Terms of Trade Shocks and Investment in Commodity-Exporting Economies[1]

Jorge Fornero Markus Kirchner Andrés Yany

Research Division
Central Bank of Chile

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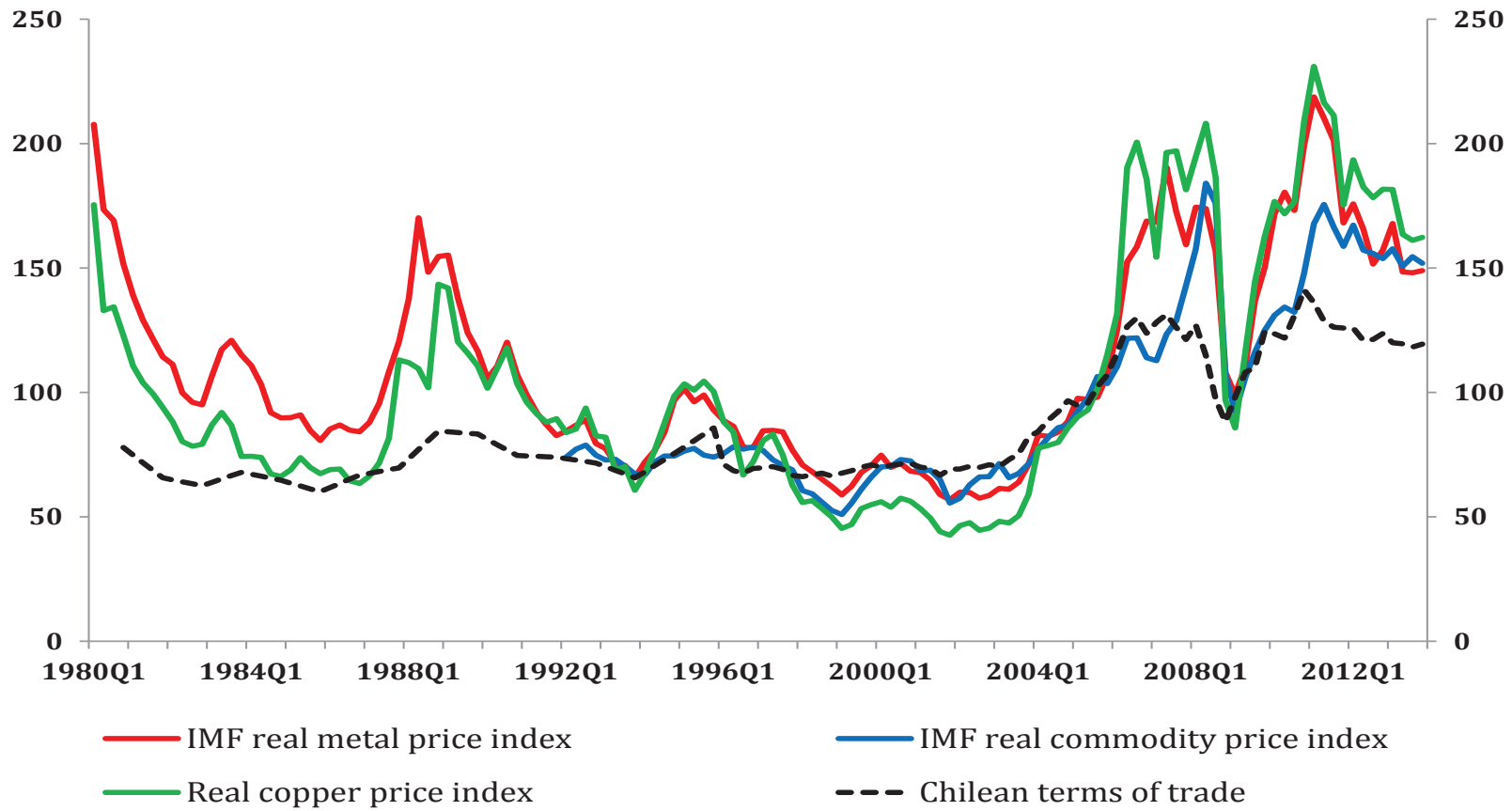
[1]The views expressed are those of the authors and do not necessarily represent official positions of the Central Bank of Chile or its Board members.

