

Appendix A

Supplementary material

Appendix A is divided into two parts. In the first part, the details of the analytical framework developed in Section 3 are provided. In the second part, additional information referred to in the main text is presented in tables and figures.

The details of the analytical framework

The analytical framework starts with equation (2) that expresses the level of total foreign exchange reserves in a single currency, the U.S. dollar, at the end of period t . It is rewritten here for convenience:

$$R_t = \sum_{i=1}^N S_{it} R_{it} \quad (2)$$

where S_{it} is an exchange rate of currency i at the end of period t , defined as a price of that currency in U.S. dollars, and R_{it} stands for reserves in currency i at the end of period t . First, equation (2) is written for first differences:

$$\begin{aligned} \Delta R_t &= \sum_{i=1}^N (S_{it} R_{it} - S_{it-1} R_{it-1}) \\ &= \sum_{i=1}^N (\Delta S_{it} R_{it} + S_{it-1} \Delta R_{it}) \end{aligned} \quad (A1)$$

where Δ is the first difference operator.

Second, the transformation into rates of growth is obtained by dividing both sides by R_{t-1} :

$$\nabla R_t = \sum_{i=1}^N \left(\frac{S_{it-1} R_{it-1}}{R_{t-1}} \frac{\Delta S_{it}}{S_{it-1}} \frac{R_{it}}{R_{it-1}} + \frac{S_{it-1} R_{it-1}}{R_{t-1}} \frac{\Delta R_{it}}{R_{it-1}} \right) \quad (A2)$$

where ∇ is the growth rate operator. After a bit of manipulation equation (A2) can be transformed into:

$$\begin{aligned} \nabla R_t &= \sum_{i=1}^N [u_{it-1} \nabla S_{it} (\nabla R_{it} + 1) + u_{it-1} \nabla R_{it}] \\ &= \sum_{i=1}^N (u_{it-1} \nabla S_{it} \nabla R_{it} + u_{it-1} \nabla S_{it} + u_{it-1} \nabla R_{it}) \end{aligned} \quad (A3)$$

which is the same as equation (4) in the main text:

$$\nabla R_t = \sum_{i=1}^N u_{it-1} \nabla R_{it} + \sum_{i=1}^N u_{it-1} \nabla S_{it} + \sum_{i=1}^N u_{it-1} \nabla S_{it} \nabla R_{it} \quad (4)$$

Equations (5) and (6) can be derived as follows. A change in reserves held in currency i can be decomposed into a change in an active component, ΔR_{it}^{AC} , and interest income:

$$\Delta R_{it} = \Delta R_{it}^{AC} + r_t R_{it-1} \quad (A4)$$

where r_{it} is the rate of return on assets in currency i . Dividing both sides by R_{it-1} one gets equation (5) in the main text:

$$\nabla R_{it} = \nabla R_{it}^{AC} + r_{it}, \quad (5)$$

Given equation (5) the first sum in equation (4) can be used to derive an active component of FX reserves:

$$\begin{aligned} \sum_{i=1}^N u_{it-1} \nabla R_{it} &= \sum_{i=1}^N u_{it-1} (\nabla R_{it}^{AC} + r_{it}) \\ &= \sum_{i=1}^N u_{it-1} \nabla R_{it}^{AC} + \sum_{i=1}^N u_{it-1} r_{it} \\ &= \nabla R_t^{AC} + r_t \end{aligned} \quad (A5)$$

where $r_t = \sum_{i=1}^N u_{it-1} r_{it}$ and $\nabla R_t^{AC} = \sum_{i=1}^N u_{it-1} \nabla R_{it}^{AC}$. Equation (6) can be directly derived from equation (A5).

An active component of FX reserves can be thought of as a product of its rate of growth and a previous period level of FX reserves. This is captured in equation (7) in the main text:

$$AC_t = \nabla R_t^{AC} R_{t-1} \quad (7)$$

Table A1. Sources of data on foreign exchange interventions

Country	Description	Source
Argentina	Banco Central de la República Argentina (BCRA) net purchases of foreign exchange (in millions of USD) Time range: 2003-2017 Frequency: daily and monthly	BCRA website
Chile	Banco Central de Chile (BCCh) tender purchases of dollars and sale of dollars by tender (in millions of USD) Time range: 2008-2017 Frequency: daily	BCCh website
the Czech Republic	Czech National Bank (CNB) traded spot transactions in foreign currency against CZK (in millions of USD) Time range: 1997-2017 Frequency: monthly	CNB website
Mexico	Banco de México (BdM) market operations (in millions of USD) Time range: 1996-2017 Frequency: monthly	BdM website
Russia	Bank of Russia (BoR) USD and euro operations (in millions of USD and millions of EUR) Time range: (August) 2008-2017 Frequency: monthly	BoR website
Turkey	Central Bank of the Republic of Turkey (CBRT, Türkiye Cumhuriyet Merkez Bankası) foreign exchange interventions including buying and selling auctions and direct foreign exchange transactions (in millions of USD) Time range: 2001-2017 Frequency: monthly	CBRT website

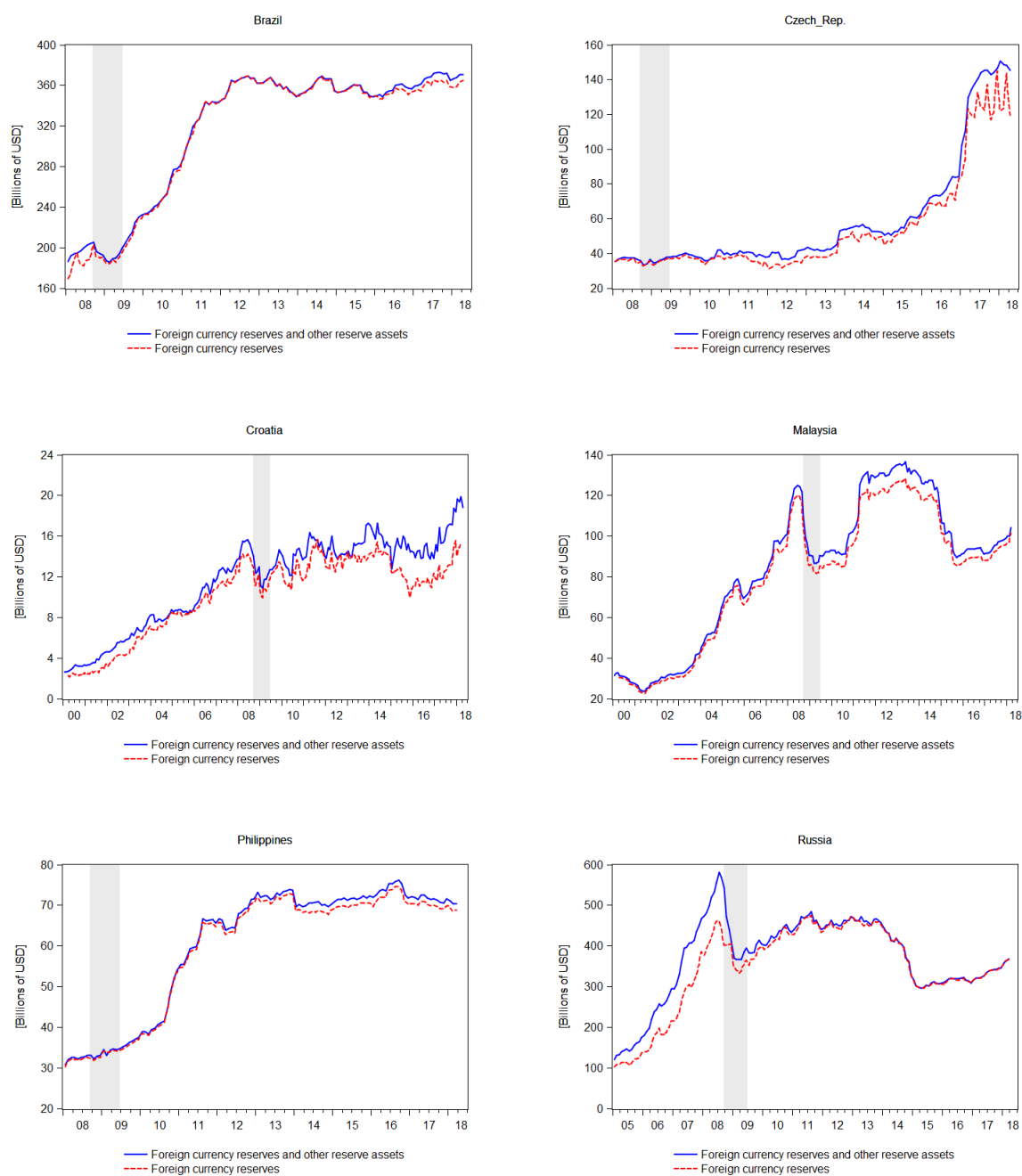
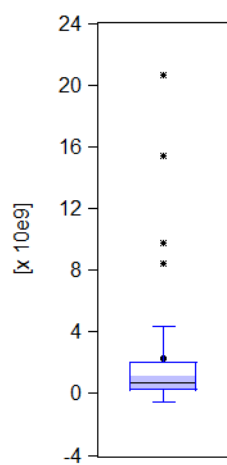
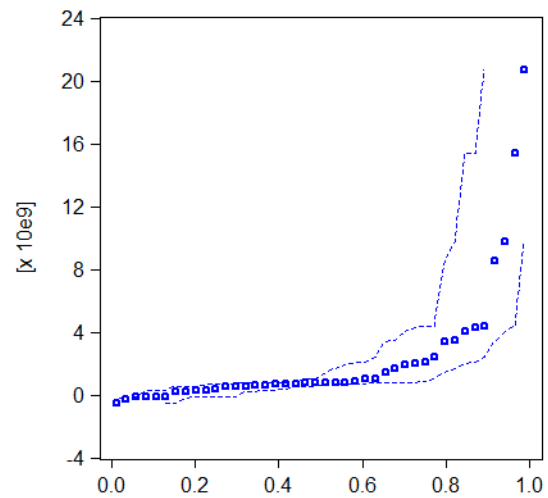


Figure A1. Foreign currency reserves and other currency reserves in Brazil, the Czech Republic, Croatia, Malaysia, the Philippines and Russia

Note: The shaded areas refer to the global financial crisis.



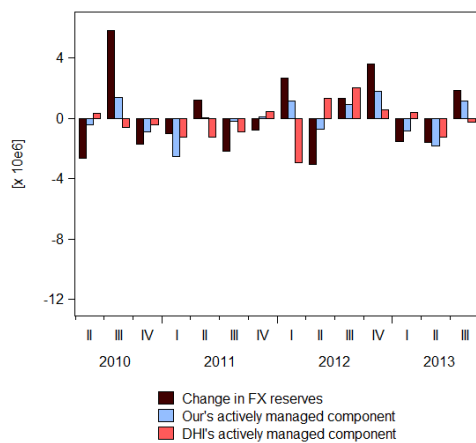
(a) Boxplot



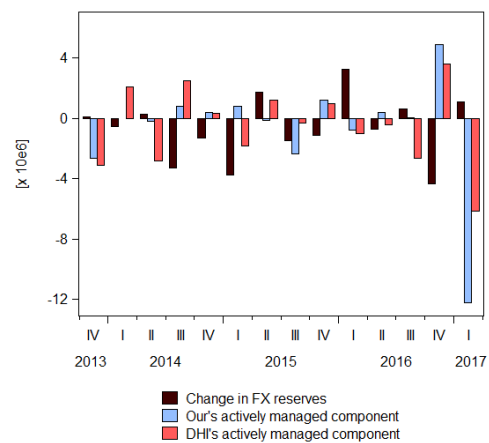
(b) Empirical quantiles

Figure A2. FX market interventions in November 2013 – April 2017

Note: An asterisk in panel (a) denotes a far outlier. It is an observation that is above the third quartile plus three times the difference between the third and first quartiles, i.e. above $QR_3 + 3(QR_3 - QR_1)$.



