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Cyclicality of International Reserves, Exchange Rate Flexibility, and Output Volatility

Eiji Fujii[a,b] and Xingwang Qian[c]

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Abstract: This paper investigates the cyclicality of international reserves and their role in macroeconomic stabilization. We challenge two widely held assumptions: (1) central banks typically manage IR counter-cyclically—accumulating reserves during booms and drawing them down during downturns; and (2) such interventionist management is primarily associated with rigid exchange rate regimes. Analyzing data from 179 countries (1972-2022), we find that counter-cyclical IR management is less common than often assumed. However, as a macroprudential policy, counter-cyclical international reserves significantly reduce output volatility, particularly when interacting with *de facto* flexible exchange rate regimes. This stabilizing effect is especially pronounced in emerging markets between the 1997 Asian financial crisis and the 2008 global financial crisis.

Keywords: *International reserves; cyclicality; exchange rate regime; macroprudential policy; output volatility.*

JEL Classifications: F34, F31

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Corresponding address: [a] School of Economics, Kwansei Gakuin University, 1–155 Uegahara Ichiban-cho, Nishinomiya, Hyogo 662-8501, Japan. Email: efujii@kwansei.ac.jp; [b] Center for Economic Studies and Ifo Institute, Munich, Germany; [c] Economics and Finance Department, SUNY Buffalo State University, 1300 Elmwood Ave, Buffalo, 14222 NY, USA. Email: qianx@buffalostate.edu.

1. Introduction

According to the International Monetary Fund (2009), international reserves (IR) are "external assets that are readily available to and controlled by monetary authorities for meeting balance of payments financing needs, for intervention in exchange markets to affect the currency exchange rate, and for other related purposes (such as maintaining confidence in the currency and the economy and serving as a basis for foreign borrowing)." While the specific purposes for which monetary authorities accumulate or decumulate IR may vary, they share a prudential objective: to counter external forces that might otherwise generate macroeconomic volatility.

It is often argued that managing IR in a counter-cyclical manner, termed counter-cyclical international reserves (CCIR), is beneficial. Central banks can "lean against the wind" by accumulating IR during economic booms and decumulating them during downturns. This approach can effectively absorb capital inflows during periods of economic expansion and release "saved fuel" during downturns to support domestic currency and growth, thereby fostering stability. Indeed, CCIR have been found to stabilize real exchange rate volatility caused by terms of trade shocks and facilitate smoother current account adjustments (Aizenman *et al*., 2012; Aizenman and Riera-Crichton, 2008). Furthermore, CCIR can mitigate the effects of the boom-and-bust cycles in capital flows driven by global financial markets, serving as a substitute for counter-cyclical capital controls (Jeanne, 2016; Jeanne *et al*., 2012; Ostry *et al*., 2011) and reducing exposure to financial crises (Arce *et al*., 2019) to promote stable economic growth.

Nonetheless, empirical research on the cyclicality of IR policy remains relatively limited. Existing studies primarily examine how IR mitigate the adverse effects of external shocks during downturns (Aizenman *et al*., 2012; Jeanne, 2016). However, the broader role of cyclical IR management—particularly its interaction with exchange rate regimes—has been largely overlooked. This paper investigates the behavior of IR across business cycles, considering both expansionary and contractionary phases simultaneously, to explore how CCIR interact with exchange rate flexibility to promote macroeconomic stability. In particular, we challenge two commonly held assumptions: (1) central banks generally manage IR in a counter-cyclical manner to accumulate reserves during economic expansions and decumulate them during downturns; and (2) CCIR management, which involves direct foreign exchange market intervention to prevent

currency appreciation in good times and depreciation in bad times, is primarily associated with rigid exchange rate regimes.

Further, we explore the welfare implications of the counter-cyclicality of IR and its relationship with exchange rate flexibility. Specifically, we investigate whether CCIR, in interaction with exchange rate regimes, help mitigate output volatility. Our analysis covers a sample of 179 countries—including emerging markets and developing economies (EMDE), and advanced economies—over five decades (1972-2022).