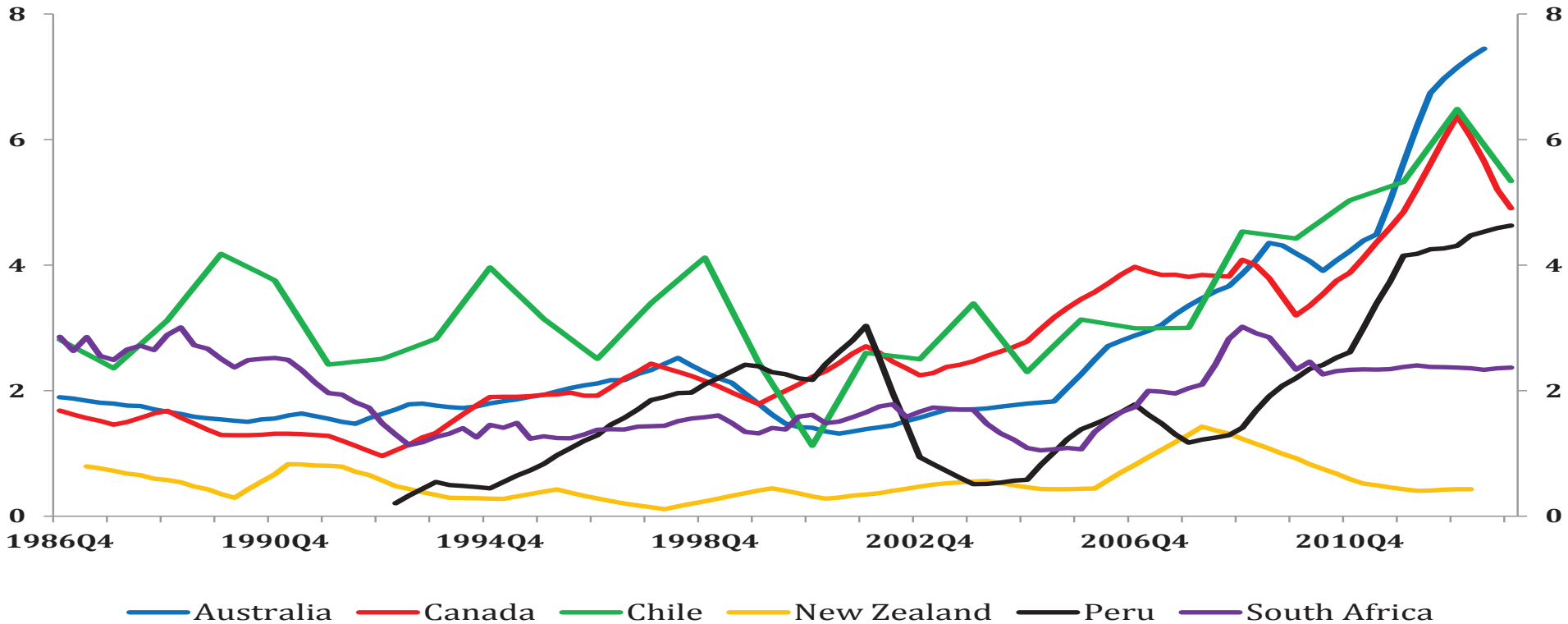
Motivation

- In recent years we have seen the expansive phase of a commodity price cycle. However,
  - Growth in emerging economies is slowing down with possible negative effects on commodity prices. Besides, monetary policy in the US is expected to be normalized soon
  - Commodity exporters may be vulnerable to fall in prices
- This boom has been beneficial for commodity exporters:
  - Mining investment has surged
  - Spending and aggregate demand has increased and that boosted GDP growth rates above OECD average

Commodity price indexes and Chilean ToT (2005=100)



Mining investment share in selected countries (% of nominal GDP)



Objective

- Analyze in a broad perspective the macroeconomic effects of commodity price shocks in small commodity exporters, focusing on metals prices and their propagation through sectoral investment
- Two different methodologies to study these developments: a SVAR analysis and a DSGE model

Literature

- Two major strands of the literature
  1. Time series methods (such as SVARs)
     - Bernanke et al.(1997), Blanchard and Galí(2007), Kilian (2008,2009), Kilian and Lewis (2011), Lombardi et al.(2012), Baumeister and Peersman (2013), Gubler and Hertweck (2013) and Filardo and Lombardi (2014)
  2. DSGE models
     - Kilian et al.(2009), Tober and Zimmermann (2009), Bodenstein et al.(2011) and Bodenstein et al.(2012)
- However, most of them have focused on oil price shocks in developed countries and/or net commodity importers with a few exceptions
  - Medina et al.(2008), Desormeaux et al.(2010), Kumhof and Laxton (2010), Knop and Vespignani (2014) and Malakhovskaya and Minabutdinov (2014)

Contribution

1. We study the impact of commodity price shocks on sectoral investment in commodity-exporting economies based on a SVAR approach
2. We augment an otherwise standard New Keynesian SOE model with a commodity sector by an endogenous production structure to analyze the transmission channels and policy implications of commodity price shocks