(a) May 2010 – October 2013



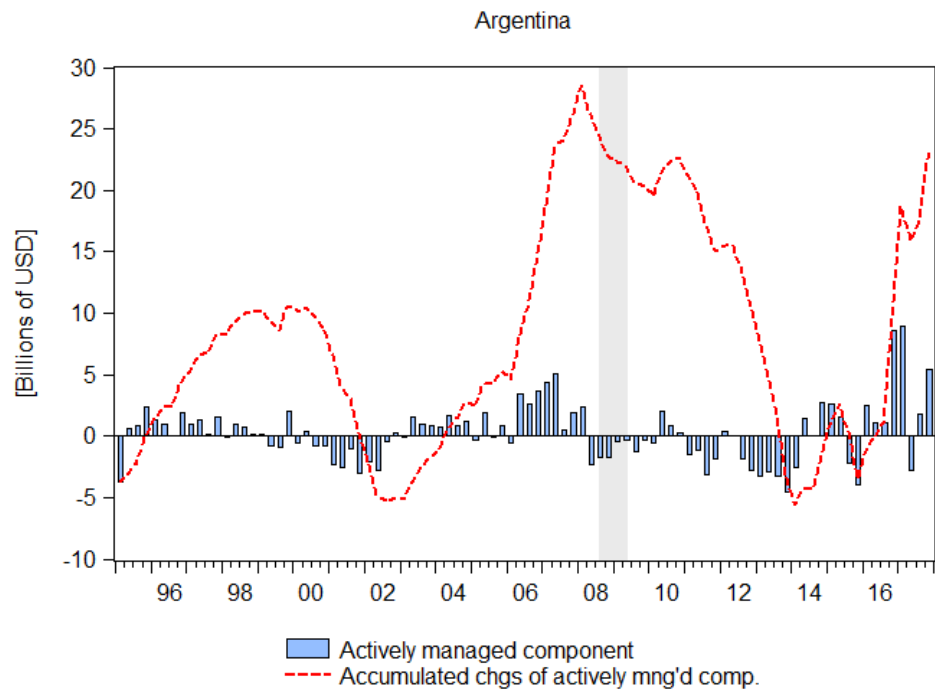
(b) November 2013 – April 2017

Figure A3. Foreign exchange reserves and interventions in the Czech Republic, 2010-2017
(quarterly, millions of USD)

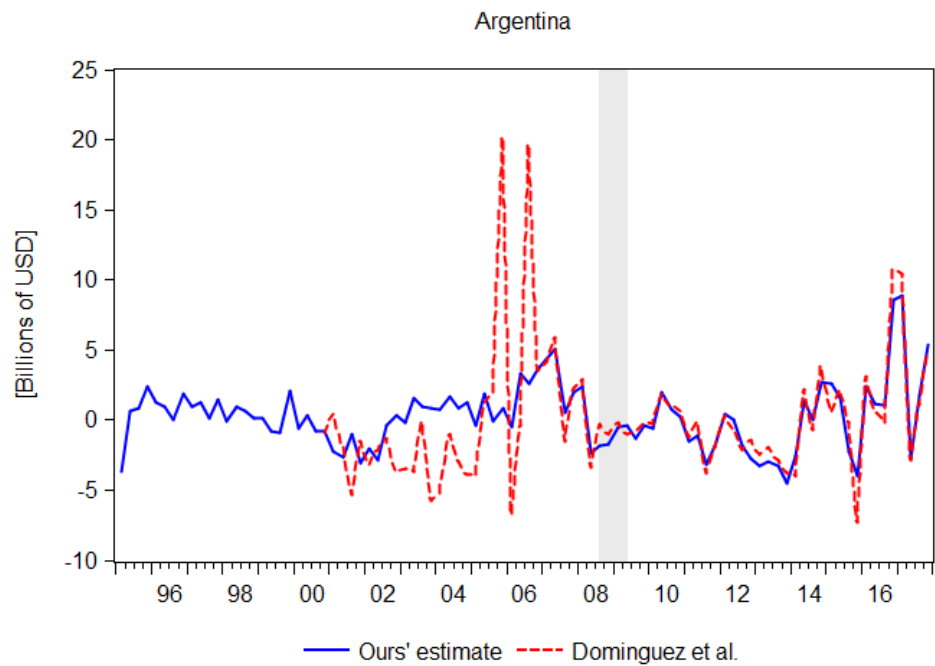
Source: own calculations based on data from the IMF and CNB.

Appendix B

Detailed results on individual countries



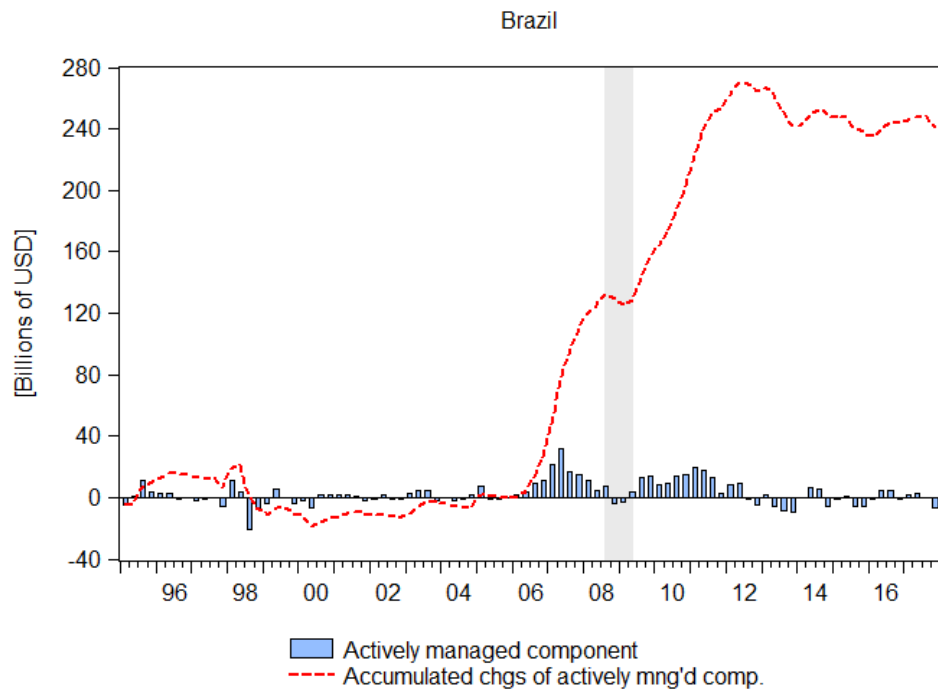
(a) The active component of FX reserves and its accumulated changes under a new approach



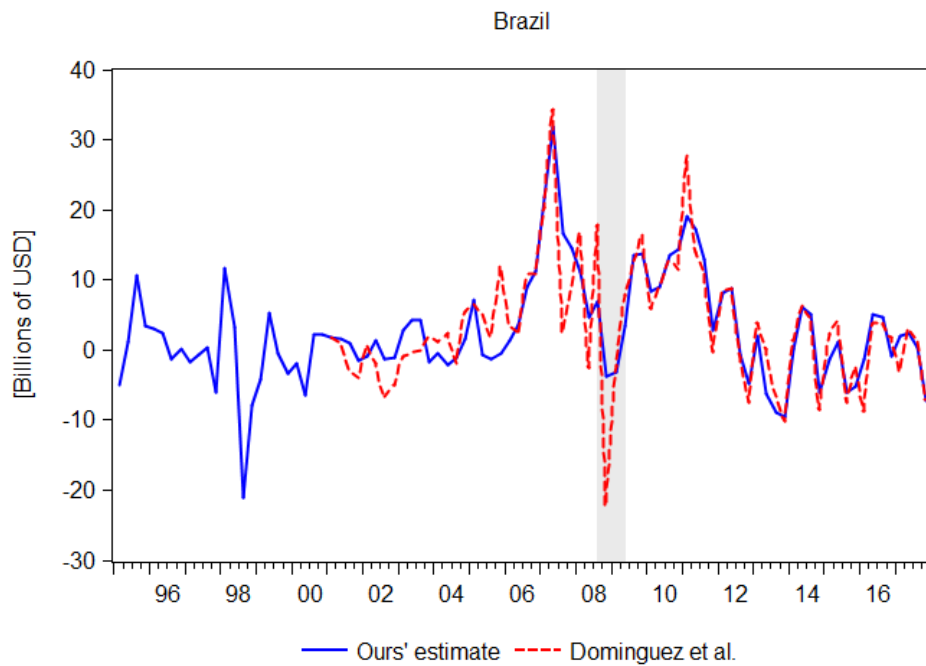
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B1. Estimates of the active component of FX reserves in Argentina

Note: The shaded areas refer to the global financial crisis.



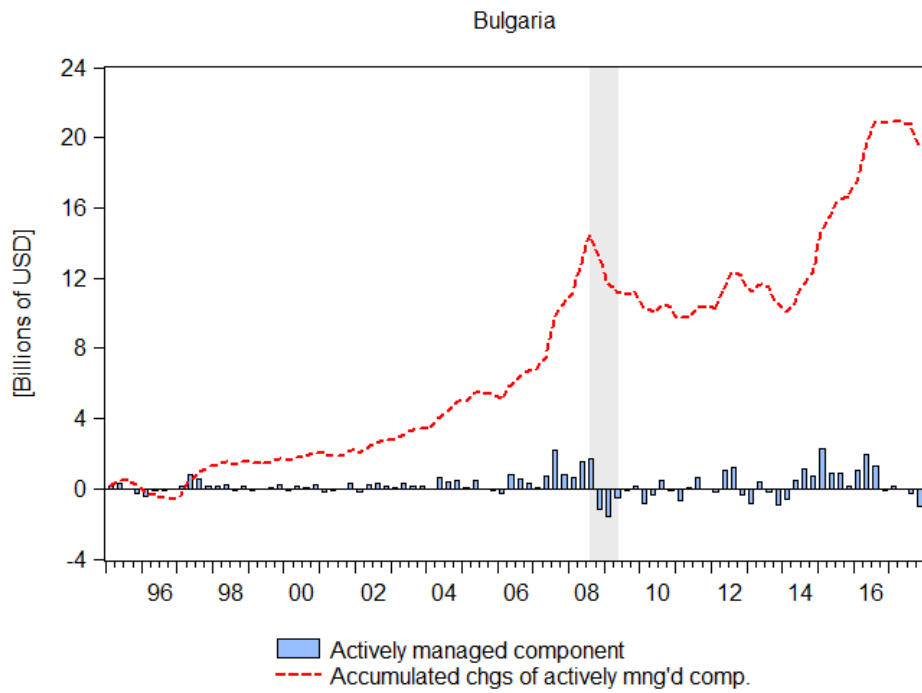
(a) The active component of FX reserves and its accumulated changes under a new approach



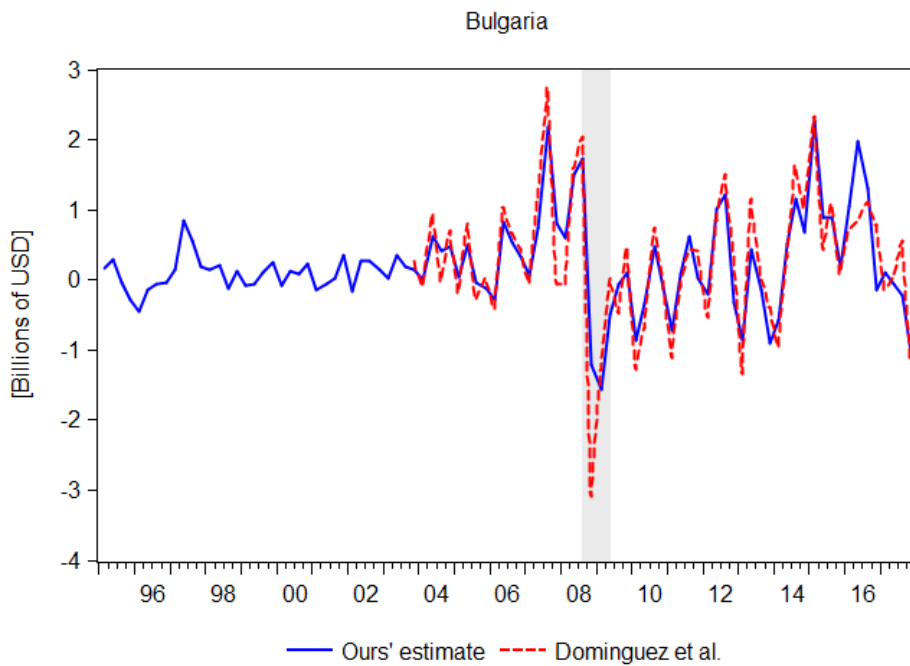
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B2. Estimates of the active component of FX reserves in Brazil

Note: The shaded areas refer to the global financial crisis.