We align CCIR management with a prudential policy stance over business cycles—accumulating (or decumulating) assets during favorable (or unfavorable) economic conditions. Empirically, we define a country as practicing a CCIR policy when the cyclical components of IR and real GDP are positively and significantly correlated. In contrast, a pro-cyclical IR policy is identified when this correlation is significantly negative, indicating reserve accumulation during downturns and decumulation during expansions. Finally, IR management is classified as *a*-cyclical when no significant correlation exists between the cyclical components of IR and real GDP.

Contrary to conventional views, we find that only 33% of the world's economies (59 countries) have managed their international reserves in a counter-cyclical manner over the past half-century. Interestingly, about 11% (19 countries) exhibit pro-cyclical IR management, which may amplify economic booms and worsen downturns during crises. The remaining 56% (101 countries) follow an *a*-cyclical approach, showing no significant relationship between IR and business cycles.

The cyclicality of IR has also evolved over time. CCIR policies became more common among EMDE after the 1997 Asian financial crisis, increasing from 42 countries before 1997 to 64 afterward. However, the 2008 global financial crisis significantly disrupted this trend, reducing the number of CCIR countries to just 28 post-2008. Since then, nearly three-quarters of countries have managed their IR in an *a*-cyclical manner.

The implementation of CCIR policies helps alleviate exchange rate pressures by purchasing foreign currency assets during periods of economic prosperity (thereby limiting local currency appreciation) and selling them during downturns (to prevent local currency depreciation). While such official foreign exchange transactions are often associated with rigid exchange rate regimes, our findings suggest otherwise. We observe that countries with *de facto* flexible exchange rate

regimes are more likely to adopt CCIR policies—an outcome that may seem counterintuitive but can be understood within the broader context of maintaining macroeconomic stability.

Our empirical evidence confirms the macroeconomic welfare benefits of CCIR policies. However, unlike previous studies that emphasizes CCIR's role in stabilizing real exchange rates to smooth current account adjustments (Aizenman *et al.*, 2012), mitigating the effects of the global financial cycle (Jeanne, 2016; Jeanne and Sandri, 2023), or reducing financial crisis exposure (Arce *et al.*, 2019), we find that CCIR significantly reduces output volatility. We identify this causal relationship using instrumental variable regressions, drawing on literature on legal origins and democratic institutions (La Porta *et al.*, 1997; Acemoglu *et al.*, 2001).

The novelty of our findings lies in showing that CCIR policies stabilize output primarily by complementing the buffering role of flexible exchange rates in managing external shocks. While flexible exchange rate arrangements help absorb these shocks, they often amplify exchange rate volatility and its associated macroeconomic consequences. By "leaning against the wind," CCIR policies mitigate the impact of this volatility, thereby enhancing overall macroeconomic stability.

Notably, our results indicate that CCIR reduce output volatility, but this effect is observed specifically in countries with *de facto* flexible exchange rate regimes. This finding helps explain the absence of a clear trade-off between reduced exchange rate volatility and macroeconomic stability, as highlighted by Flood and Rose (1995). It also suggests that CCIR policies are more likely to be implemented as part of a coordinated macroprudential framework rather than merely as an intervention tool to maintain an exchange rate peg.

The remainder of this paper is organized as follows: Section 2 reviews the related literature. Section 3 describes the data and defines the measure of IR cyclicality used in the analysis. Section 4 explores the cyclical behavior of IR across 179 countries and investigates the macroeconomic determinants of counter-cyclicality. Section 5 conducts cross-country analyses of the determinants of CCIR and their effects on macroeconomic stability, emphasizing the role of exchange rate flexibility. It also examines the implications of the 1997 Asian currency crisis and the 2008 global financial crisis. Section 6 extends the analysis to a panel data framework, investigating CCIR trends over time within individual countries. Finally, Section 7 provides concluding remarks.