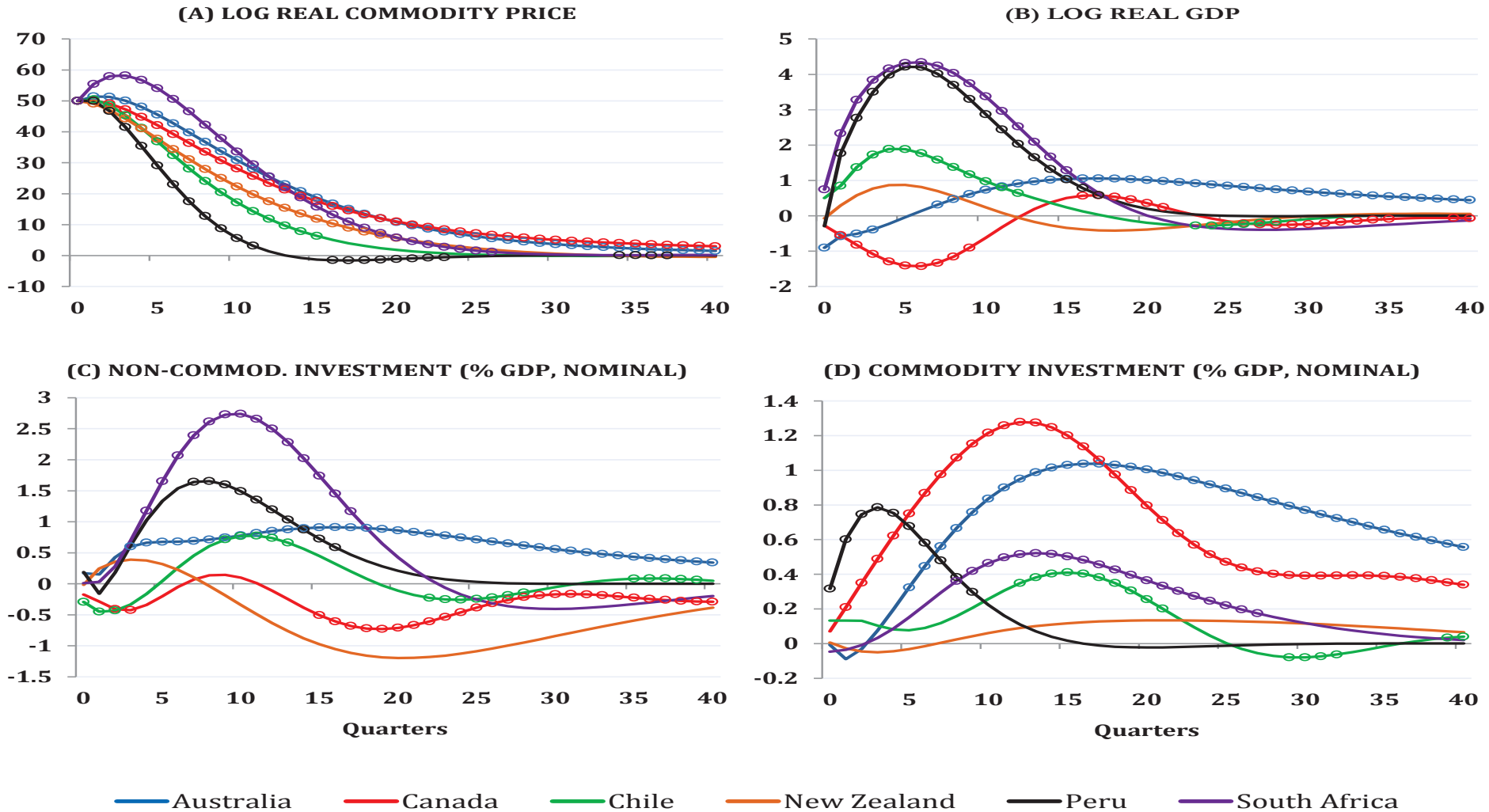
Summary of results

- Cross-country analysis:
  - The higher the share of metal commodity exports, the larger the effects on real GDP
  - Expansionary effects are driven by mining investment, which increases with delay
- Real copper price shock has been a key driver in real investment and GDP growth after the mid-2000s in Chile
- Investment in commodities is mainly driven by sectoral shocks (productivity developments and commodity prices), but not by policy rules
- However, in general, flexible inflation targeting, floating exchange rates and structural fiscal rules are essential to efficiently manage commodity price volatility

SVAR analysis

- Estimate structural VAR for Australia, Canada, Chile, New Zealand, Peru and South Africa
- All countries approached as small open economies
- Specification: one lag for parsimony and control for quadratic trends in data
  - Exogenous block (4 variables):
    - real world GDP, annual US CPI inflation rate, US federal funds nominal rate, real commodity price
  - Domestic endogenous block (7 variables):
    - real GDP, nominal mining and non-mining investment (% nominal GDP), annual CPI inflation rate, annual nominal interest rate, real exchange rate, CA (% nominal GDP)