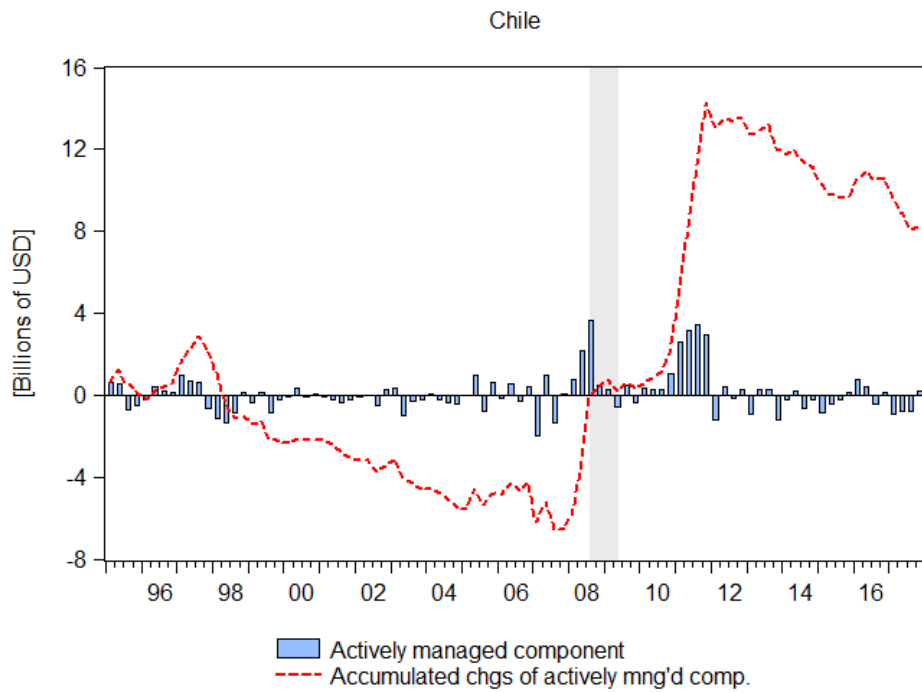
(a) The active component of FX reserves and its accumulated changes under a new approach



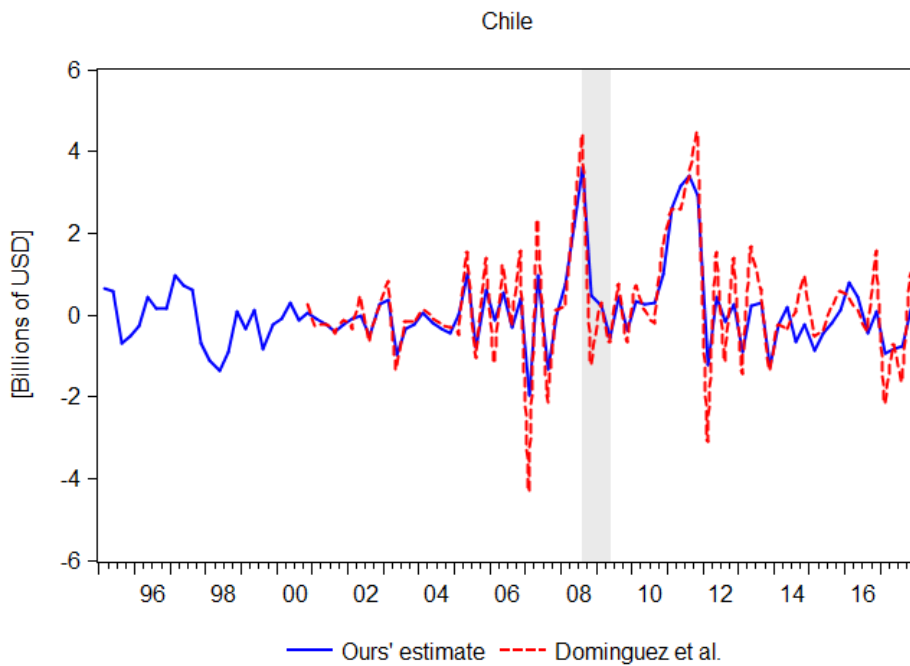
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B3. Estimates of the active component of FX reserves in Bulgaria

Note: The shaded areas refer to the global financial crisis.



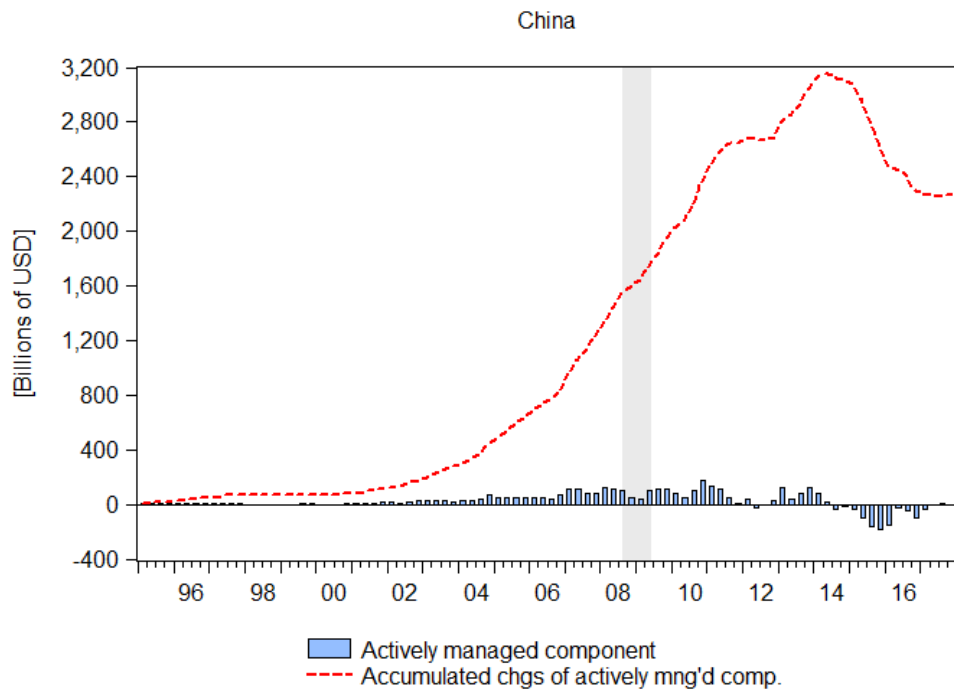
(a) The active component of FX reserves and its accumulated changes under a new approach



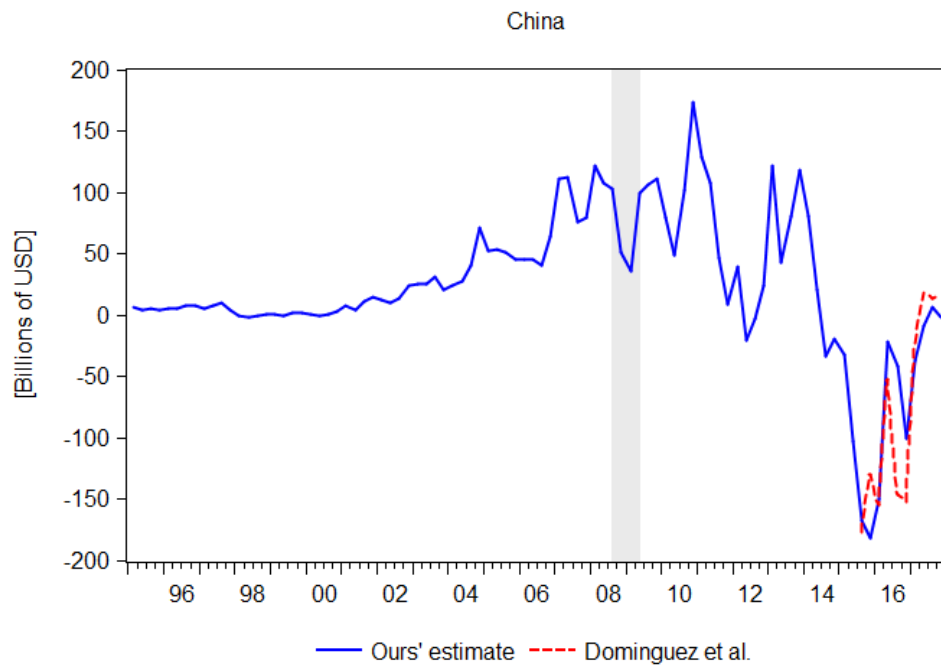
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B4. Estimates of the active component of FX reserves in Chile

Note: The shaded areas refer to the global financial crisis.



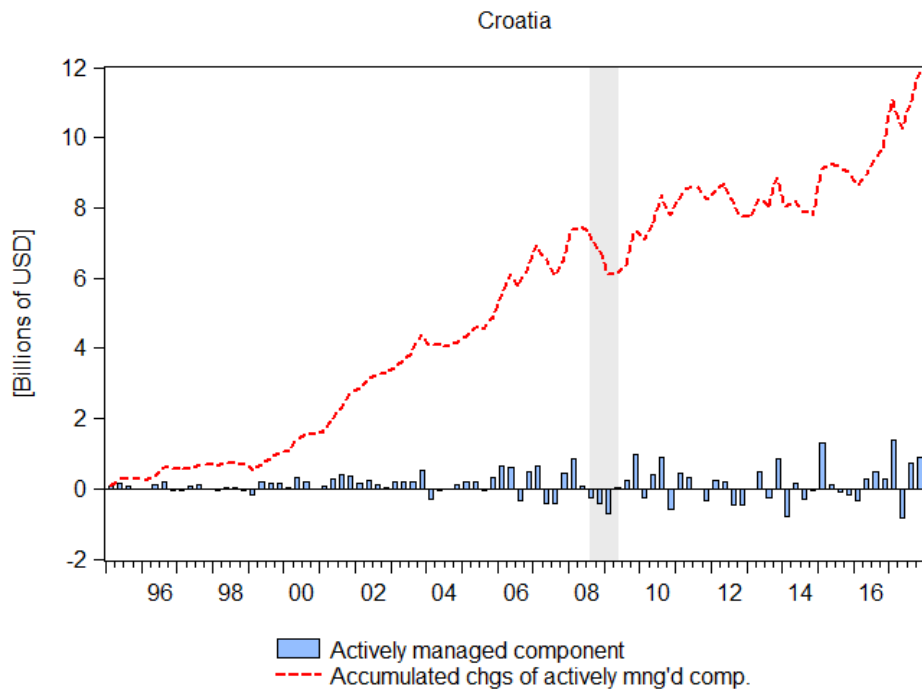
(a) The active component of FX reserves and its accumulated changes under a new approach



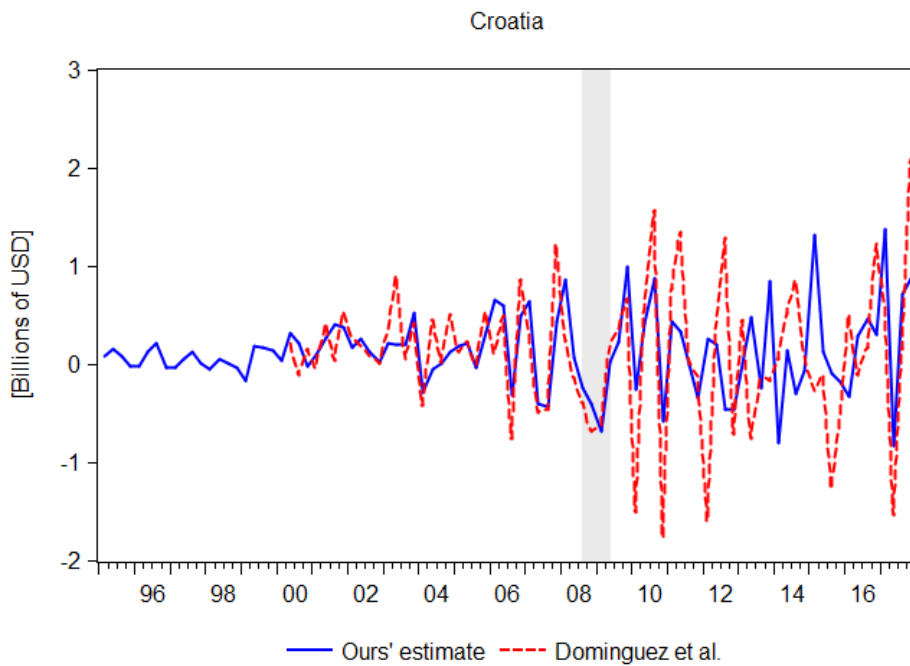
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B5. Estimates of the active component of FX reserves in China

Note: The shaded areas refer to the global financial crisis.



