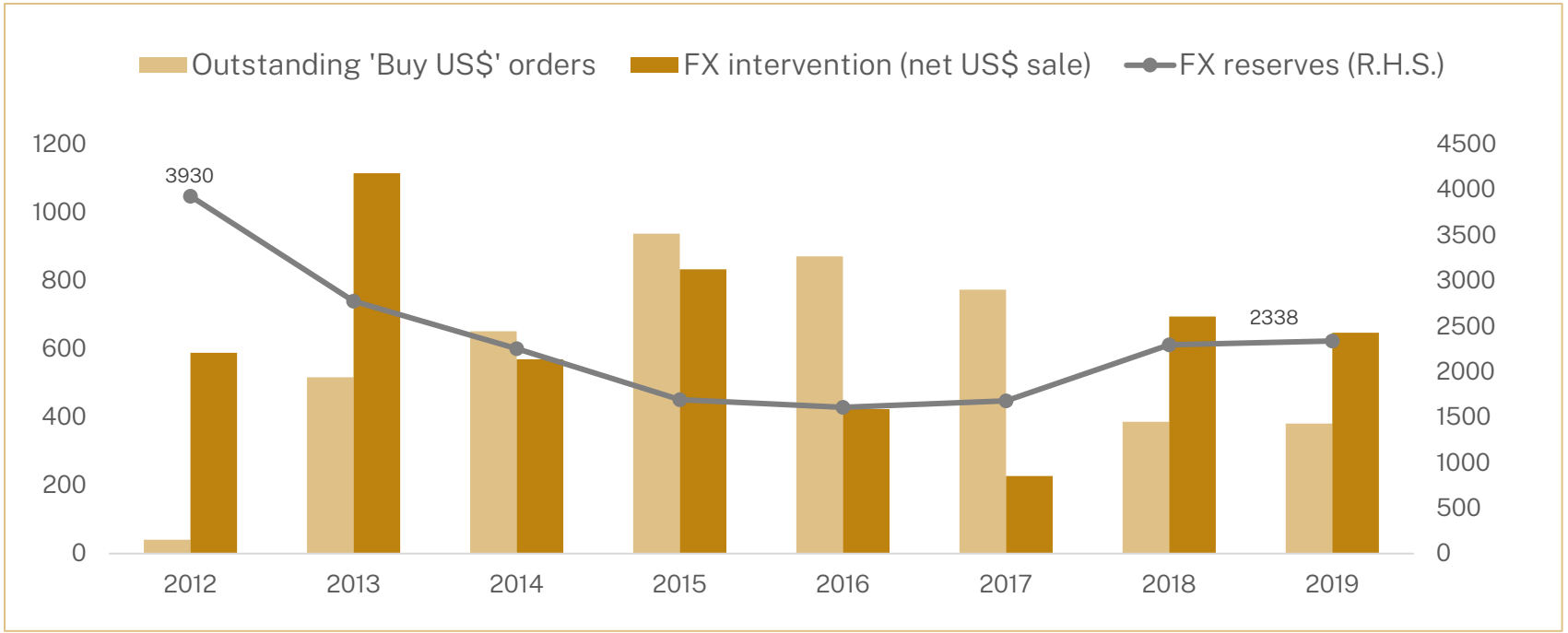
Figure 1. Real GDP (2013p), 1997-2019, million kina.



Source: PNG Economic Database 2021.

Forex market went into an imbalance

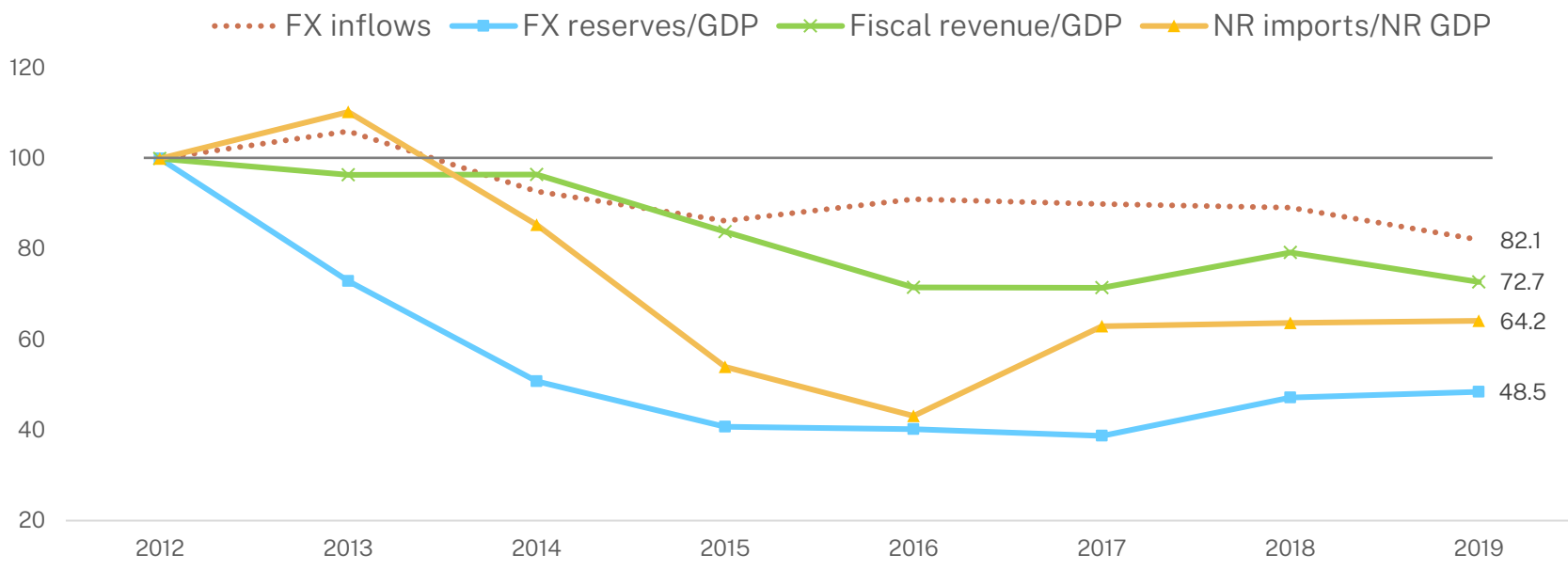
Figure 2. PNG' forex market, million US$; 2012-2019.



Source: Bank of PNG (Annual Reports).

Economic indicators were blurry during this period

Figure 3. State of the economy compared to the pre-forex crisis level, 2012=100.

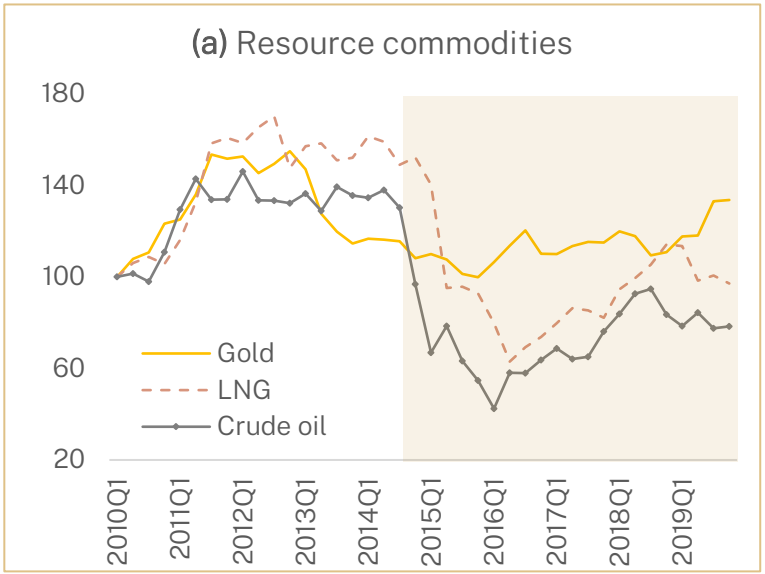


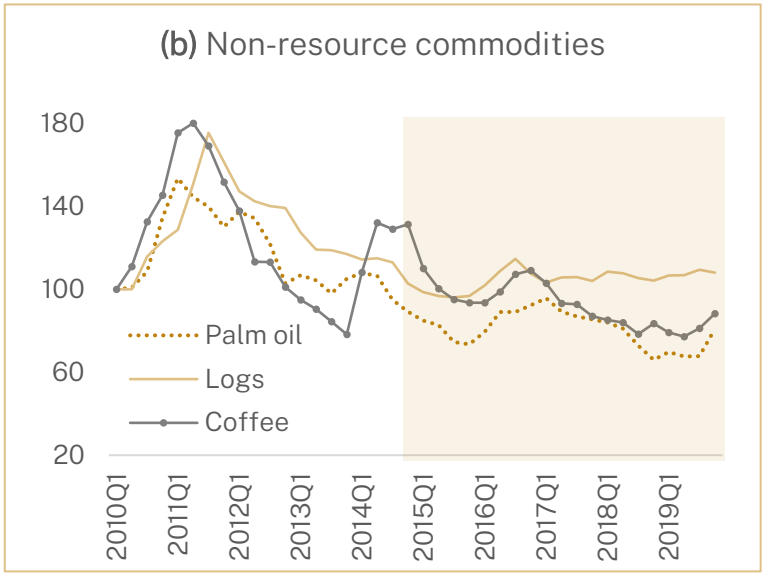
Source: Bank of PNG (annual reports & Quarterly Economic Bulletin); Authors' calculation.
Note: NR: non-resource; FX: foreign exchange; Fiscal revenue excludes foreign grants.

Why forex shortage? Three hypotheses

A. Slump in commodity prices

Figure 4. Global commodity prices, 2010-2019; 2010=100.