SVAR cross-country comparison: impulse responses



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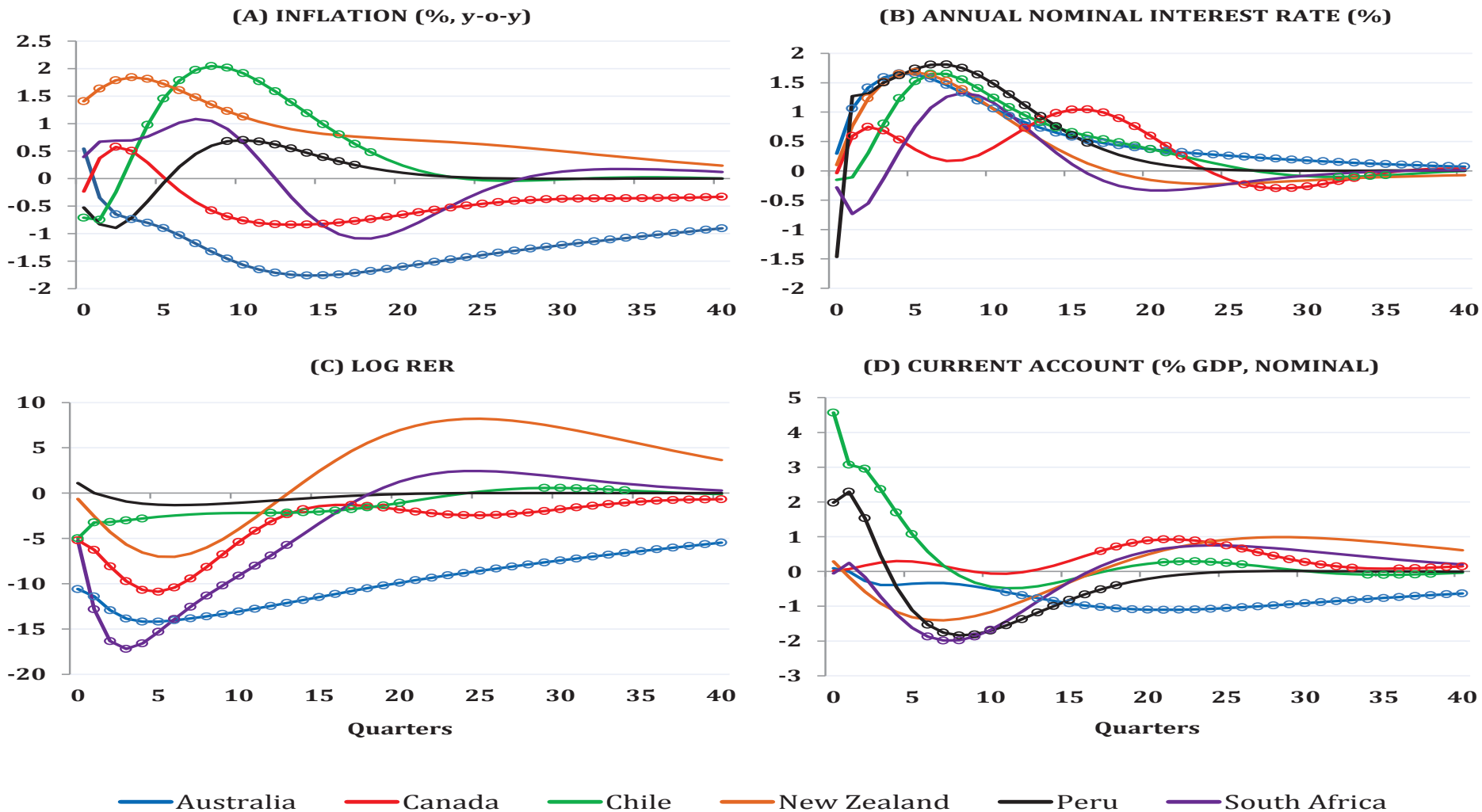
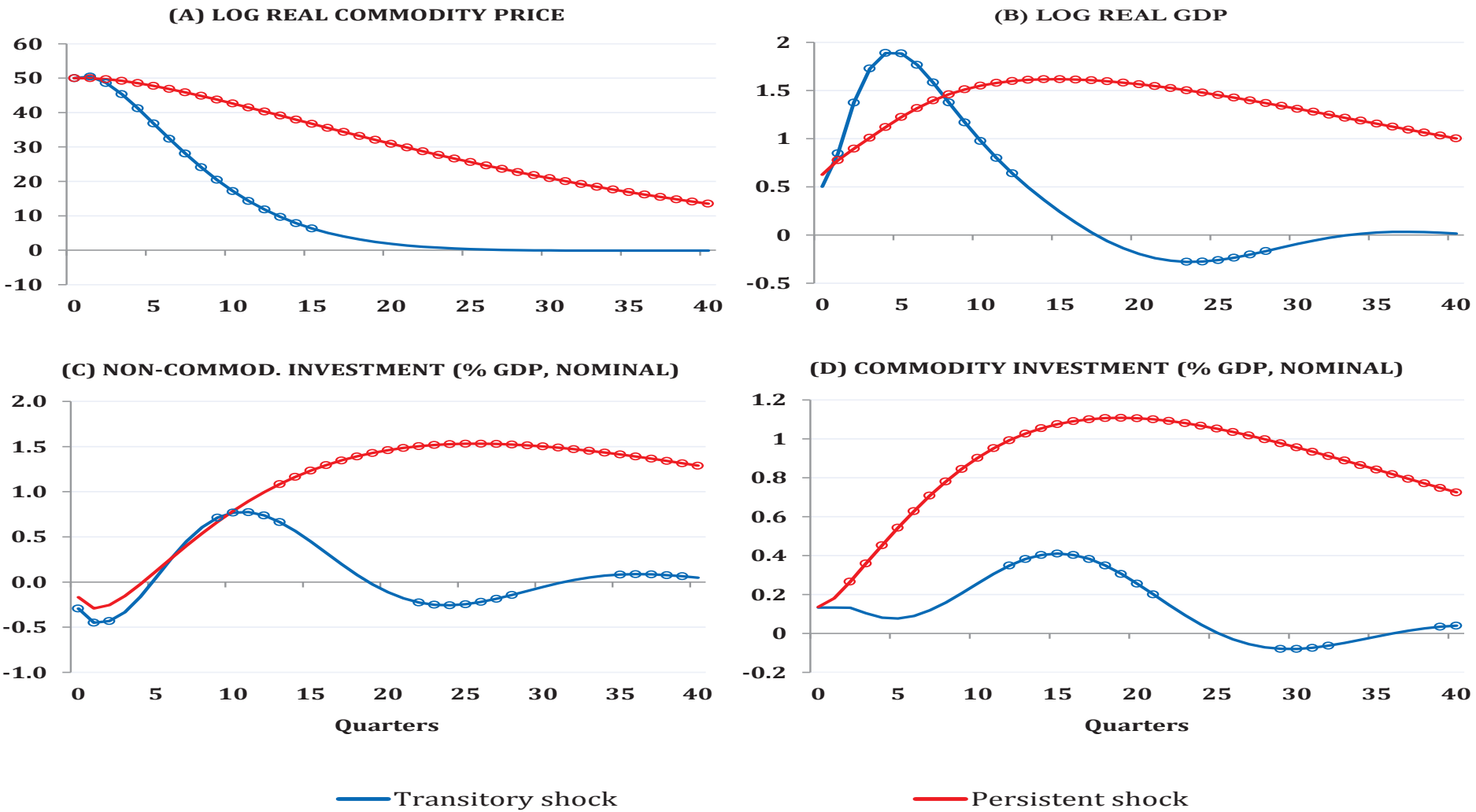


Chile: comparison of impulse responses under persistent and transitory shocks



Main findings from SVAR analysis across countries

- Commodity price shocks are relatively persistent with positive delayed responses of mining investment
- Investment in non-commodity sectors
  - Countries with important share in commodity exports: positive spillovers from investment in commodity (Chile, Peru and South Africa)
  - Countries with a more diversified trade structure: fall in non-commodity investment (Canada and New Zealand)
- Other results: local currencies appreciate in the short run and CA balances deteriorate in the medium term
- The persistence of commodity price shocks is crucial for the size and persistence of responses

DSGE model for Chile

- We extend the DSGE model for Chile of Medina and Soto (2007), which has similar structure to:
  - Smets and Wouters (2003)
  - Christiano et al. (2005)
  - Adolfson et al. (2007)
- Specific features of the Chilean economy:
  - Commodity (copper) sector S comprises one firm partially owned by the government with share χ. The remaining share belongs to foreign investors. Government taxes foreign commodity profits
  - Gov't expenditure follows a structural balance fiscal rule
  - Dynamics of foreign variables described by the external block of the SVAR model for Chile

Commodity sector's problem (S)

- Cobb-Douglas production function

$$Y_{S,t} = a_{S,t} T_t^{\eta_S} K_{S,t-1}^{1-\eta_S}$$

where $a_{S,t}$ is exogenous and measures the specific technology shock and T_t is the trend.