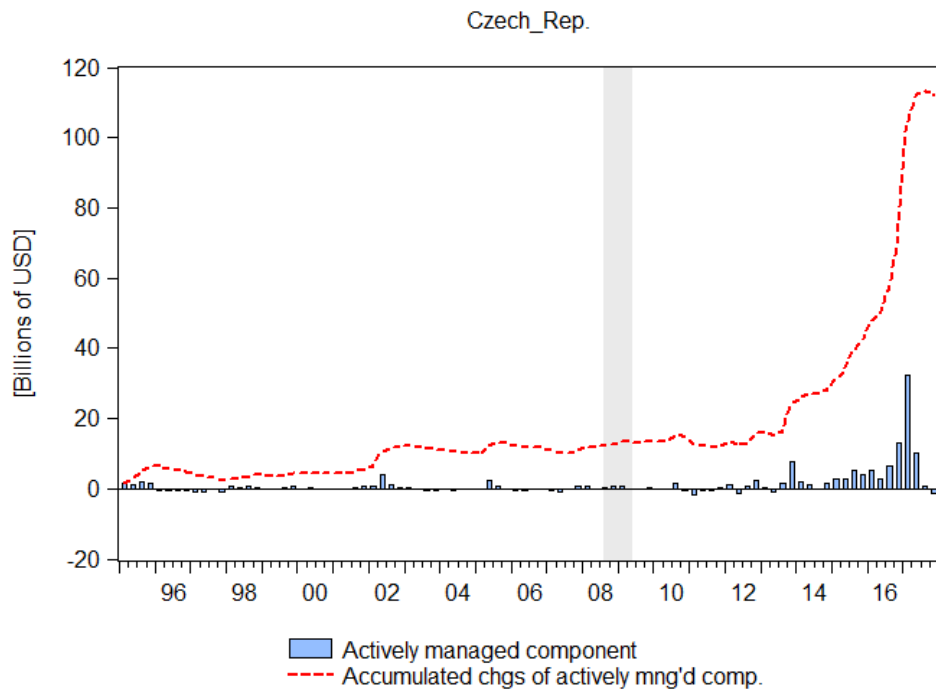
(a) The active component of FX reserves and its accumulated changes under a new approach



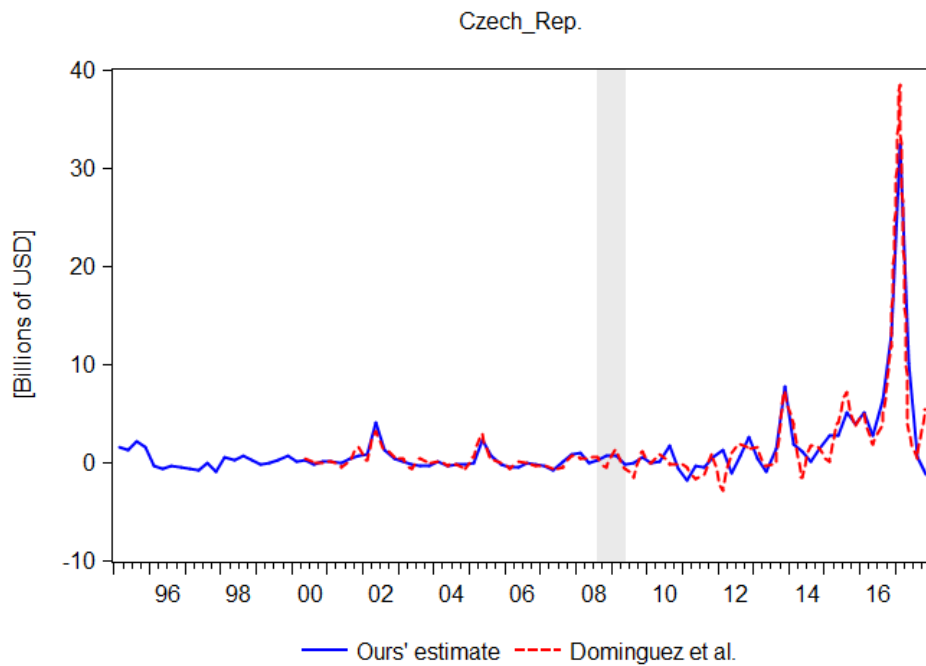
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B6. Estimates of the active component of FX reserves in Croatia

Note: The shaded areas refer to the global financial crisis.



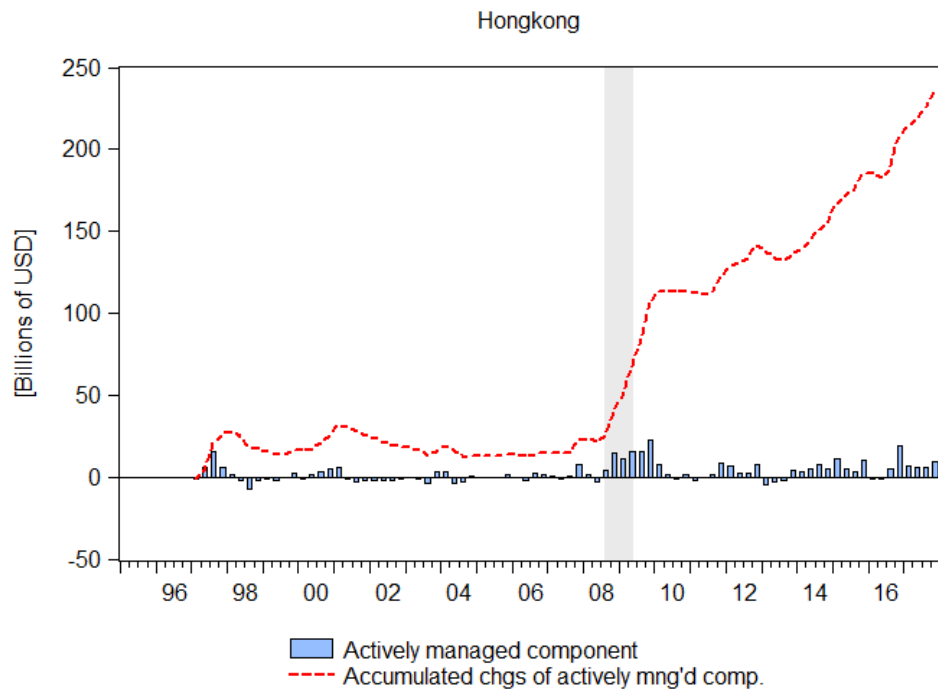
(a) The active component of FX reserves and its accumulated changes under a new approach



(b) The active component of FX reserves: the new approach vs. the DHI approach

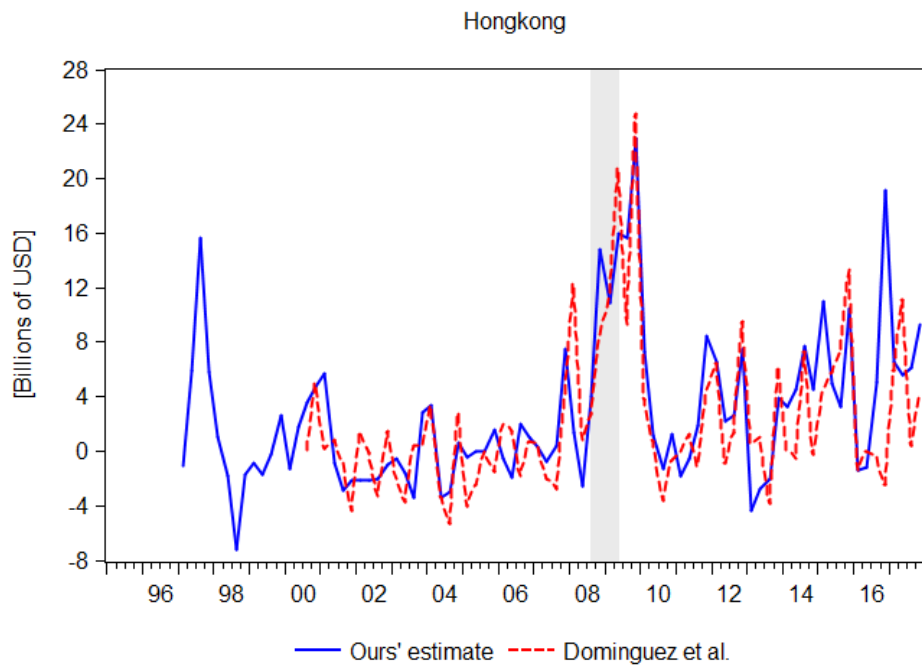
Figure B7. Estimates of the active component of FX reserves in the Czech Republic

Note: The shaded areas refer to the global financial crisis.



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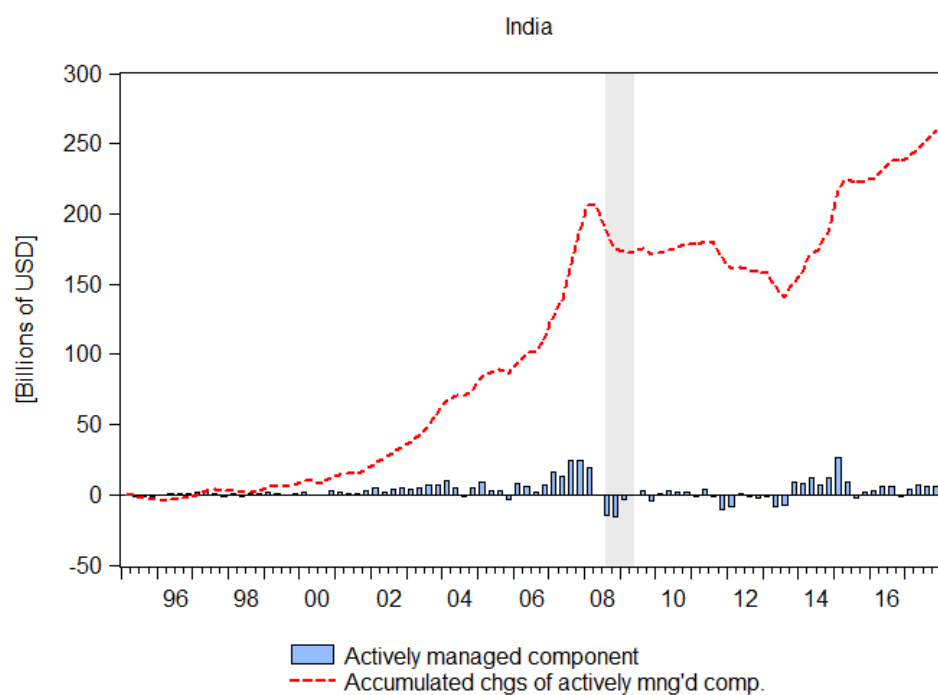
(a) The active component of FX reserves and its accumulated changes under a new approach



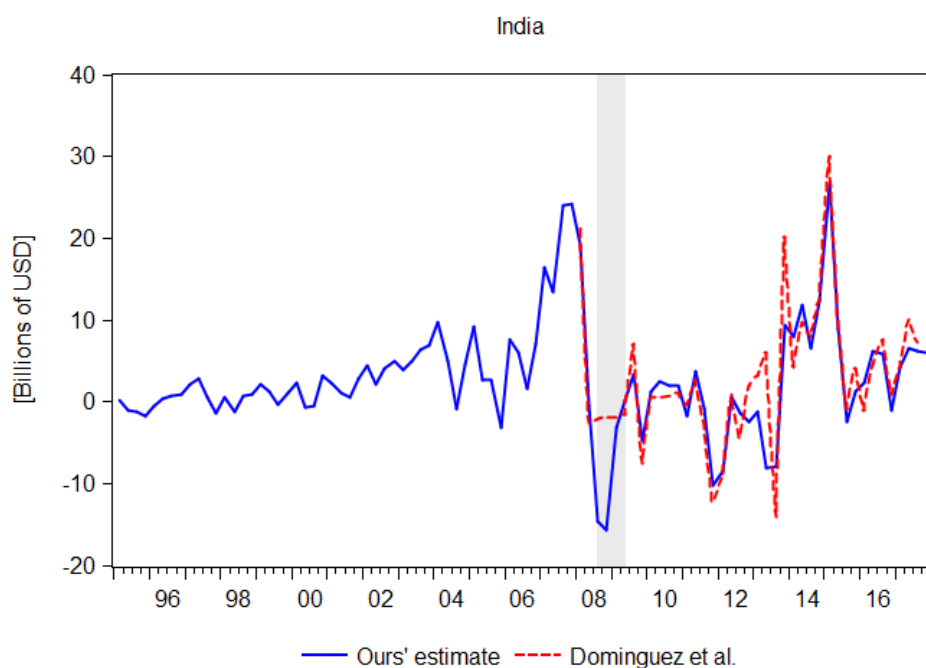
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B8. Estimates of the active component of FX reserves in Hong Kong

Note: The shaded areas refer to the global financial crisis.