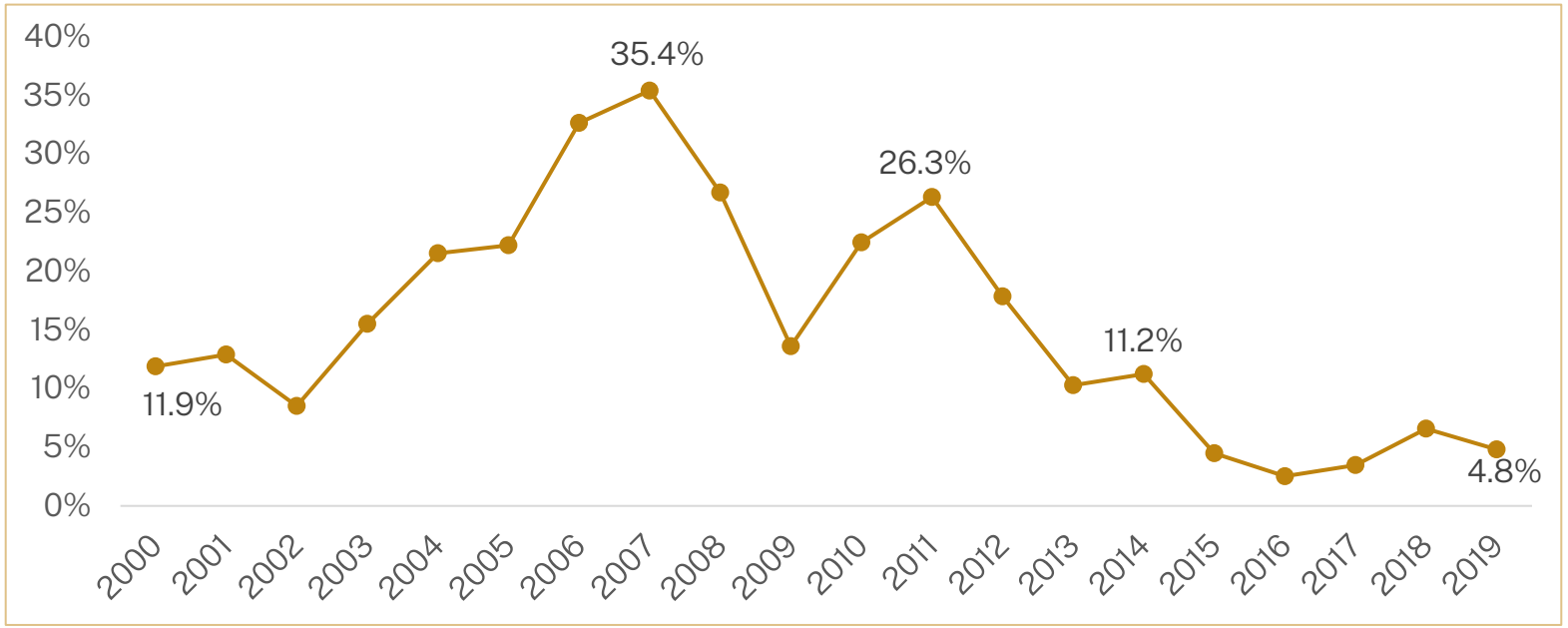




Source: World Bank Commodity Price Data (The Pink Sheet), 2020.

B. Lower than expected revenue from resource exports

Figure 5. Resource revenue as % of resource GDP.



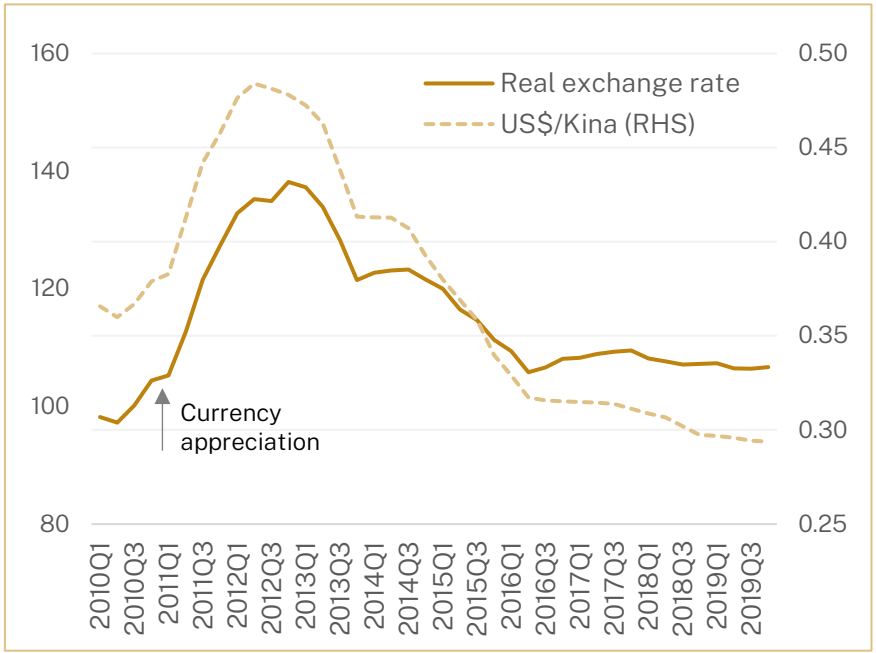
Source: PNG Economic Database, 2021.

C. Exchange rate rigidity

- Kina is overvalued (Nakatani 2017; Fox & Schroder 2018; Davies 2021; IMF 2020).
- Currency depreciation can improve trade balance (Nakatani 2018; Nguyen and Sum 2019).
- What about its potential impact of on inflation- a major concern for central bank?

> *"... a faster pace of depreciation may not necessarily have the desired results of clearing the market and inducing a supply response, and may only be inflationary as PNG is heavily reliant on imports, as past experience has shown."*
>
> ... Bank of Papua New Guinea, Monetary Policy Statement, September 2015, p. 7.

Figure 6. Nominal and real exchange rate (2010=100).



Source: Bank of PNG (Quarterly Economic Bulletin); International Monetary Fund.

Focus of this study….

- Is there a net benefit from currency depreciation or would it be just inflationary?
  - ✓ *Address policymakers' concerns: trade balance improvements vs. rise in inflation*
- Does a resource boom improves the non-resource economy? Any Dutch disease?
- What are the major sources PNG's business cycles- domestic *vs.* external?
  - ✓ *3 shocks: commodity prices, resource exports and the exchange rate*
- Enhance our understanding of the relationship of macroeconomic variables using a quarterly GDP for PNG based on economic indicators.

2. Literature

Literature is yet to reach a consensus

- A real exchange rate depreciation can improve the trade balance.
  - Bahmani-Oskooee and Niroomand (1998) : Developed countries
  - Kim and Ying (2007) : East Asian countries
  - An et al. (2014) : Latin American economies
  - Gervais et al. (2016) : Emerging market economies
  - Narayan and Narayan (2007) : Fiji
  - Nakatani (2018); Nguyen and Sum (2019) : Papua New Guinea

- High import dependence and large external debt can make currency devaluation ineffective.
  - Bahmani-Oskooee and Kandil (2009) : Turkey
  - Prakash and Maiti (2016) : Fiji
  - Bahmani-Oskooee and Gelan (2013) : Africa

3. Empirical framework

Variables

pc	:	Commodity price index (2010=100)
yw	:	Foreign output (million US$, 2010p)
$resx$	:	Resource exports (million US$)
$ydnr$	:	Non-resource domestic GDP (million Kina, 2013p)
pd	:	Trimmed-mean inflation rate (%)
q	:	Real exchange rate (2010=100)
nrx	:	Non-resource exports (million US$)
nrm	:	Non-resource imports (million US$)
tb	:	Trade balance (million US$)

- Resource exports = mining and petroleum exports
- Non-resource exports = (Total exports) – (Resource exports)
- Non-resource imports = (Total imports) – (Imports by the mining and petroleum sector)
- All variables are in real terms; *pc, resx, nrx, nrm* and *tb are* deflated by the U.S. CPI.

Commodity price index

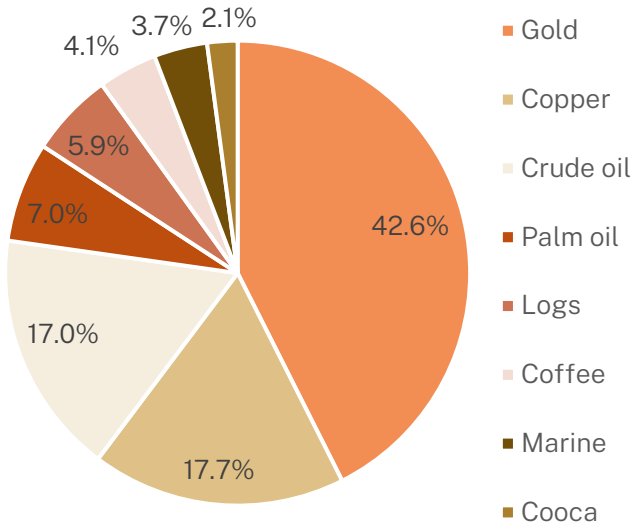
- 8-commodity basket (excluding LNG);
- Export coverage: 70%;
- Calculated as:

$$pc_t = \left[\left(\prod_{i=1}^{n} pc_{it}^{w_i} \right)^{\frac{1}{\sum_{i=1}^{n} w_i}} \right] / CPI_{US_t}$$

pc_{it}	: price of commodity *i* in quarter *t*
w_i	: fixed export weight for commodity *i*
n	: number of commodities
CPI_{US_t}	: consumer price index for the United States

Source: World Bank Pink Sheet (commodity price); BPNG QEB Table 8.2 (export share).

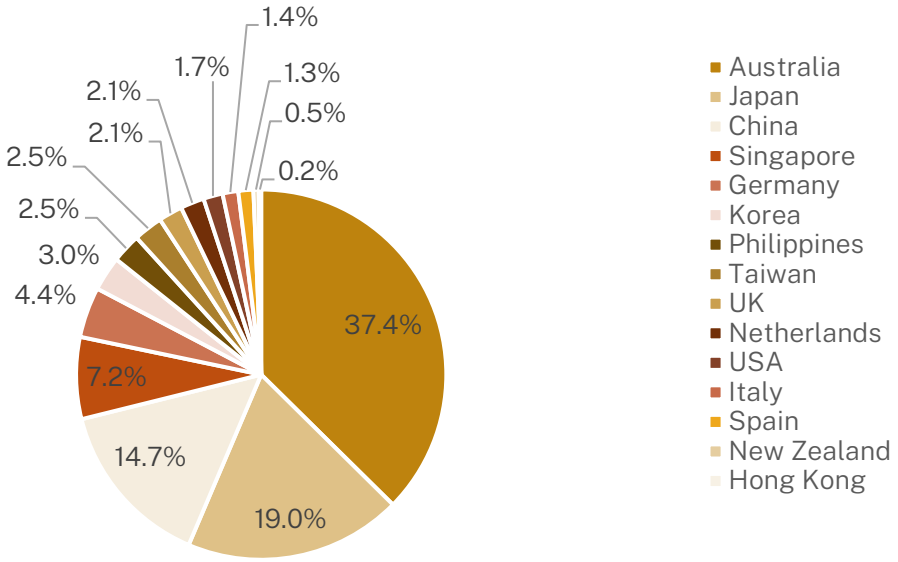
Figure 7. Commodity sample weights, 1997-2019 (average).