- Define gross profits:

$$\Pi_{S,t} = P_{S,t} Y_{S,t} - P_{C,t} T_t \kappa_S,$$

where $\kappa_S \geq 0$ are fixed costs of production

- The firm maximizes cash flows $CF_{S,t} = \Pi_{S,t} - P_{I_S,t} I_{S,t}$

$$\max E_t \sum_{i=0}^{\infty} \Lambda_{t,t+i} \frac{CF_{S,t+i}}{P_{C,t+i}},$$

Capital accumulation

$$K_{S,t} = (1-\delta_S)K_{S,t-1} + \left[1 - \Phi_S\left(\frac{X_{S,t-n+1}}{X_{S,t-n}}\right)\right] X_{S,t-n+1}$$

where $X_{S,t-n+1}$ are investment projects in $t-n+1$ and $\Phi_S(\cdot)$ is an adjustment convex cost function

- Capital accumulation is slow in sector S:
  - Convex costs to start investment projects (CEE, 2005)
  - We assume *time to build* (Kydland and Prescott, 1982; Uribe and Yue, 2006): between the start of the project and capital installation to become productive last $n \geq 1$ periods

Investment

- Effective investment flow in period t is

$$I_{S,t} = \sum_{j=0}^{n-1} \varphi_j X_{S,t-j},$$

where φ_j is the project's share that are at $j = 0, \ldots, n-1$ periods of its completion, with $\sum_{j=0}^{n-1} \varphi_j = 1$

- The relevant investment bundle combines both domestic and foreign goods

$$I_{S,t} = \left[\gamma_{I_S}^{\frac{1}{\eta_{I_S}}} I_{H,t}(S)^{1-\frac{1}{\eta_{I_S}}} + (1-\gamma_{I_S})^{\frac{1}{\eta_{I_S}}} I_{F,t}(S)^{1-\frac{1}{\eta_{I_S}}} \right]^{\frac{\eta_{I_S}}{\eta_{I_S}-1}}$$

Optimality

- From FOC:

$$K_{S,t} \quad : \quad \frac{Q_{S,t}}{P_{C,t}} = E_t \left\{ \Lambda_{t,t+1} \left[\begin{array}{c} \frac{Q_{S,t+1}}{P_{C,t+1}}(1-\delta_S) \\ + \frac{P_{S,t+1} A_S F^S_{K_S}(T_{t+1}, K_{S,t})}{P_{C,t+1}} \end{array} \right] \right\}$$

$$X_{S,t} \quad : \quad \varphi_0 \frac{P_{I_S,t}}{P_{C,t}} + \varphi_1 E_t \left\{ \Lambda_{t,t+1} \frac{P_{I_S,t+1}}{P_{C,t+1}} \right\} + \varphi_2 E_t \left\{ \Lambda_{t,t+2} \frac{P_{I_S,t+2}}{P_{C,t+2}} \right\}$$

$$+ \cdots + \varphi_{n-1} E_t \left\{ \Lambda_{t,t+n-1} \frac{P_{I_S,t+n-1}}{P_{C,t+n-1}} \right\}$$

$$= E_t \left\{ \begin{array}{c} \Lambda_{t,t+n-1} \frac{Q_{S,t+n-1}}{P_{C,t+n-1}} \left[\begin{array}{c} 1 - \Phi_S \left(\frac{X_{S,t}}{X_{S,t-1}} \right) \\ - \Phi'_S \left(\frac{X_{S,t}}{X_{S,t-1}} \right) \frac{X_{S,t}}{X_{S,t-1}} \end{array} \right] \\ + \Lambda_{t,t+n} \frac{Q_{S,t+n}}{P_{C,t+n}} \Phi'_S \left(\frac{X_{S,t+1}}{X_{S,t}} \right) \left(\frac{X_{S,t+1}}{X_{S,t}} \right)^2 \end{array} \right\}$$