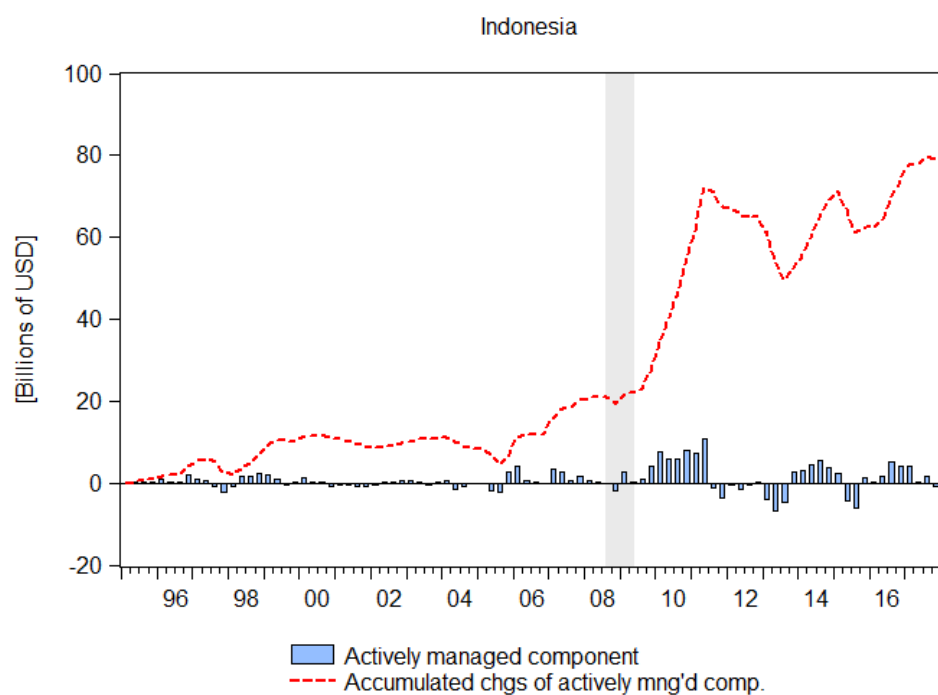
(a) The active component of FX reserves and its accumulated changes under a new approach



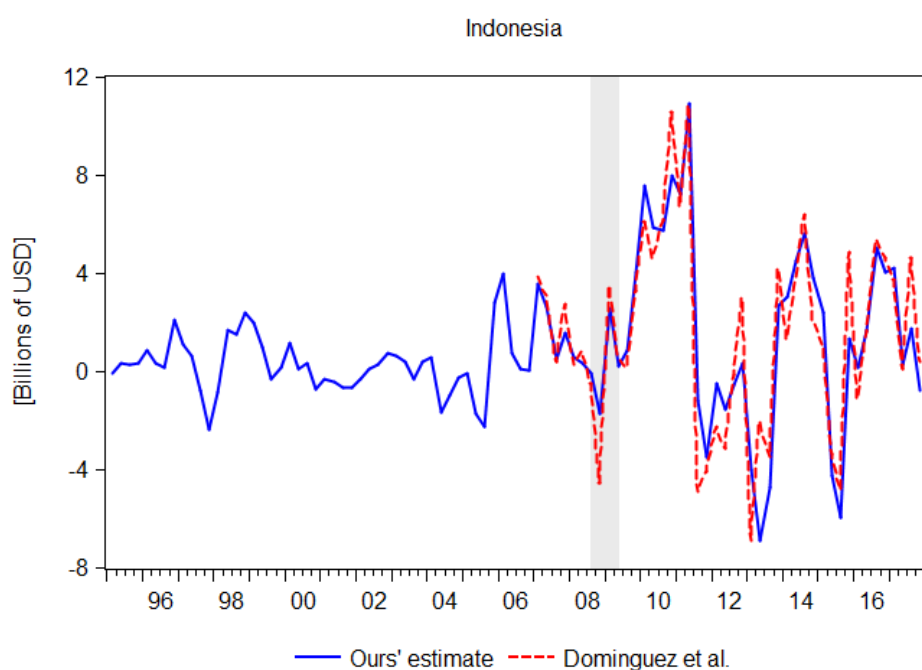
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B9. Estimates of the active component of FX reserves in India

Note: The shaded areas refer to the global financial crisis.



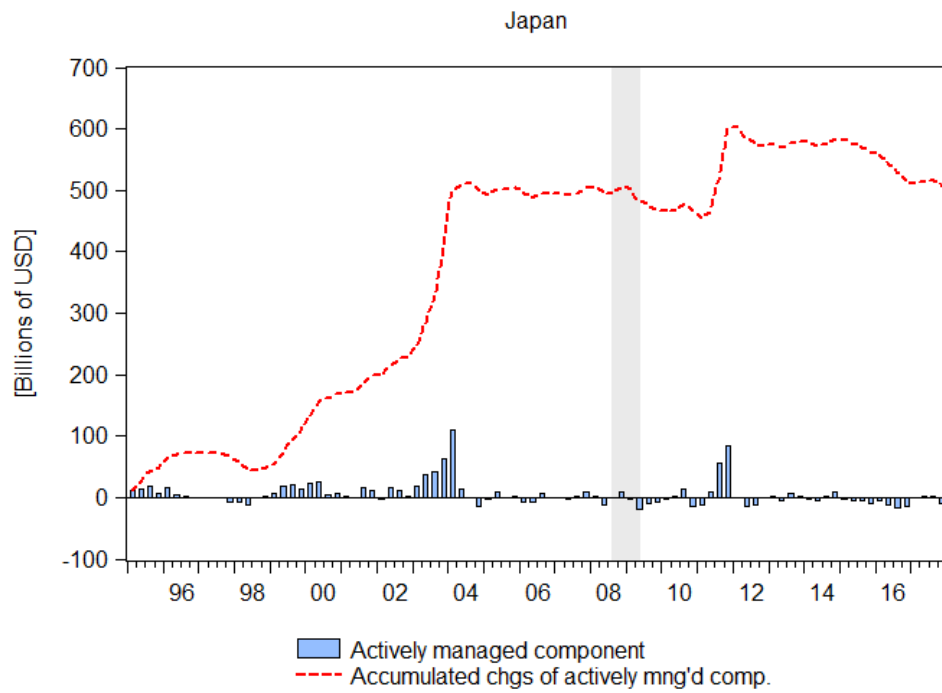
(a) The active component of FX reserves and its accumulated changes under a new approach



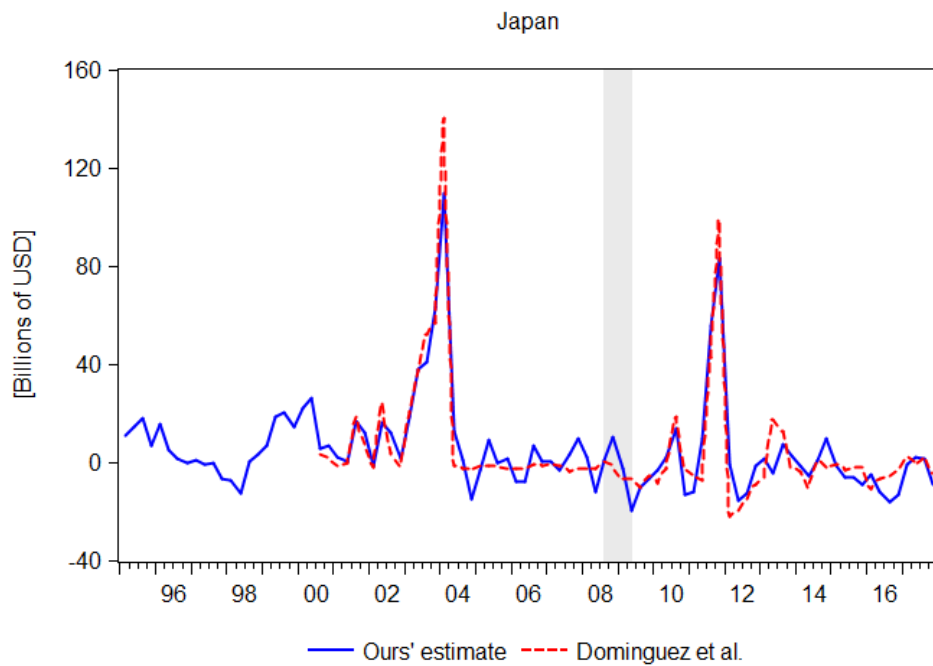
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B10. Estimates of the active component of FX reserves in Indonesia

Note: The shaded areas refer to the global financial crisis.



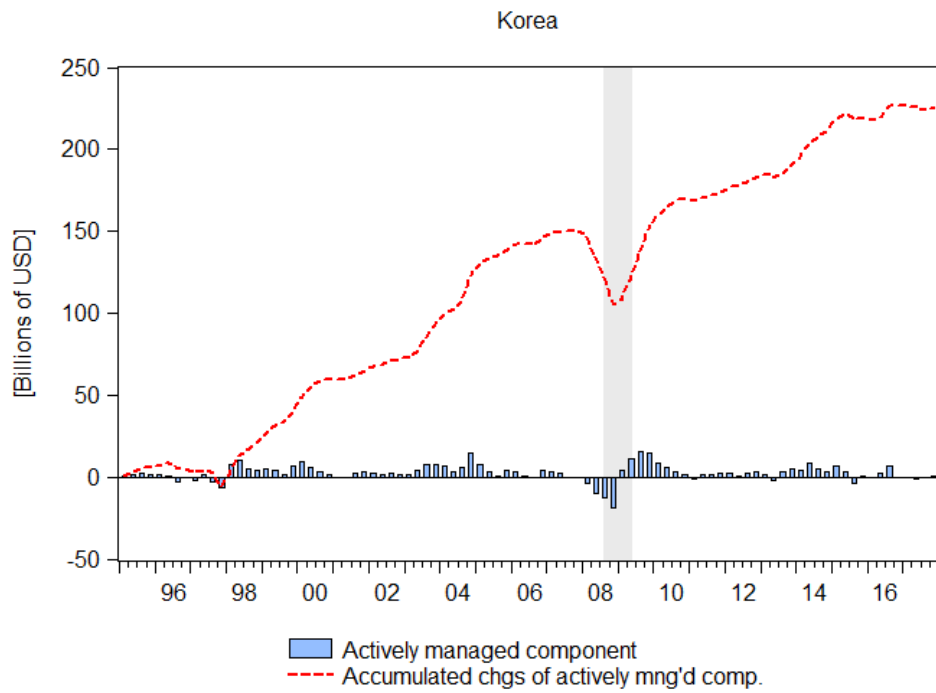
(a) The active component of FX reserves and its accumulated changes under a new approach