Foreign output

- Export-weighted real GDP (2010p) of 15 export partners;
- Coverage: 97% of total exports.

Figure 8. Foreign GDP sample weights, 1997-2019 (average).



Source: World Bank (real GDP); IMF, Direction of Trade Statistics (export share).

Domestic output

- Quarterly GDP is not available for PNG.
- PNG-specific studies (Nguyen & Sum, 2019; Tumsok et al., 2019; Ofoi & Sharma, 2021) rely on statistical methods (e.g., Chow-Lin, 1971) for quarterly interpolation of annual GDP.
- Such statistically interpolated series is questionable and may not accurately capture business cycle fluctuations (Miralles et al., 2003).

Figure 9. Annual real GDP (2013p), 1997-2019, million Kina.

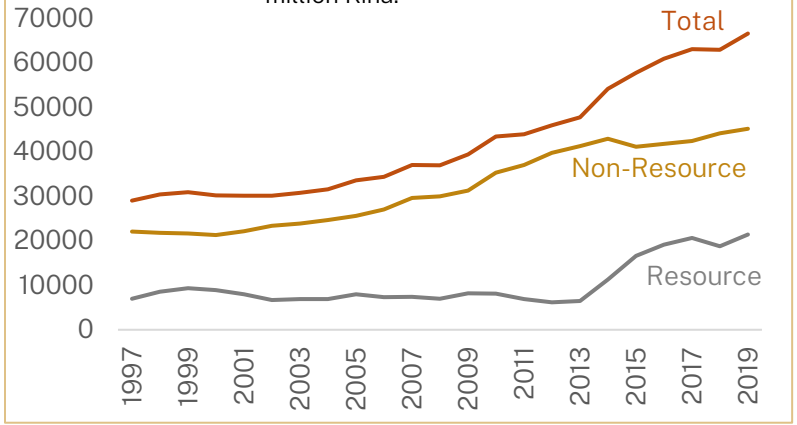
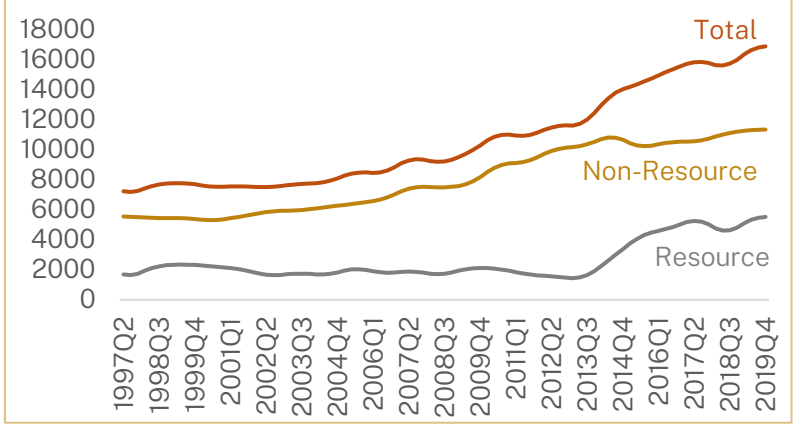


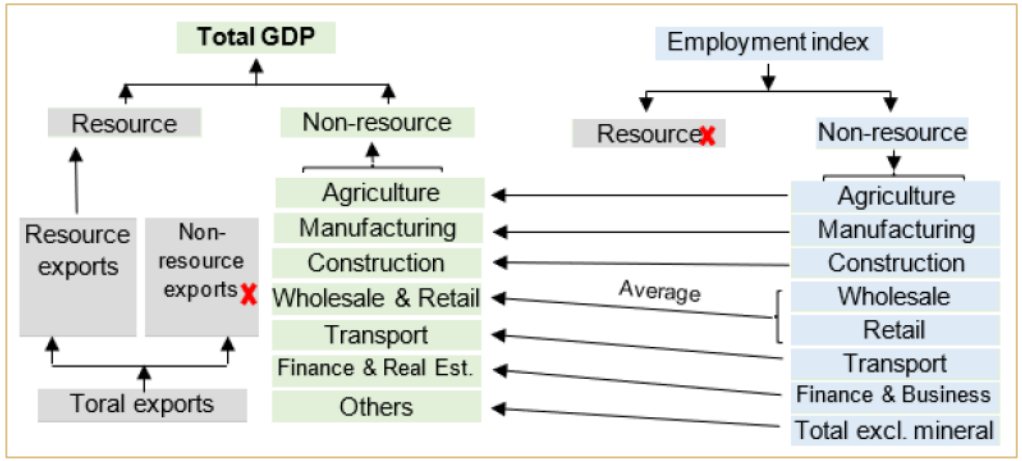
Figure 10. Quarterly real GDP (Chow-Lin), million Kina.



Domestic output (constructed)

- This study proposes an interpolated measure of quarterly GDP based on the available information on employment and resource exports.
- Annual non-resource GDP is highly correlated with non-resource employment (0.90) while the correlation of resource GDP is higher with resource exports (0.94) than with resource employment (0.83).

Figure 11. Quarterly GDP mapping.



Domestic output (constructed)

Non-resource GDP : $ydnr_{it} = ydnr_{iT} \times \frac{emp_{i,t}}{\sum_{t=1}^{4} emp_{it}}$

Resource GDP : $ydr_t = ydr_T \times \frac{resx_t}{\sum_{t=1}^{4} resx_t}$

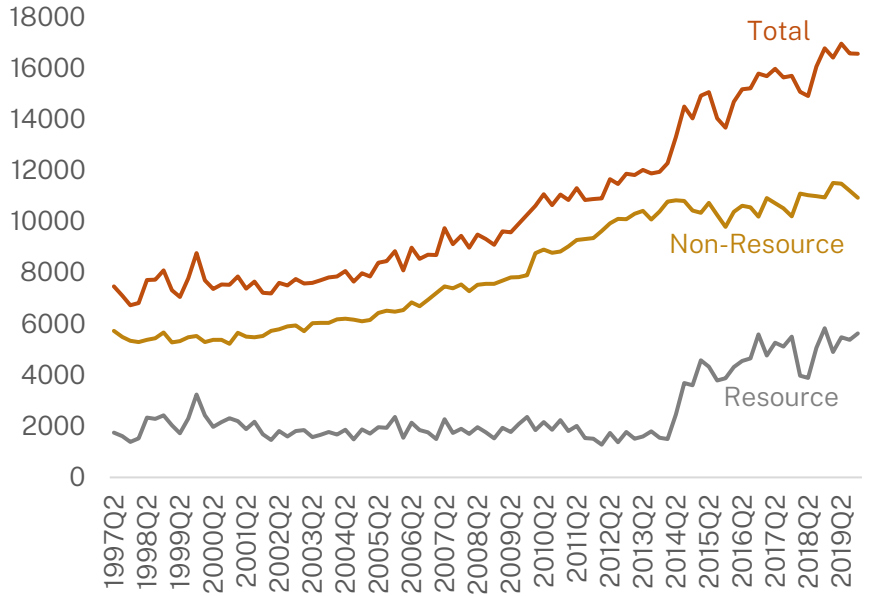
Total GDP : $yd_t = \sum_{i=1}^{n} ydnr_{i,t} + ydr_t$

$ydnr_{i,t}$: Non-resource GDP for sector *i* in quarter *t*
$emp_{i,t}$: Employment index for sector *i* in quarter *t*
$resx_t$: Resource exports in quarter *t*
t : Quarter in year *T*

Source:

- GDP: BPNG 2007 (1997-2002); NSO (2006-2018); National Budgets (2003-2005, 2019);
- Employment: BPNG QEB Table 9.7 & QEB June 2003.

Figure 12. Quarterly real GDP (constructed), 2013p, 1997-2019, million kina.



An SVAR model for PNG

Extended model

$$X_t = [pc_t \quad yw_t \quad resx_t \quad ydnr_t \quad pd_t \quad q_t \quad nrx_t \quad nrm_t]'$$

$$B_0 X_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{2,1} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{3,1} & b_{3,2} & 1 & 0 & 0 & 0 & 0 & 0 \\ b_{4,1} & b_{4,2} & b_{4,3} & 1 & 0 & 0 & 0 & 0 \\ b_{5,1} & 0 & 0 & b_{5,4} & 1 & 0 & 0 & 0 \\ b_{6,1} & b_{6,2} & b_{6,3} & b_{6,4} & b_{6,5} & 1 & 0 & 0 \\ b_{7,1} & b_{7,2} & b_{7,3} & b_{7,4} & b_{7,5} & b_{7,6} & 1 & 0 \\ b_{8,1} & 0 & 0 & b_{8,4} & b_{8,5} & b_{8,6} & b_{8,7} & 1 \end{bmatrix} \begin{bmatrix} pc_t \\ yw_t \\ \text{resx}_t \\ ydnr_t \\ pd_t \\ q_t \\ nrx_t \\ nrm_t \end{bmatrix} \quad (1)$$