- Persistent commodity price shocks generate additional investment in sector S

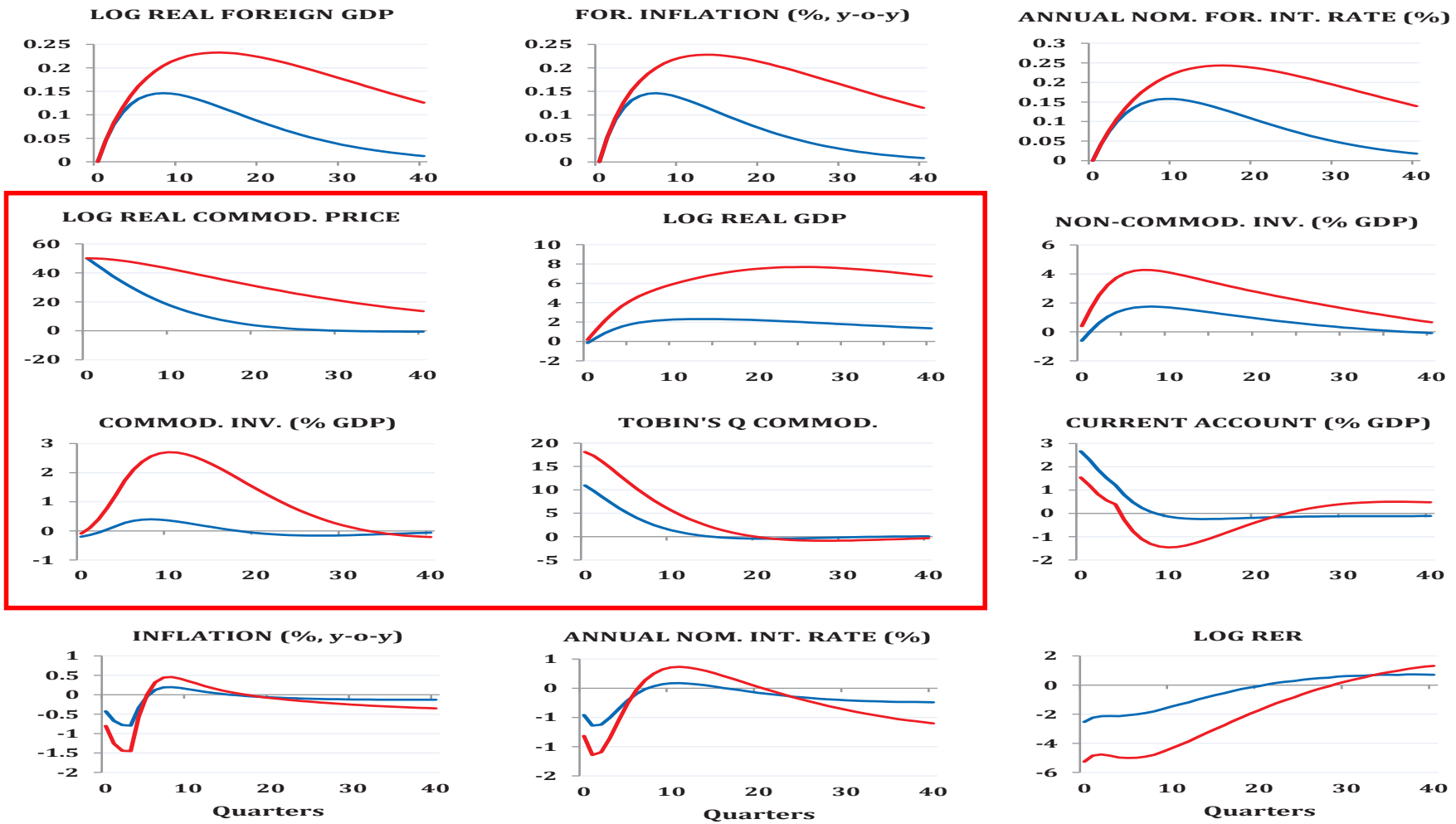
Structural fiscal rule

- The fiscal rule determines gov't spending depending on the structural balance

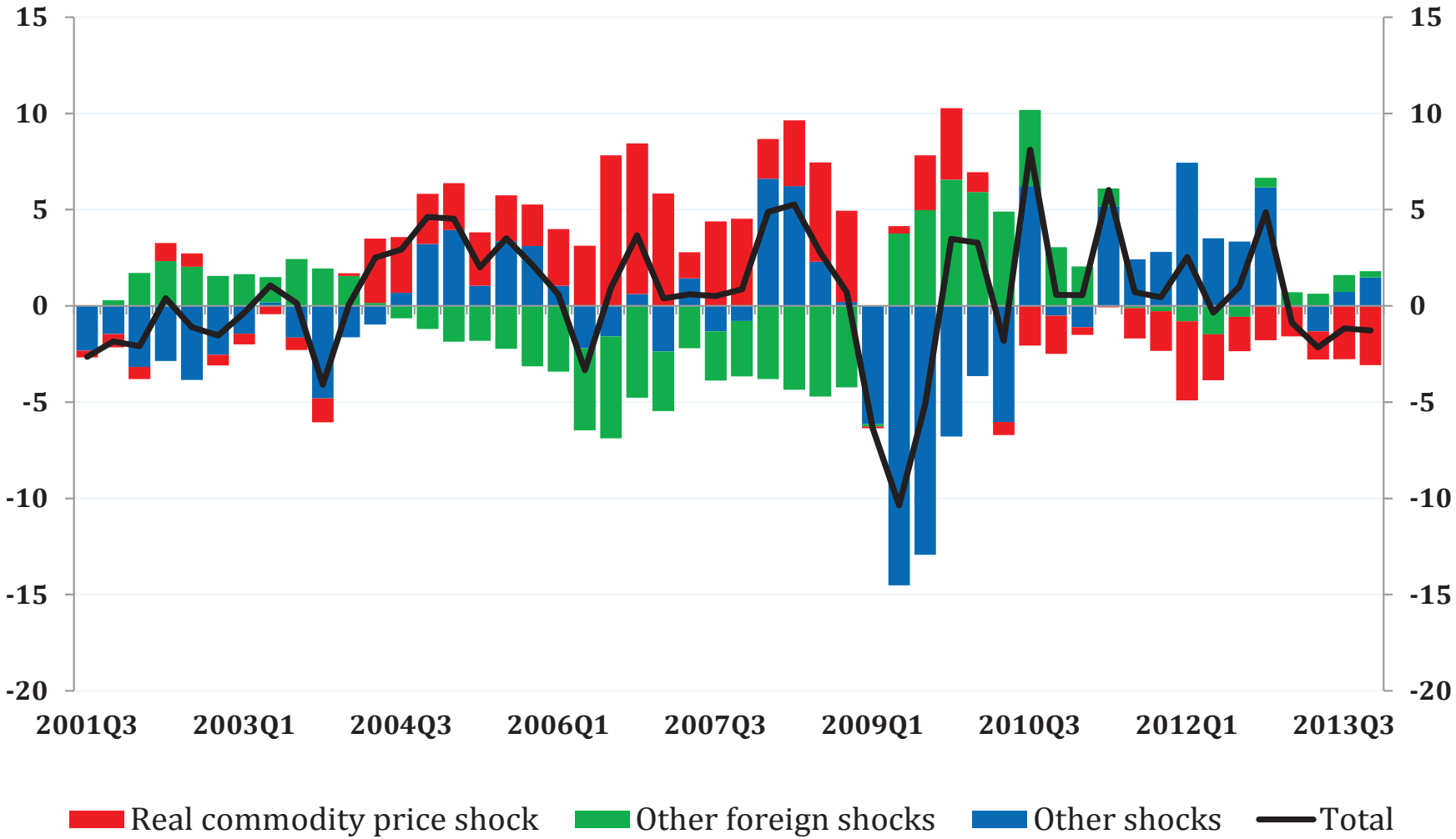
$$\frac{P_{G,t}G_t}{P_{Y,t}Y_t} = \left[\begin{array}{c} \left(1 - \frac{1}{(1+i^*_{t-1})\Theta_{t-1}}\right) \frac{\varepsilon_t B^*_{G,t-1}}{P_{Y,t}Y_t} + \frac{\tau_t P_{Y,t}\bar{Y}_t}{P_{Y,t}Y_t} + \chi \frac{CF_{S,t}}{P_{Y,t}Y_t} \\ +\tau_S(1-\chi)\frac{\Pi_{S,t} - \delta_S Q_{S,t}K_{S,t-1}}{P_{Y,t}Y_t} - \frac{VC_t}{P_{Y,t}Y_t} - \frac{Target}{P_Y Y} \end{array} \right] \frac{P_{G,t}\zeta_{G,t}T_t}{P_{Y,t}Y_t}$$