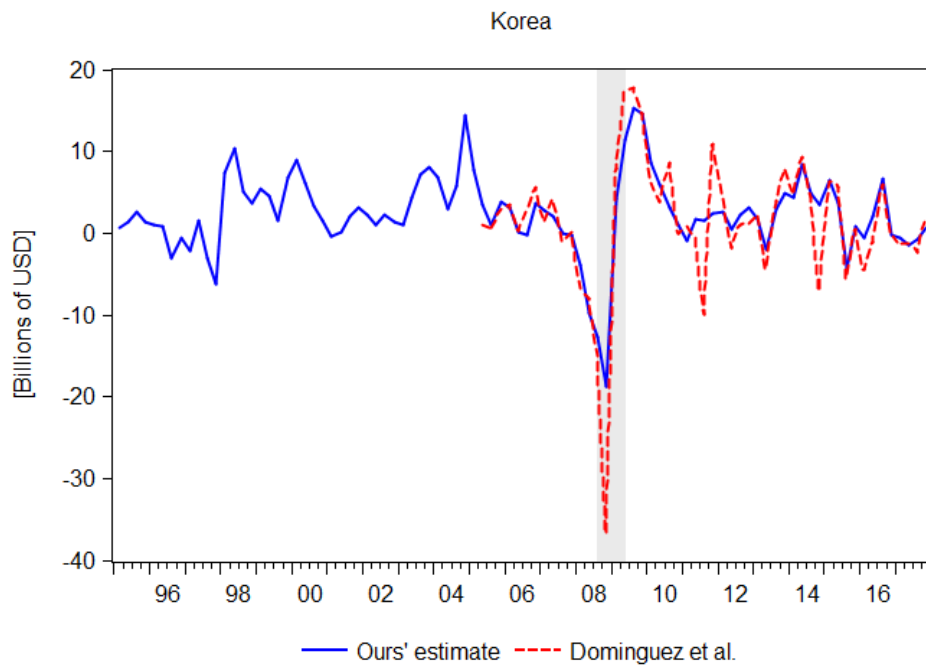
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B11. Estimates of the active component of FX reserves in Japan

Note: The shaded areas refer to the global financial crisis.



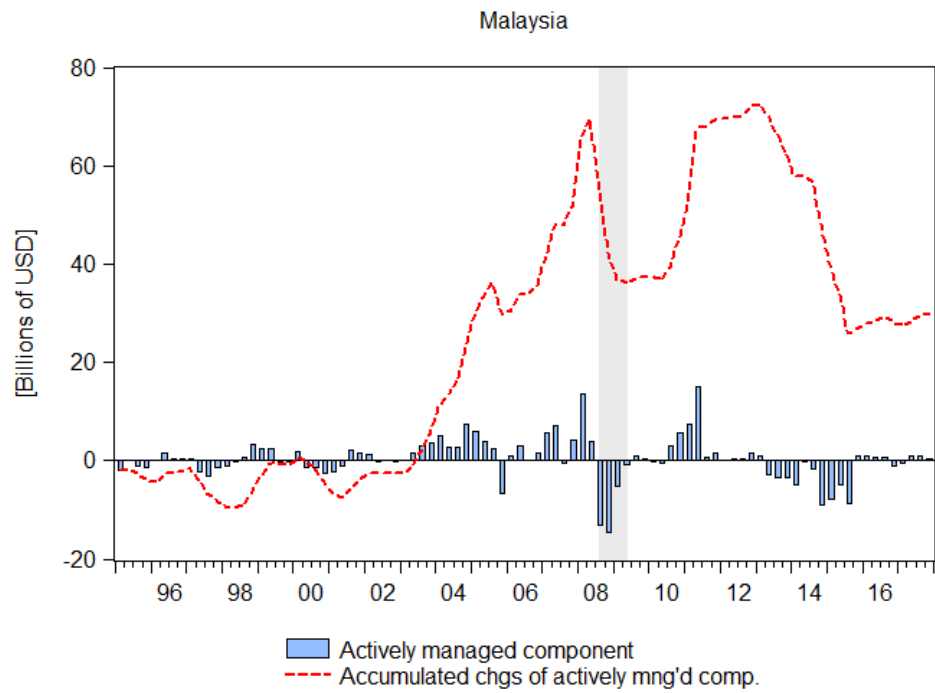
(a) The active component of FX reserves and its accumulated changes under a new approach



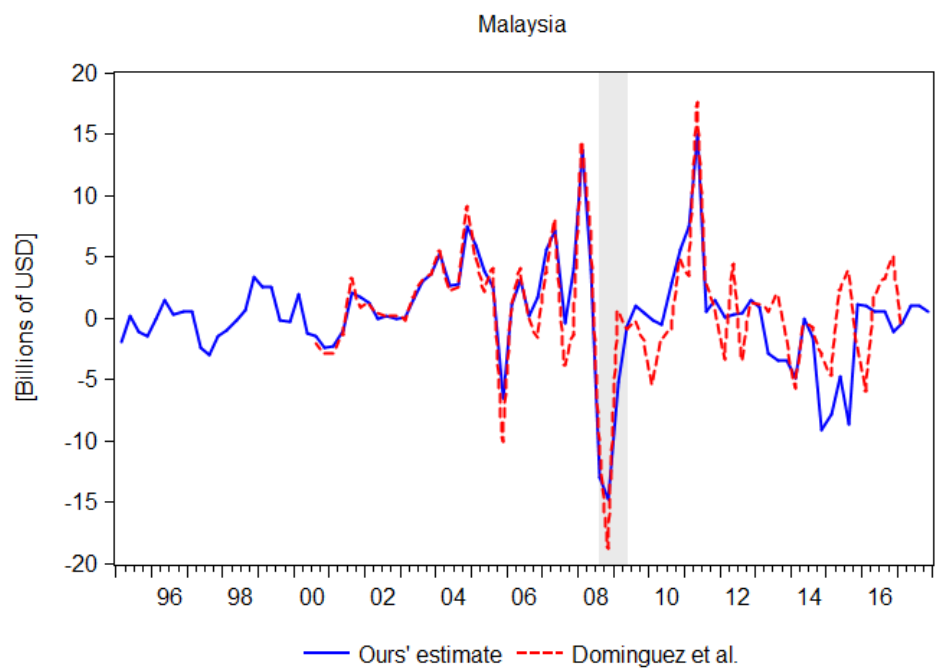
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B12. Estimates of the active component of FX reserves in Korea

Note: The shaded areas refer to the global financial crisis.



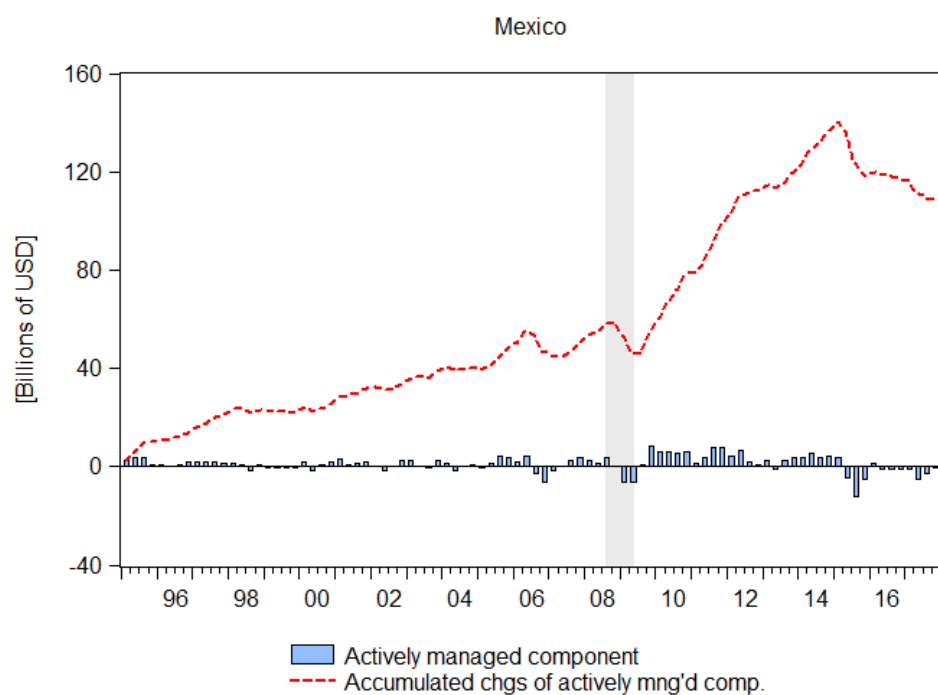
(a) The active component of FX reserves and its accumulated changes under a new approach



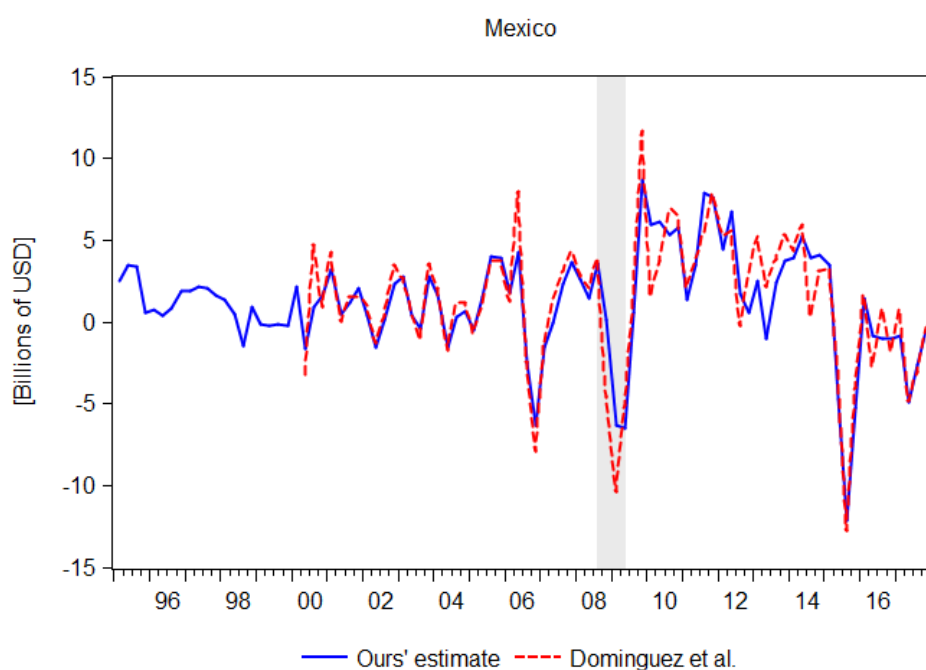
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B13. Estimates of the active component of FX reserves in Malaysia

Note: The shaded areas refer to the global financial crisis.