Lag restrictions, $j = 1, 2$

$$B_j X_{t-j} = \begin{bmatrix} b_{1,1}^j & b_{1,2}^j & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{2,1}^j & b_{2,2}^j & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{3,1}^j & b_{3,2}^j & b_{3,3}^j & b_{3,4}^j & 0 & b_{3,6}^j & 0 & 0 \\ b_{4,1}^j & b_{4,2}^j & b_{4,3}^j & b_{4,4}^j & b_{4,5}^j & b_{4,6}^j & b_{4,7}^j & b_{4,8}^j \\ b_{5,1}^j & b_{5,2}^j & b_{5,3}^j & b_{5,4}^j & b_{5,5}^j & b_{5,6}^j & b_{5,7}^j & b_{5,8}^j \\ b_{6,1}^j & b_{6,2}^j & b_{6,3}^j & b_{6,4}^j & b_{6,5}^j & b_{6,6}^j & b_{6,7}^j & b_{6,8}^j \\ b_{7,1}^j & b_{7,2}^j & b_{7,3}^j & b_{7,4}^j & b_{7,5}^j & b_{7,6}^j & b_{7,7}^j & b_{7,8}^j \\ b_{8,1}^j & b_{8,2}^j & b_{8,3}^j & b_{8,4}^j & b_{8,5}^j & b_{8,6}^j & b_{8,7}^j & b_{8,8}^j \end{bmatrix} \begin{bmatrix} pc_{t-j} \\ yw_{t-j} \\ \text{resx}_{t-j} \\ ydnr_{t-j} \\ pd_{t-j} \\ q_{t-j} \\ nrx_{t-j} \\ nrm_{t-j} \end{bmatrix} \quad (2)$$

Compact model

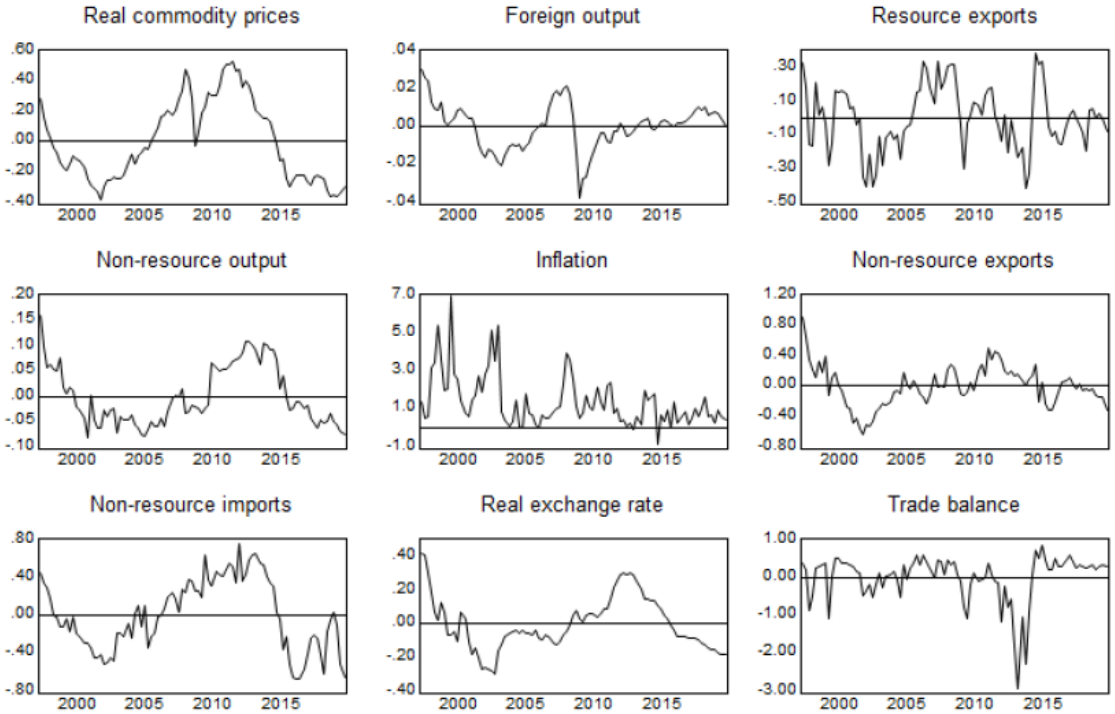
$$X_t = [pc_t \quad yw_t \quad ydnr_t \quad pd_t \quad q_t \quad tb_t]'$$

$$B_0 X_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ b_{2,1} & 1 & 0 & 0 & 0 & 0 \\ b_{3,1} & b_{3,2} & 1 & 0 & 0 & 0 \\ b_{4,1} & b_{4,2} & b_{4,3} & 1 & 0 & 0 \\ b_{5,1} & b_{5,2} & b_{5,3} & b_{5,4} & 1 & 0 \\ b_{6,1} & b_{6,2} & b_{6,3} & b_{6,4} & b_{6,5} & 1 \end{bmatrix} \begin{bmatrix} pc_t \\ yw_t \\ ydnr_t \\ pd_t \\ q_t \\ tb_t \end{bmatrix} \quad (3)$$

Lag restrictions, $j = 1, 2$

$$B_j X_{t-j} = \begin{bmatrix} b_{1,1}^j & b_{1,2}^j & 0 & 0 & 0 & 0 \\ b_{2,1}^j & b_{2,2}^j & 0 & 0 & 0 & 0 \\ b_{3,1}^j & b_{3,2}^j & b_{3,3}^j & b_{3,4}^j & b_{3,5}^j & b_{3,6}^j \\ b_{4,1}^j & b_{4,2}^j & b_{4,3}^j & b_{4,4}^j & b_{4,5}^j & b_{4,6}^j \\ b_{5,1}^j & b_{5,2}^j & b_{5,3}^j & b_{5,4}^j & b_{5,5}^j & b_{5,6}^j \\ b_{6,1}^j & b_{6,2}^j & b_{6,3}^j & b_{6,4}^j & b_{6,5}^j & b_{6,6}^j \end{bmatrix} \begin{bmatrix} pc_{t-j} \\ yw_{t-j} \\ ydnr_{t-j} \\ pd_{t-j} \\ q_{t-j} \\ tb_{t-j} \end{bmatrix} \quad (4)$$

Variables in the SVAR model (linearly detrended)



Notes: All variables are log-linearly detrended (except the inflation rate, which is in percent). The horizontal axis represents the variable-specific trend.

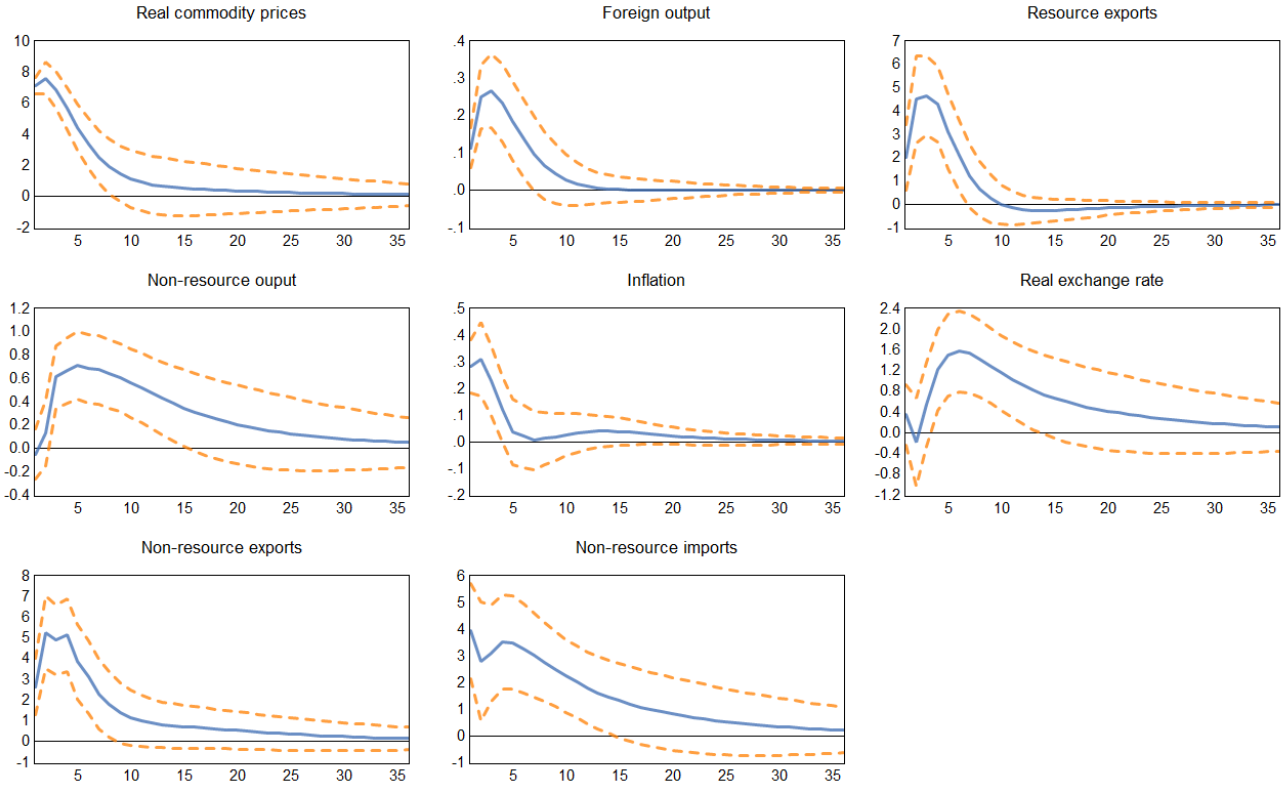
4. Results

RESULTS (**Extended** model)