- where χ is the Gov't share of the mining sector's cash flow and τ_S is a commodity tax rate
- $VC_t = [\chi + \tau_S(1-\chi)]Y_{S,t}\varepsilon_t(P^*_{S,t} - \bar{P}^*_{S,t})$ is the copper price cyclical adjustment. It increases if the effective price is higher than the reference price $\bar{P}^*_{S,t}$

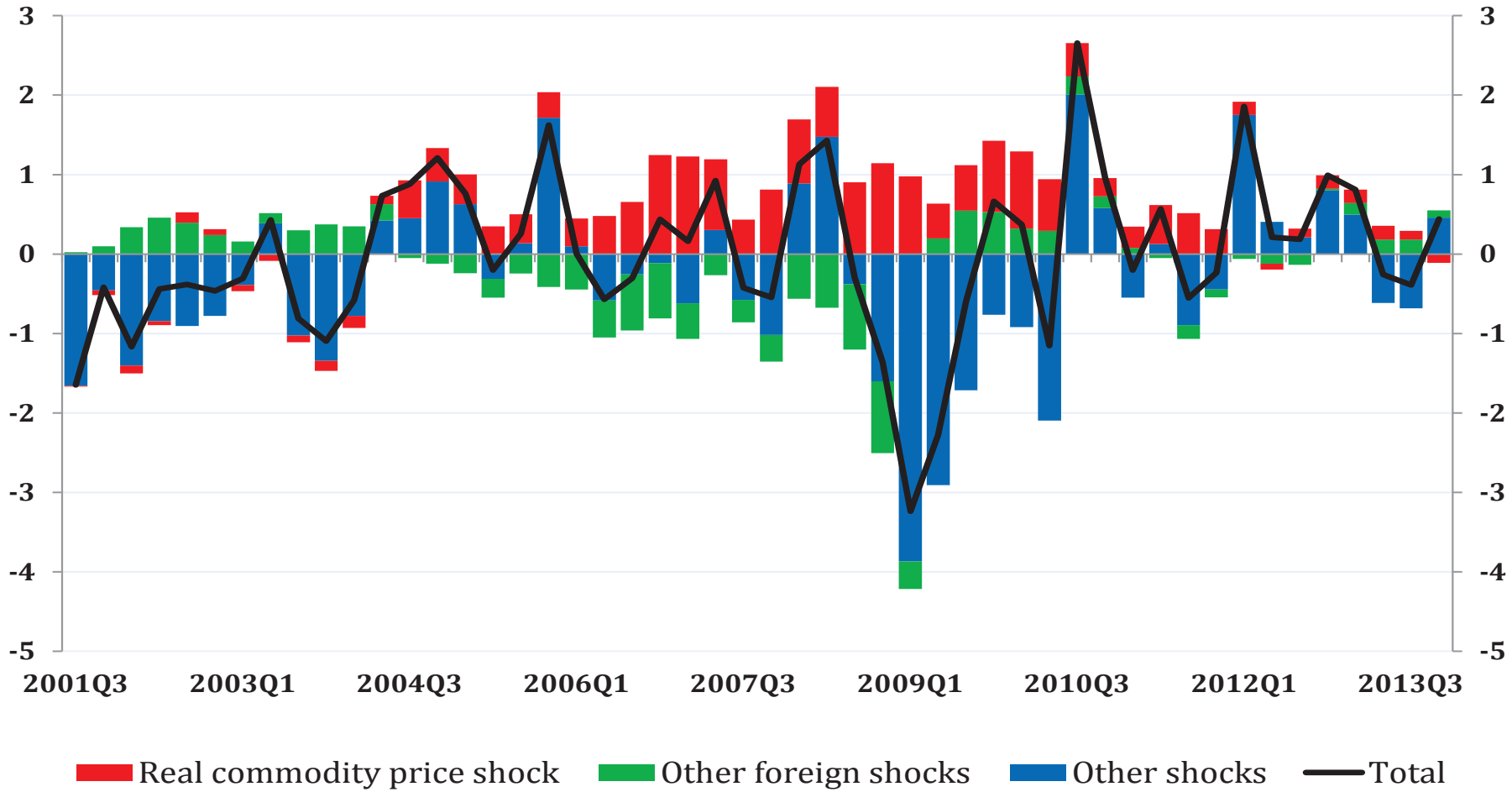
Impulse responses to commodity price shock (50%) with low and high persistence