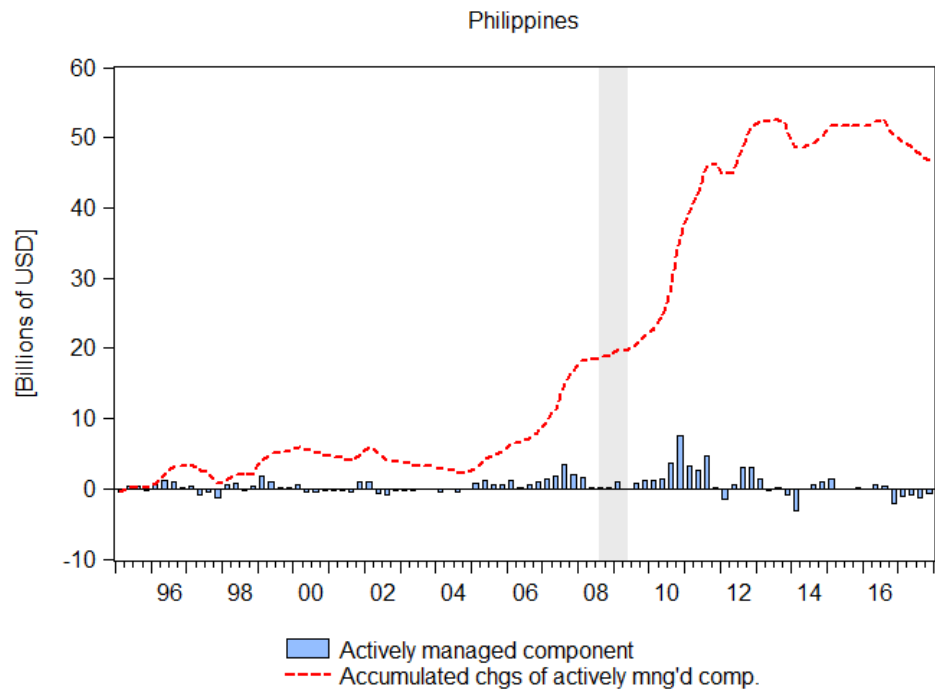
(a) The active component of FX reserves and its accumulated changes under a new approach



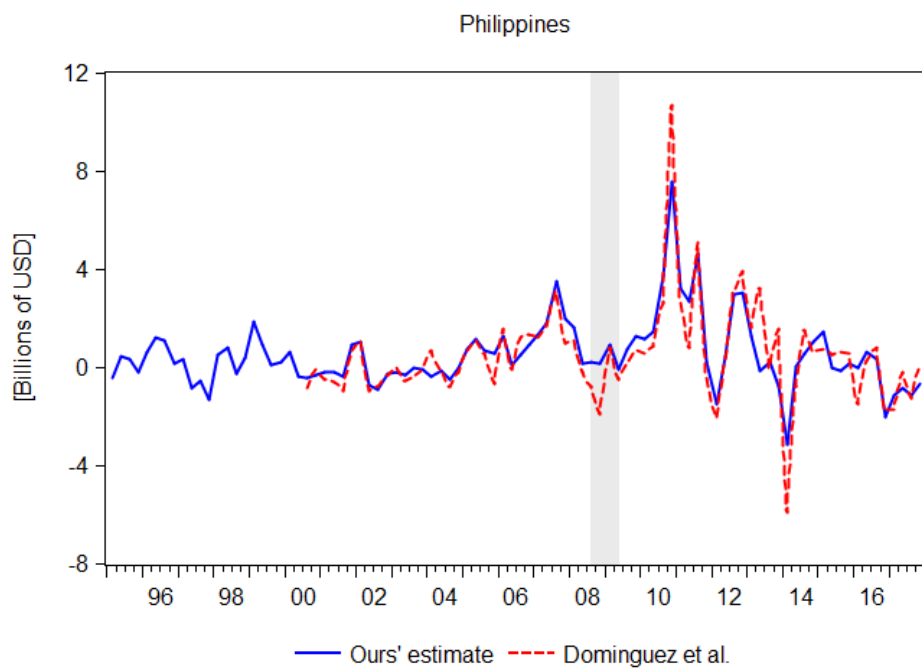
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B14. Estimates of the active component of FX reserves in Mexico

Note: The shaded areas refer to the global financial crisis.



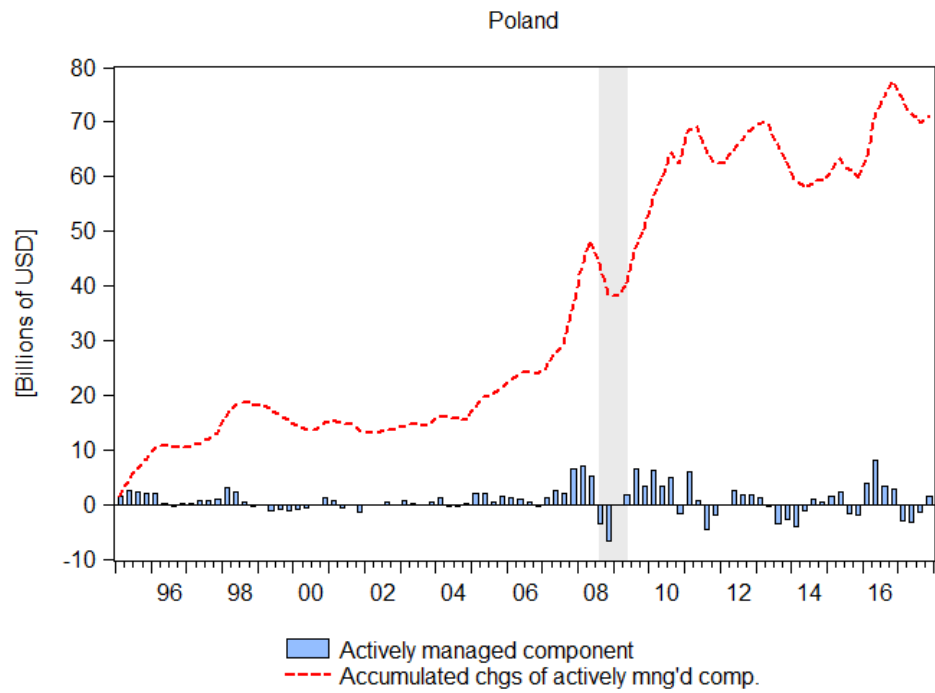
(a) The active component of FX reserves and its accumulated changes under a new approach



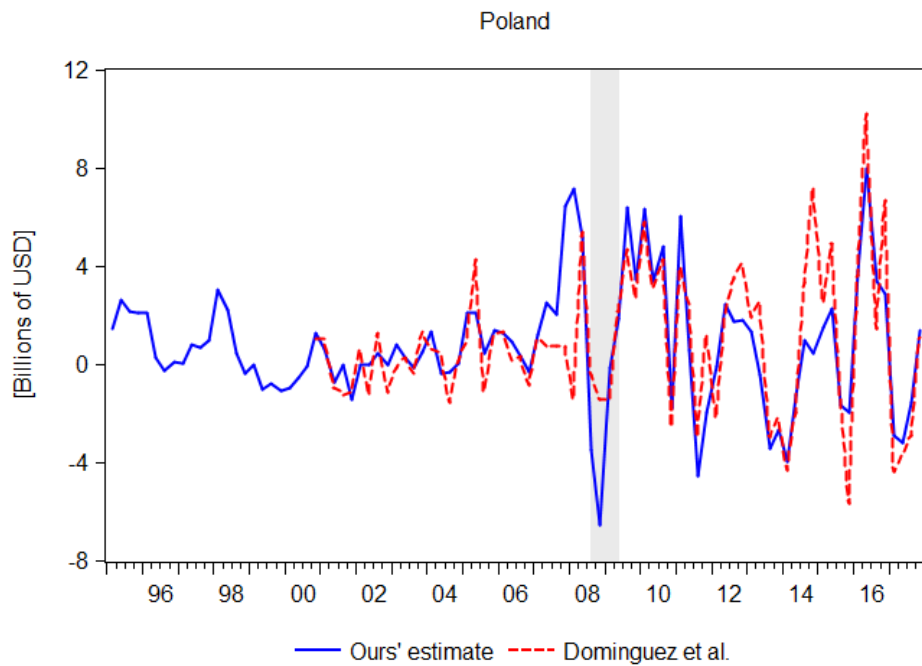
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B15. Estimates of the active component of FX reserves in the Philippines

Note: The shaded areas refer to the global financial crisis.



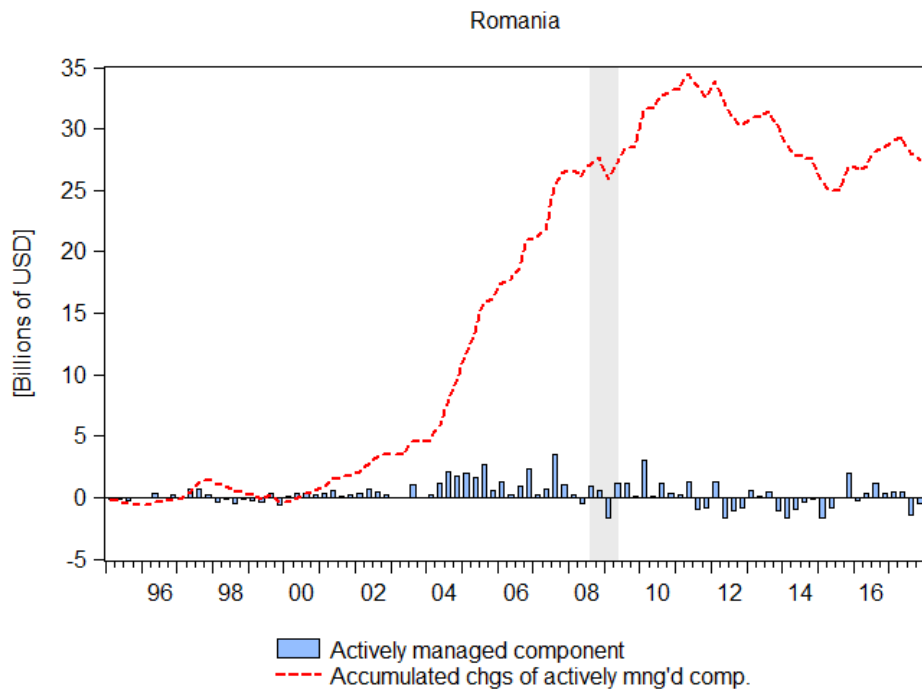
(a) The active component of FX reserves and its accumulated changes under a new approach



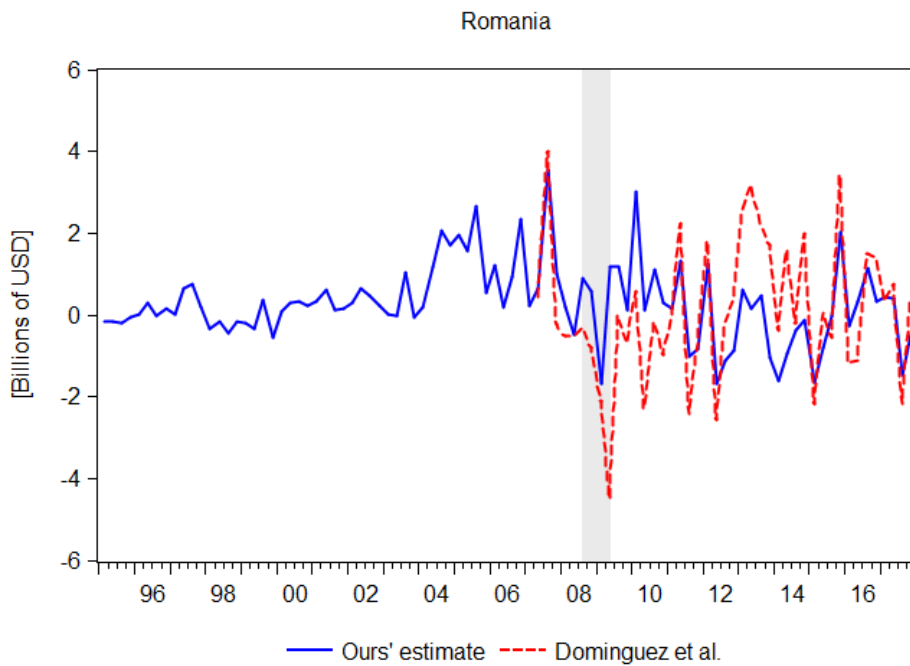
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B16. Estimates of the active component of FX reserves in Poland

Note: The shaded areas refer to the global financial crisis.