Responses to a one S.D. structural shock

Note: One S.E. (68%) confidence bands are reported

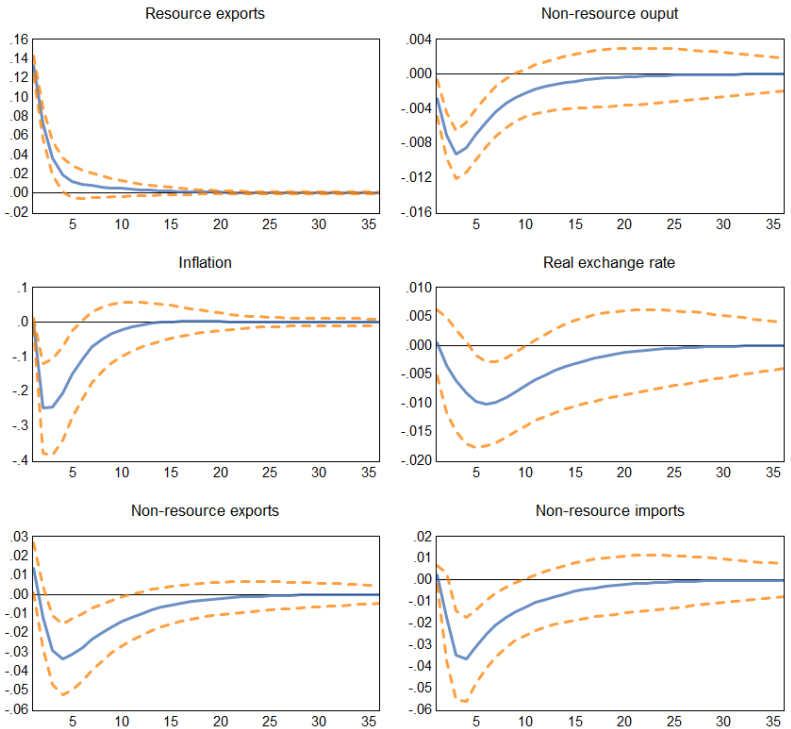
Commodity price shock



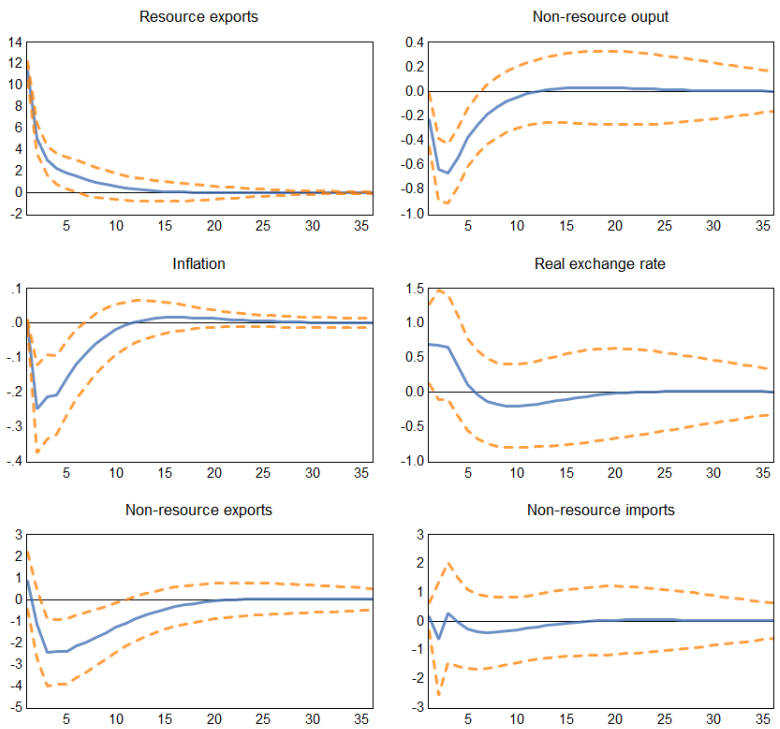
Robust

Resource exports shock

(a) Resource exports include LNG

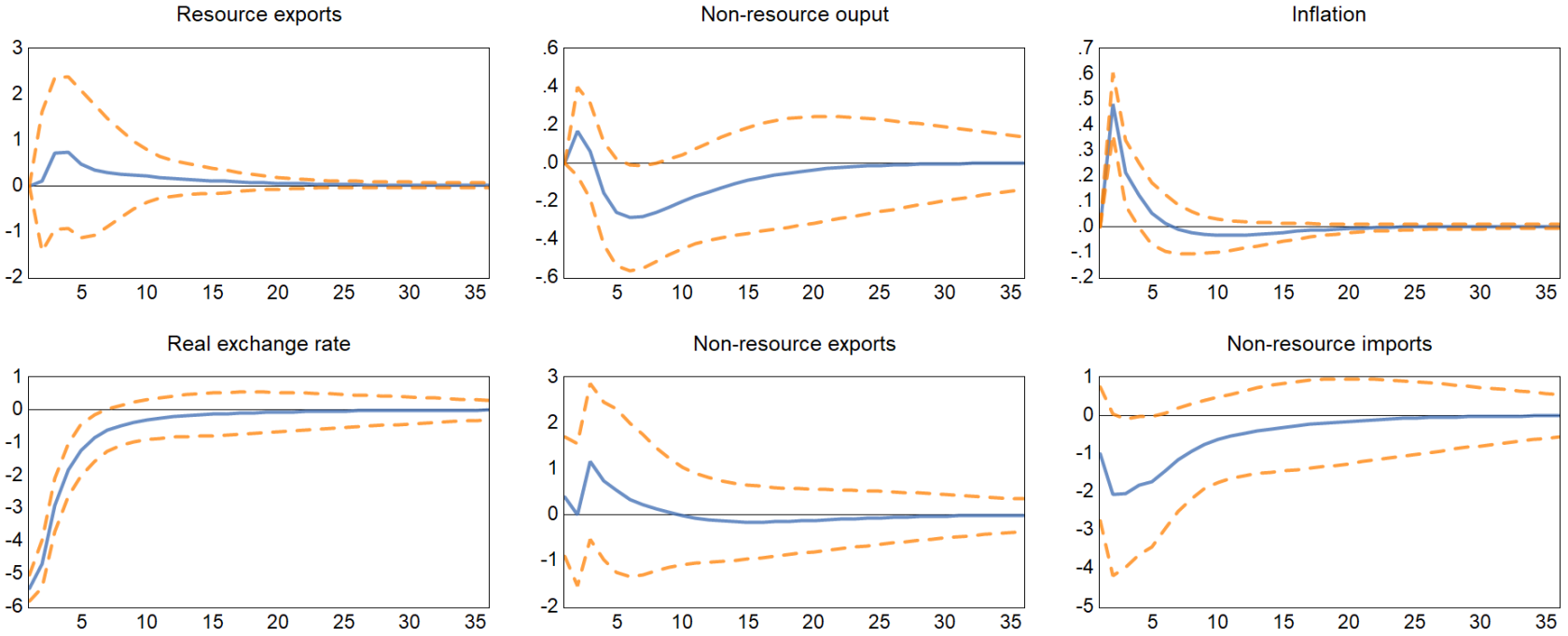


(b) Resource exports exclude LNG



Robust

Exchange rate (depreciation) shock



Robust

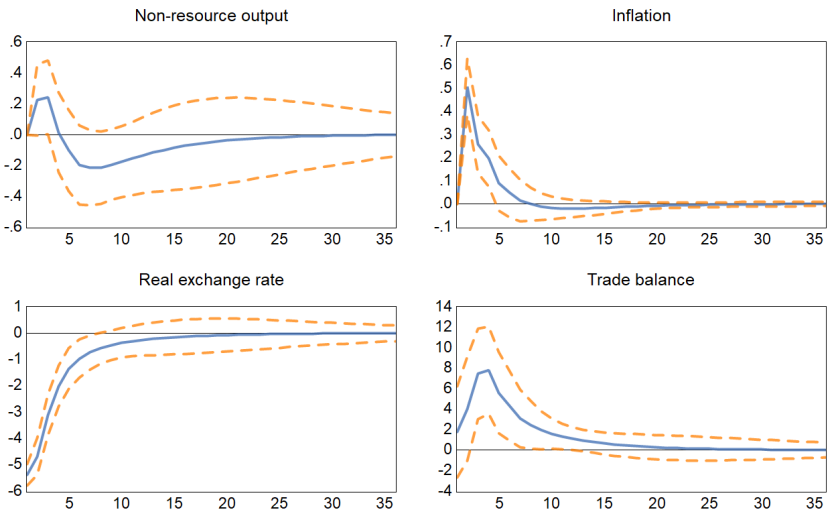
RESULTS (**Compact** model)

Responses to a one S.D. positive structural shock

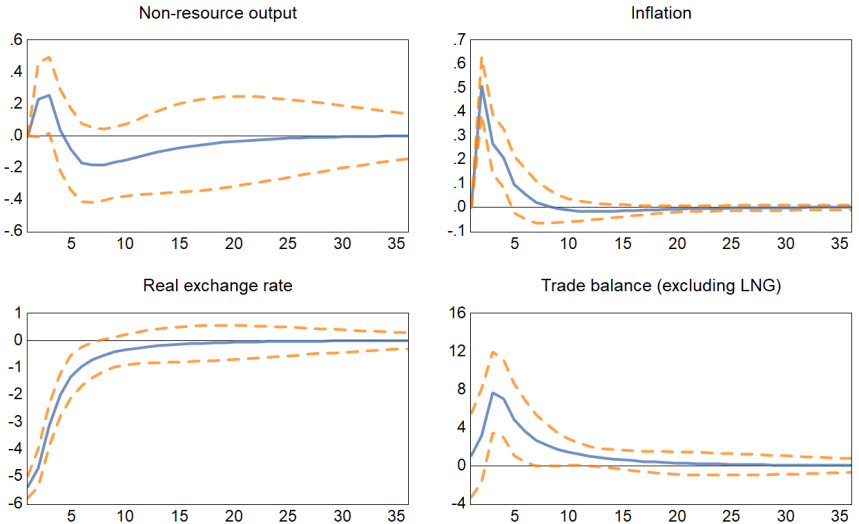
Note: One S.E. (68%) confidence bands are reported

Exchange rate (depreciation) shock

(a) Trade balance (including LNG)



(b) Trade balance (excluding LNG)

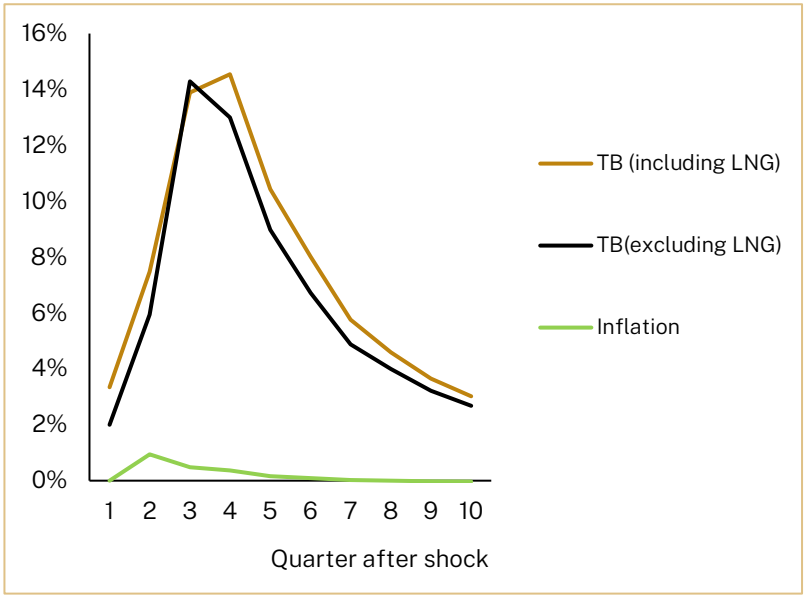


Robust

Effects of a 10% real currency depreciation

- A 10% real depreciation would raise inflation by one percentage point while improving the trade balance by 10-15%.
- Trade balance responses are more persistent than inflation.
- Positive trade balance effect persists even when LNG is excluded from the export basket.