Historical decomposition of real investment growth



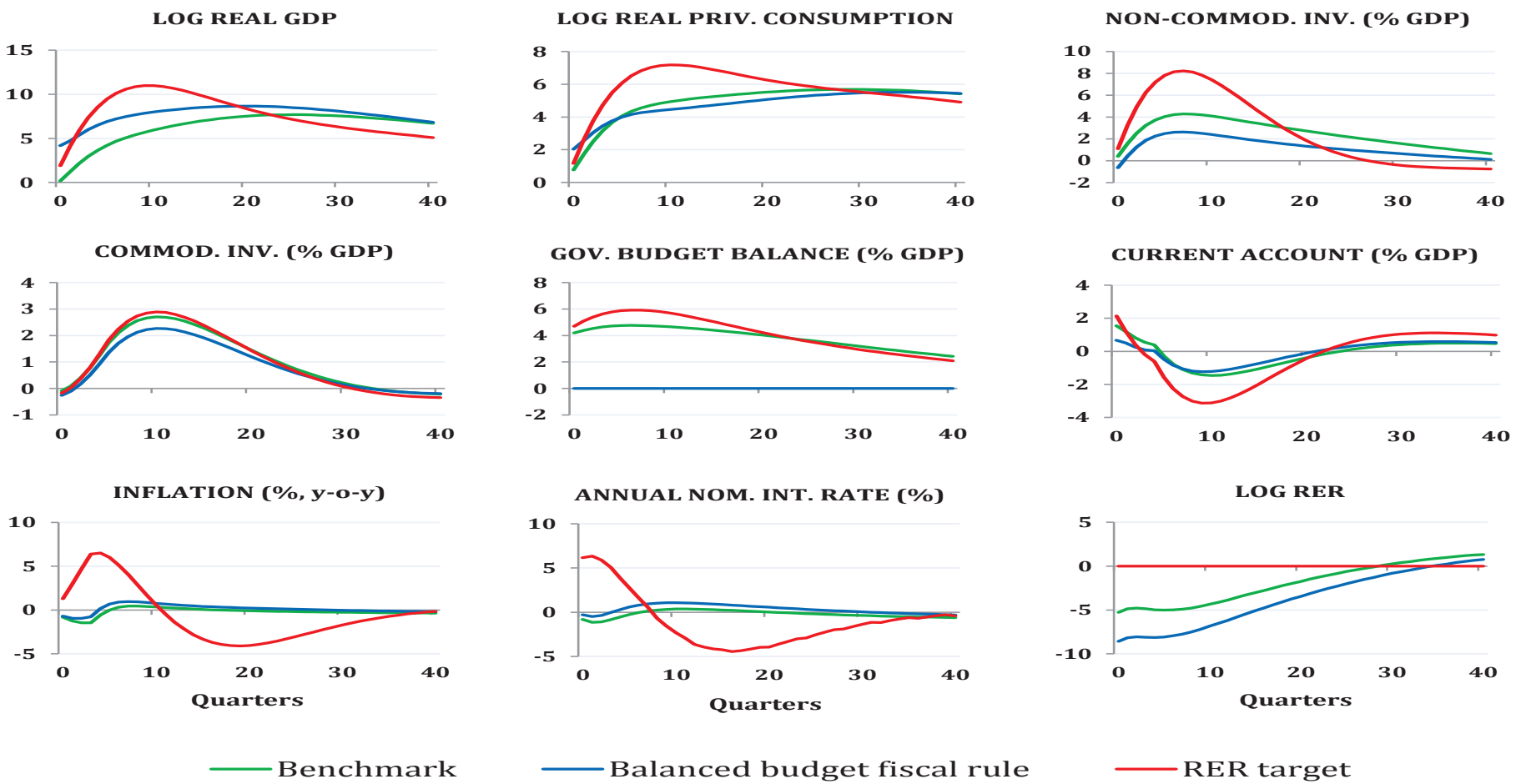
Historical decomposition of real GDP growth



Historical decompositions

1. Most of the above-average investment growth in Chile in 2004-2010 is explained by commodity price shocks
2. The investment boom seems to have come to an end after 2012 influenced by lower commodity prices
3. Regarding real GDP growth, commodity price shocks have been equally important. Their contribution gradually diminish

Counterfactual policy analysis of different rules



Policy insights

1. Monetary and fiscal policy rules do not majorly affect investment decisions in the commodity sector, which are mainly driven by sectoral productivity developments and commodity prices
2. Real GDP response is smaller in the benchmark case: flexible inflation targeting, floating exchange rates and structural fiscal rules are essential to limit the effects of commodity price volatility on output

Conclusions

- Our results suggest expansionary effects of commodity price increases in countries with an important share of commodity exports, driven by positive responses of commodity investment that spill over to non-commodity sectors
- The size of the macroeconomic responses to commodity shocks depends strongly on the persistence of the shock
- Commodity price fluctuations have been a significant driving force of the investment cycle in Chile

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