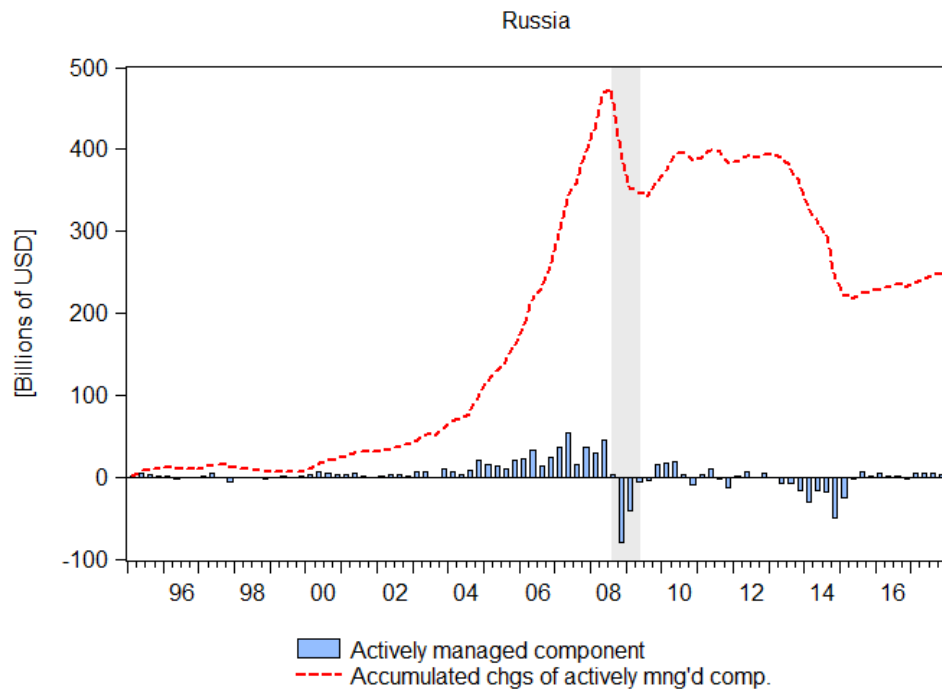
(a) The active component of FX reserves and its accumulated changes under a new approach



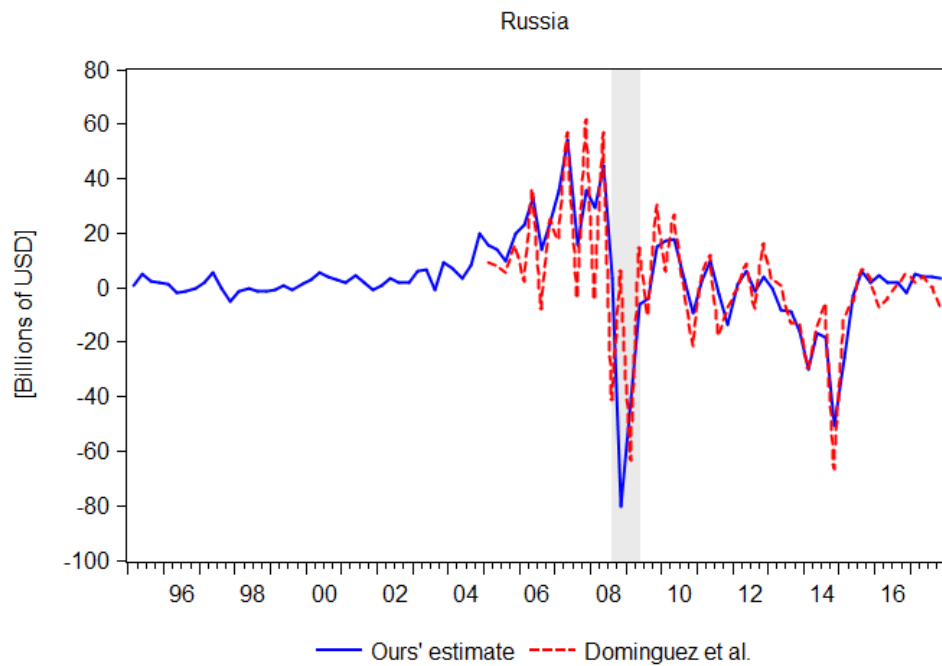
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B17. Estimates of the active component of FX reserves in Romania

Note: The shaded areas refer to the global financial crisis.



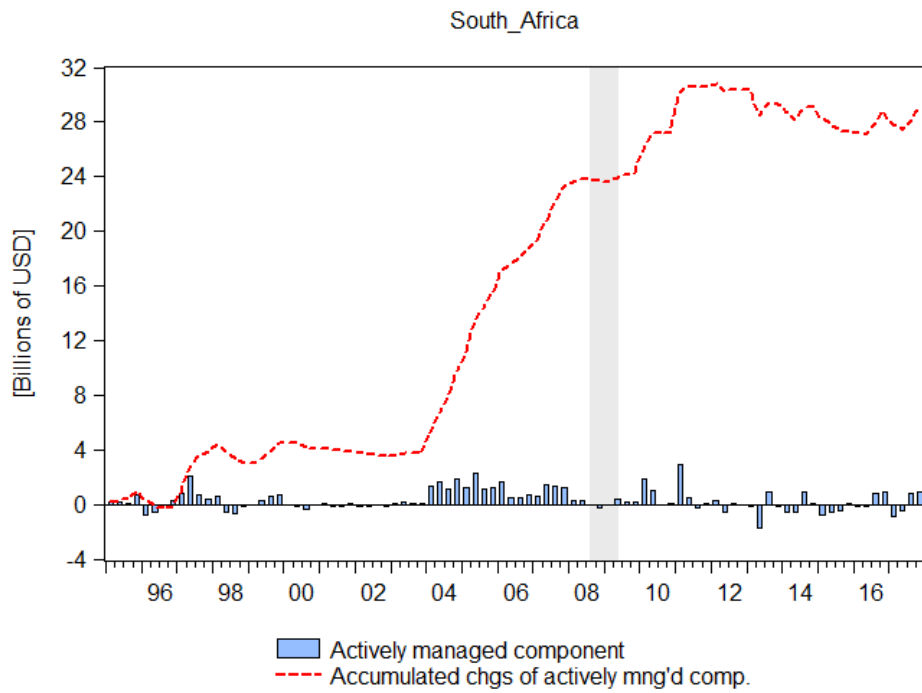
(a) The active component of FX reserves and its accumulated changes under a new approach



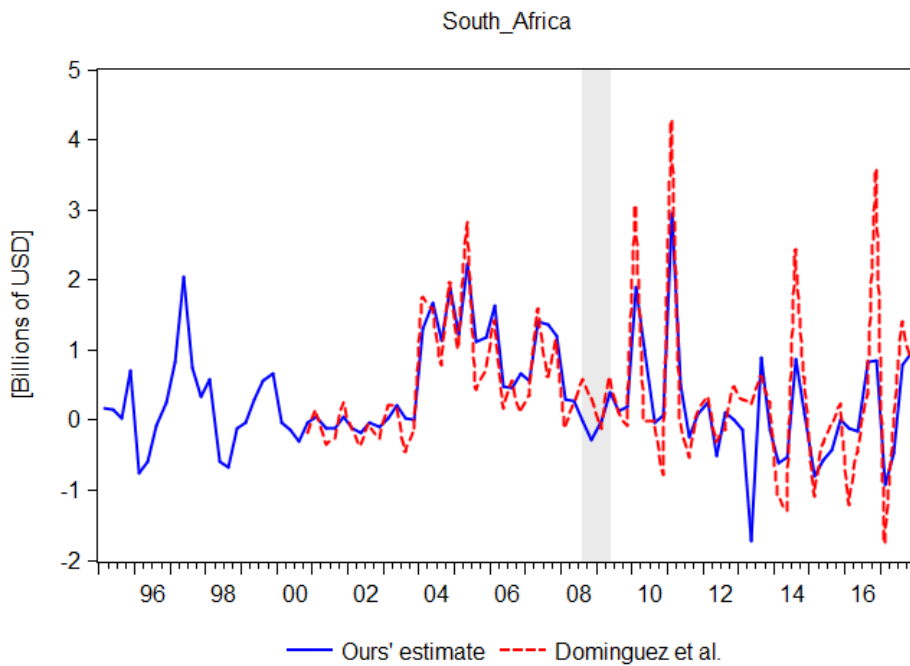
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B18. Estimates of the active component of FX reserves in Russia

Note: The shaded areas refer to the global financial crisis.



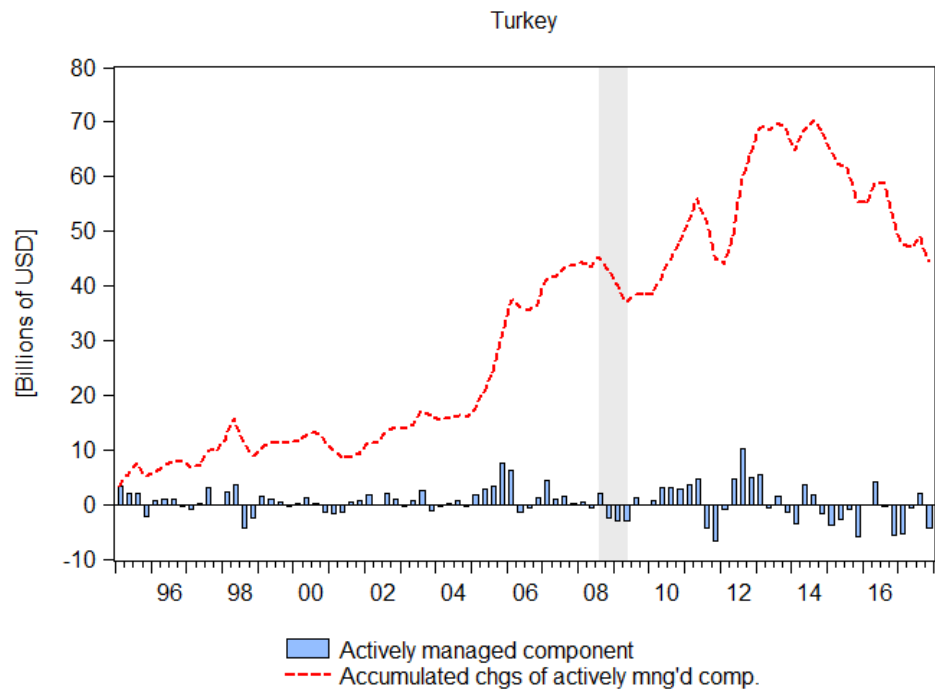
(a) The active component of FX reserves and its accumulated changes under a new approach



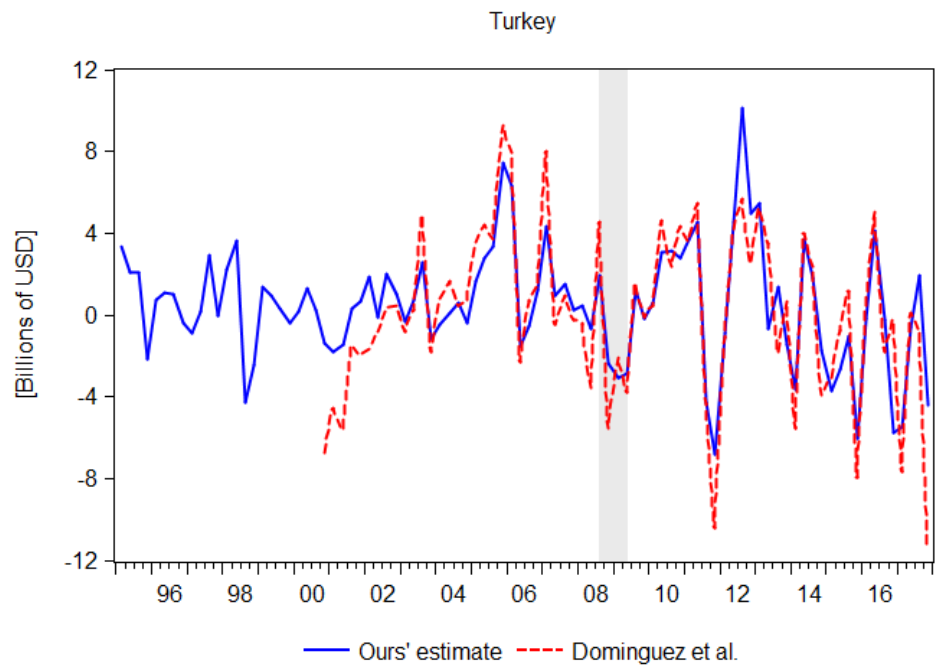
(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B19. Estimates of the active component of FX reserves in South Africa

Note: The shaded areas refer to the global financial crisis.



(a) The active component of FX reserves and its accumulated changes under a new approach



(b) The active component of FX reserves: the new approach vs. the DHI approach

Figure B20. Estimates of the active component of FX reserves in Turkey

Note: The shaded areas refer to the global financial crisis.