Figure 15. Trade balance and inflation responses to a 10% currency depreciation shock.



Source: Author's calculations.
Note: Inflation responses are in percentage points.

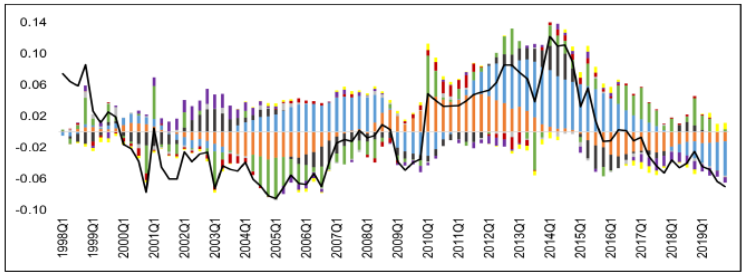
Variance decomposition

Horizon:	0	4	8	12	24		0	4	8	12	24
	Non-resource output ($ydnr_t$)						**Non-resource exports (nrx_t)**				
pc_t	0.1	8.8	19.1	20.4	14.4	pc_t	4.3	22.4	25.2	23.9	21.5
yw_t	2.1	4.2	6.5	21.4	51.7	yw_t	1.5	6.7	7.4	12.7	23.2
$resx_t$	1.9	22.7	23.3	18.2	10.6	$resx_t$	1.1	6.1	10.6	11.1	10.0
$ydnr_t$	95.9	57.5	41.0	30.9	17.8	$ydnr_t$	0.3	4.1	3.4	3.2	2.8
pd_t	0.0	1.6	1.1	0.8	0.5	pd_t	1.4	3.5	4.1	3.9	3.4
q_t	0.0	0.6	2.5	2.7	1.7	q_t	0.1	0.5	0.5	0.5	0.5
nrx_t	0.0	2.4	4.0	3.4	2.0	nrx_t	91.3	56.6	48.5	44.4	38.4
nrm_t	0.0	2.2	2.5	2.2	1.3	nrm_t	0.0	0.1	0.3	0.3	0.2
	Non-resource imports (nrm_t)						**Trade balance (tb_t)**				
pc_t	5.3	9.9	15.6	16.5	13.8	pc_t	0.2	10.1	10.8	11.2	11.2
yw_t	0.1	1.2	2.9	11.6	32.4	yw_t	1.2	3.5	3.6	4.1	10.7
$resx_t$	0.0	6.3	9.6	9.2	7.0	$ydnr_t$	0.5	2.1	3.1	3.3	3.1
$ydnr_t$	0.1	2.4	2.3	2.1	1.6	pd_t	0.2	0.4	0.4	0.4	0.4
pd_t	0.2	0.9	1.1	1.0	0.7	q_t	0.2	5.1	7.1	7.3	6.8
q_t	0.4	2.8	3.7	3.5	2.7	tb_t	97.8	78.8	75.0	73.7	67.8
nrx_t	2.2	3.1	2.6	2.3	1.7						
nrm_t	91.7	73.5	62.1	53.8	40.0						

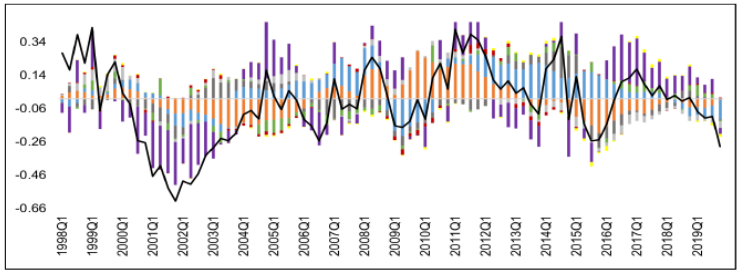
Notes: Variance decompositions (in %) are reported for 24 quarters.

Historical decomposition

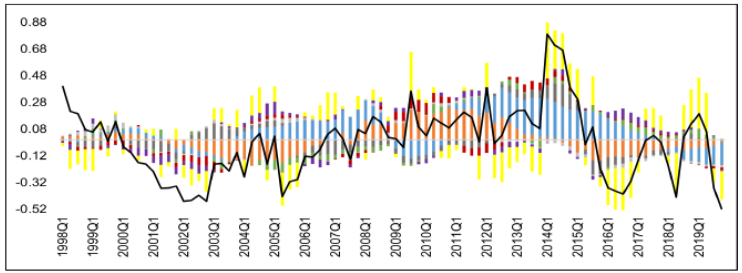
Non-resource output ($ydnr_t$)



Non-resource exports (nrx_t)



Non-resource imports (nrm_t)



Trade balance (tb_t)

Commodity price
Foreign output
Resource exports
Non-resource output
Inflation
Real exchange rate
Non-resource exports
Non-resource imports
Trade balance
Actual

5. Robustness

Robustness

Three alternate model specifications:

(a) Exchange rate is ordered last;

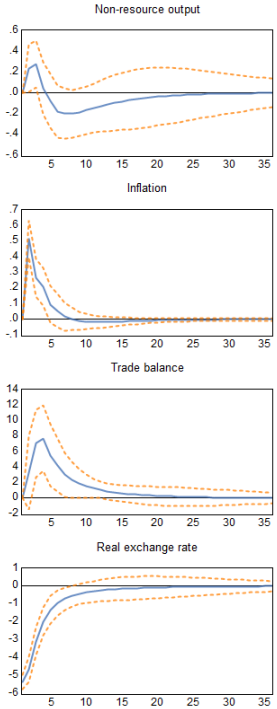
(b) Non-resource output is interpolated using Chow-Lin method;

(c) Non-resource output is replaced with total domestic output.

Robustness: Exchange rate depreciation shock in the **compact** model

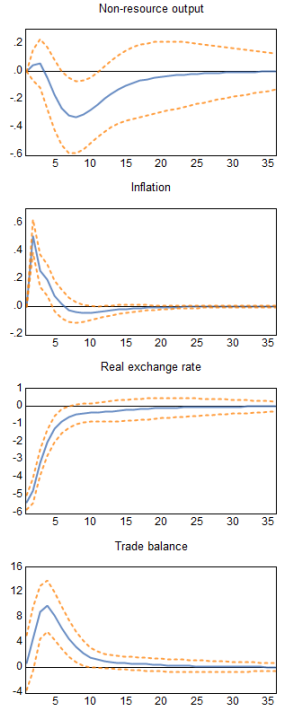
(a) Exchange rate ordered last

$$X_t = \begin{bmatrix} pc_t \\ yw_t \\ ydnr_t \\ pd_t \\ tb_t \\ q_t \end{bmatrix}$$



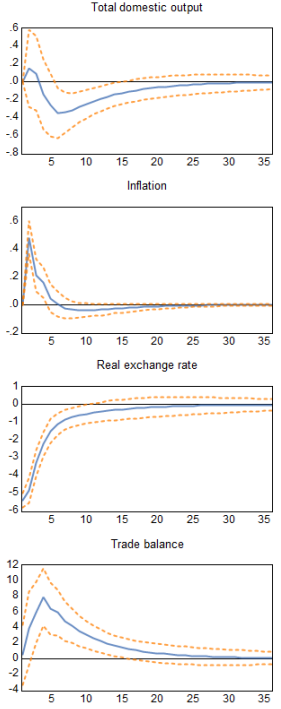
(b) *Non-resource output* interpolated using Chow-Lin

$$X_t = \begin{bmatrix} pc_t \\ yw_t \\ ydnr_t^* \\ pd_t \\ q_t \\ tb_t \end{bmatrix}$$



(c) Non-resource output replaced with *total output*

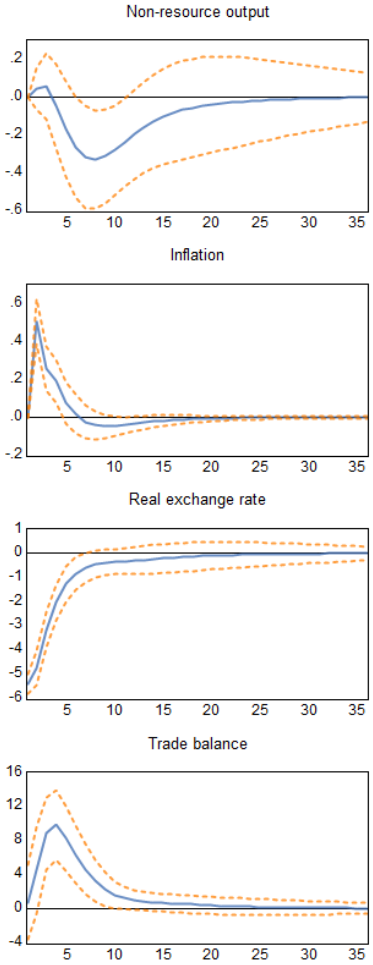
$$X_t = \begin{bmatrix} pc_t \\ yw_t \\ yd_t \\ pd_t \\ q_t \\ tb_t \end{bmatrix}$$



Benchmark

Robustness: The problem with statistical interpolation

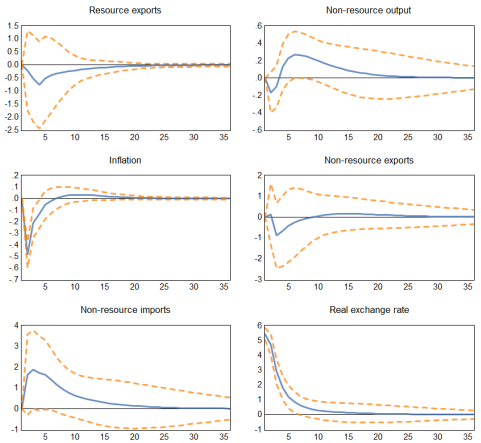
$$X_t = \begin{bmatrix} pc_t \\ yw_t \\ ydnr_t^* \\ pd_t \\ q_t \\ tb_t \end{bmatrix}$$



Benchmark

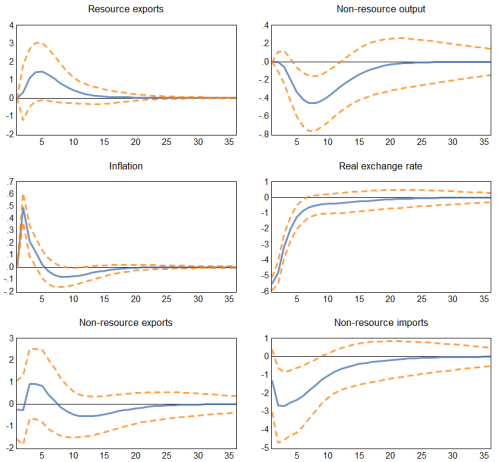
Robustness: Exchange rate depreciation shock in the **extended** model

(a) Exchange rate ordered last



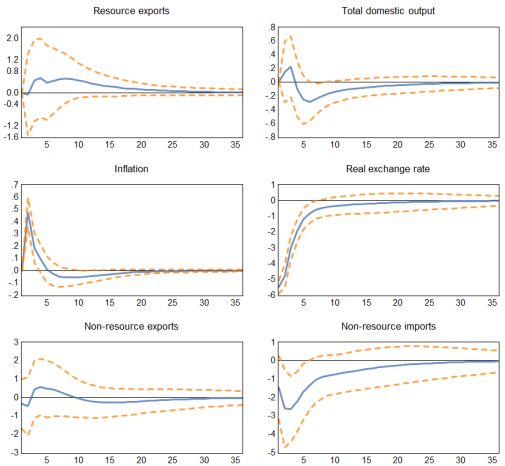
$$X_t = \begin{bmatrix} pc_t \\ yw_t \\ resx_t \\ ydnr_t \\ pd_t \\ nrx_t \\ nrm_t \\ q_t \end{bmatrix}$$

(b) *Non-resource output* interpolated using Chow-Lin



$$X_t = \begin{bmatrix} pc_t \\ yw_t \\ resx_t \\ ydnr_t^* \\ pd_t \\ q_t \\ nrx_t \\ nrm_t \end{bmatrix}$$

(c) Non-resource output replaced with *total output*

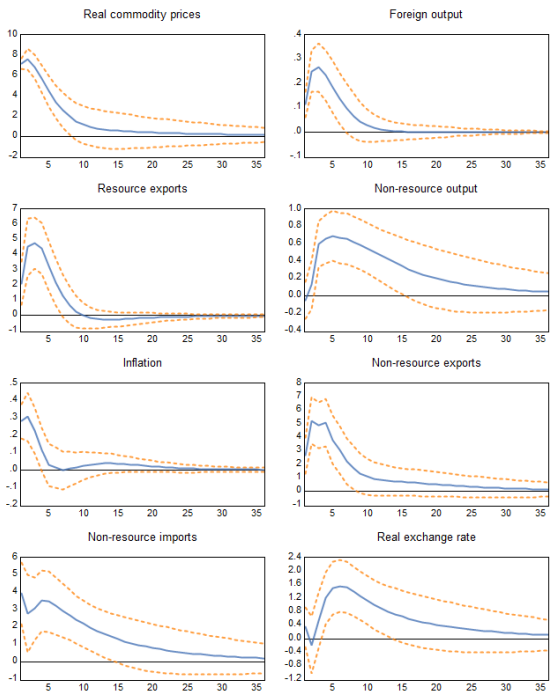


$$X_t = \begin{bmatrix} pc_t \\ yw_t \\ resx_t \\ yd_t \\ pd_t \\ q_t \\ nrx_t \\ nrm_t \end{bmatrix}$$

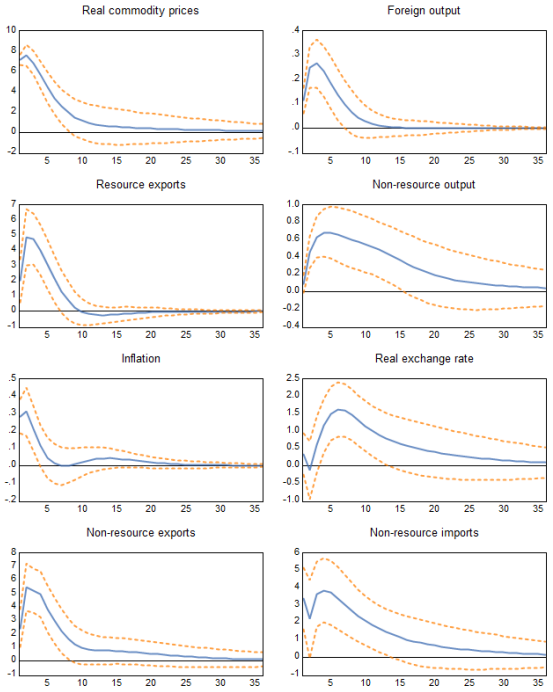
Benchmark

Robustness: Commodity price shock in the **extended** model

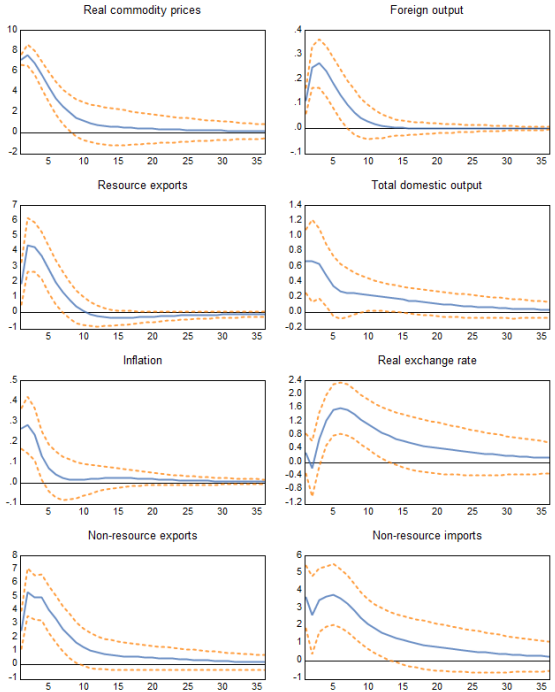
(a) Exchange rate ordered last



(b) *Non-resource output* interpolated using Chow-Lin



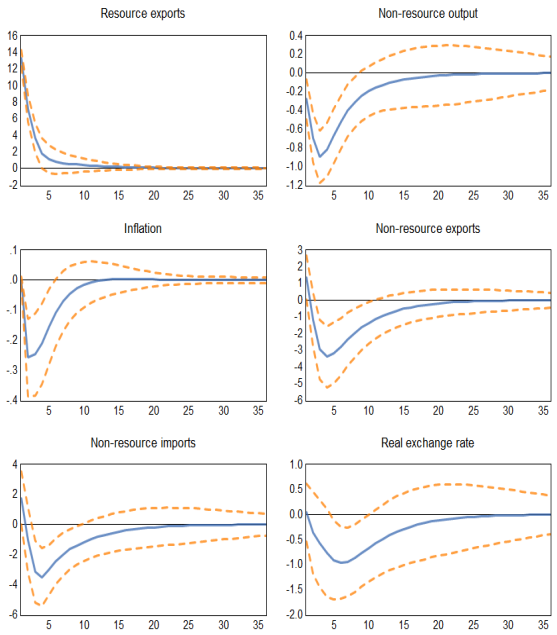
(c) Non-resource output replaced with *total output*



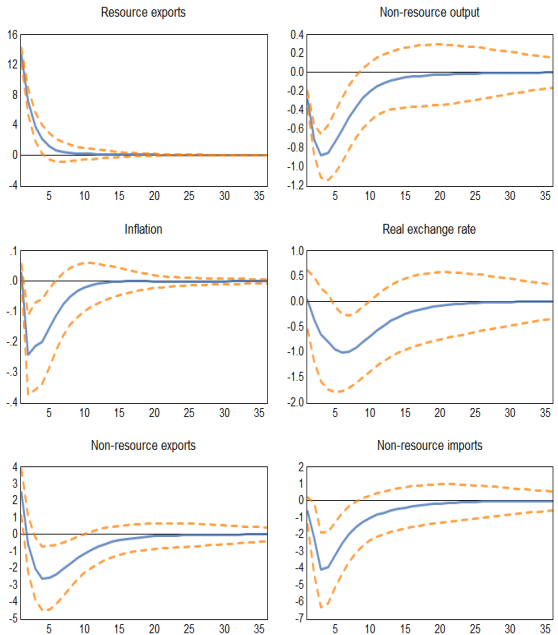
Benchmark

Robustness: Resource exports shock in the **extended** model

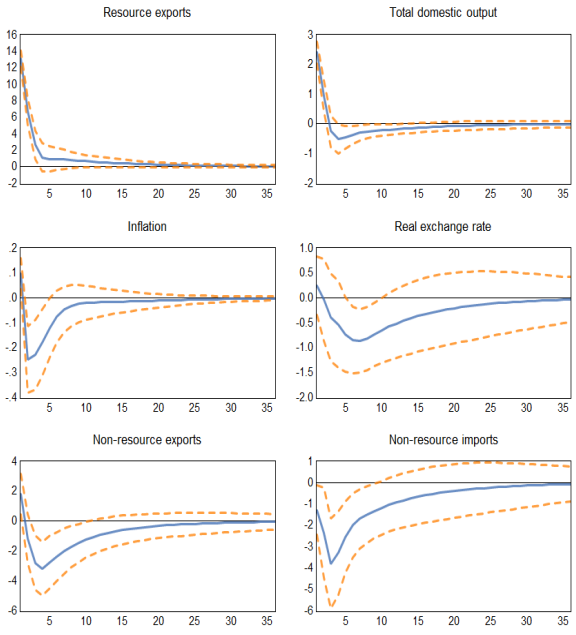
(a) Exchange rate ordered last



(b) *Non-resource output* interpolated using Chow-Lin

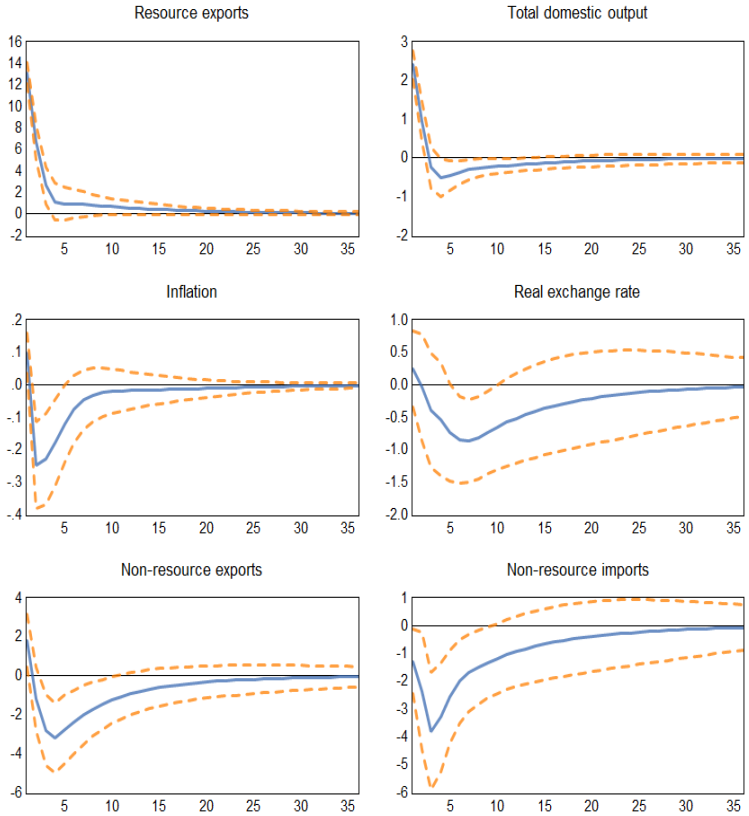


(c) Non-resource output replaced with *total output*



Benchmark

Robustness: The problem with using total domestic output



Benchmark

6. Conclusion and policy implications

Main findings and policy implications

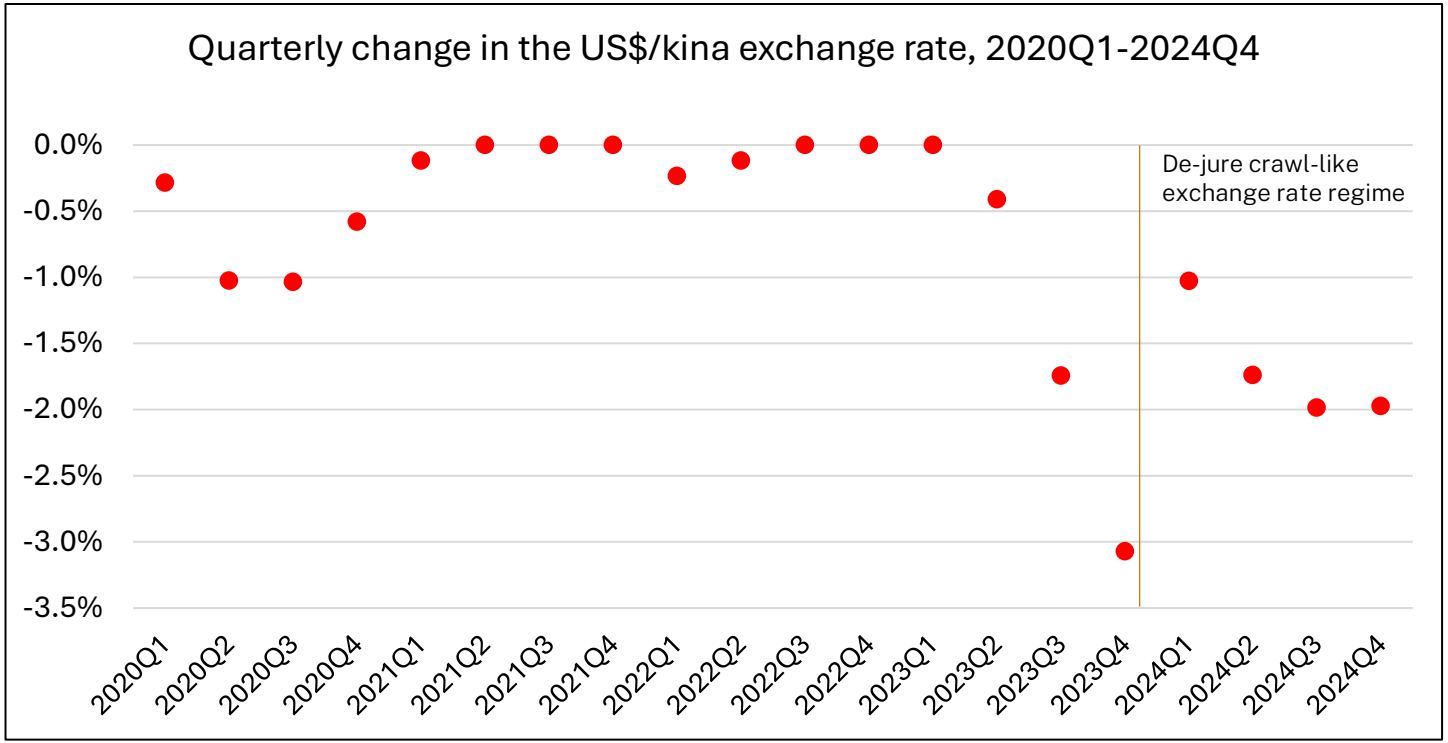
- Global events are crucial for PNG's business cycles. Favourable commodity price shocks lead to a higher resource exports, domestic output, inflation, and currency appreciation.

- The non-resource economy contracts when the resource sector expands. Ensuring a fair share of resource revenue is critical to counter potential downturns in the non-resource economy resulting from a resource boom.

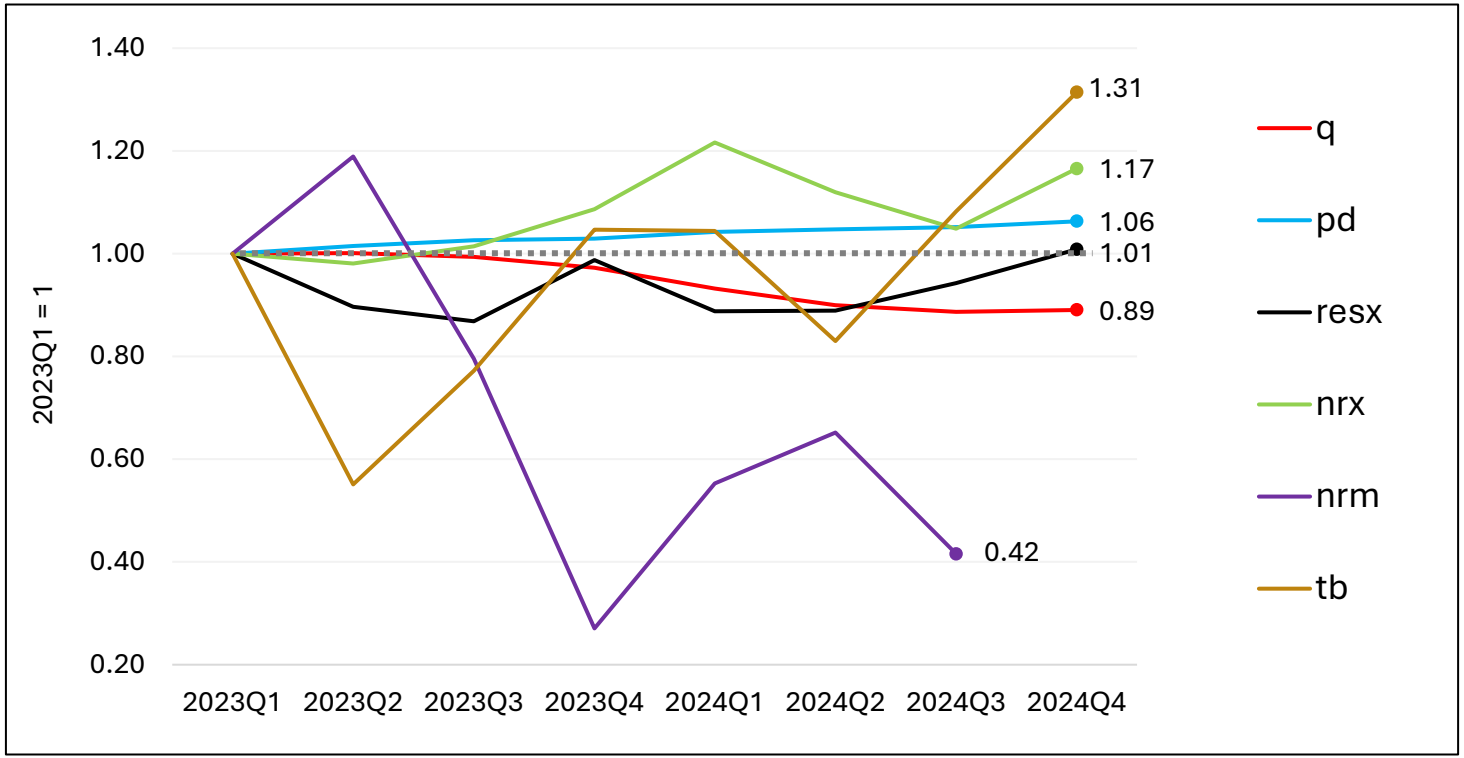
- There is a net gain from currency depreciation. The BPNG's move towards a flexible exchange rate regime is welcome initiative, which should continue.

- Aligning the exchange rate to the market rate would remove uncertainty, attract foreign capital, and reduce the backlog of foreign exchange orders.

What happened recently?



Some recent developments…



TENK YU TRU..

Please send me any feedback at:

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