2. Literature review

IR have long been a focal point of academic and policy research, particularly regarding their optimal levels and policy implications. Early studies by Heller (1966), Hamada and Ueda (1977), Frenkel and Jovanovic (1981), and Ben-Bassat and Gottlieb (1992) primarily viewed IR as a buffer stock to manage fluctuations in external transactions. This line of inquiry has seen a resurgence with more recent contributions by Alfaro and Kanczuk (2009) and Jeanne and Rancière (2011) who revisit the optimal IR holding.

In the late 1990s, the conspicuous accumulation of IR by EMDE, particularly those in Asia, sparked debates over its motives and implications within the context of global economic imbalances. Rodrik (2006) highlighted concerns over the IR holdings of EMDE reaching 30% of GDP and 8 months of imports, estimating that potential income losses due to yield spreads to be approximately 1% of GDP. Alfaro and Kanczuk (2009) argue that such high levels of IR hoarding cannot be justified as an optimal strategy.

One prominent explanation for IR hoarding among EMDE, particularly after the Asian financial crisis, is the precautionary motive, as discussed by Aizenman and Marion (2003), Aizenman *et al*. (2007), and Cheung and Qian (2009). This perspective views IR as a form of self-insurance against volatile capital flows. Alternatively, some argue that IR accumulation, particularly by China, reflects mercantilist motives aimed at maintaining large current account surpluses and managing currency appreciation pressures (Dooley *et al*., 2003). [1] These explanations are not necessarily mutually exclusive because the motives of IR accumulation may shift over time (Ghosh *et al*., 2016).

Recent literature has shed new light on IR as a macroprudential policy tool. Jeanne (2016) suggests that CCIR can serve as an alternative to counter-cyclical capital controls advocated by Ostry *et al.* (2011), IMF (2012), and Rey (2015). [2] In an era of financial globalization, EMDE often face challenges in managing volatile international capital flows. For instance, during economic overheating, conventional stabilization policies such as raising interest rates to cool the economy

[1] In evaluating the competing explanations, Aizenman and Lee (2007) find stronger support for the precautionary motives over the mercantilist motives. The authors argue that a large demand for IR arose as self-insurance to avoid costly liquidation of long-term projects when susceptible to sudden stops.

[2] In Jeanne (2016), CCIR management is combined with a tax on capital inflows to achieve efficiency. See also Farhi and Werning (2014), Jeanne *et al.* (2012), and Korinek (2011).

can inadvertently attract more capital inflows, exacerbating overheating. Conversely, during economic downturns, lowering interest rates to stimulate the economy can lead to capital outflows, worsening the downturn. In response, central banks can use IR to counteract these cycles by adjusting their accumulation or decumulation of foreign currency assets, thereby mitigating macroeconomic volatility induced by global financial cycles.[3] In fact, using a competitive equilibrium model, Arce *et al.* (2019) show that the leaning against the wind IR policy significantly reduces the exposure to financial crises to enhance welfare.

Moreover, central banks can utilize reserve requirements as a secondary monetary policy tool, as discussed by Cordella *et al*. (2014). This approach allows them to balance currency defense with economic stimulus during challenging economic periods by adjusting both IR holdings and reserve requirements. More specifically, a policy mix for EMDE in bad economic times is to sell IR and raise short-term interest rates to defend the domestic currency. The dampening effects of rising interest rates can be offset, at least partially, by lowering reserve requirements that spurs the economy.

The evolving literature on IR as a macroprudential policy tool highlights the complexities countries face in navigating financial globalization. These challenges include managing volatile capital flows and exchange rate vulnerabilities across different phases of the business cycle. In response, this paper examines IR management through the lens of cyclicality, exploring how a counter-cyclical approach—accumulating IR during booms and utilizing them during downturns to mitigate external shocks—can enhance macroeconomic stability.

While our perspective incorporates a broad range of theoretical views on IR, we depart from the conventional empirical focus on IR levels (relative to GDP or imports). Instead, we analyze the macro-stabilizing effects of cyclical IR management across both expansionary and contractionary phases of the business cycle, rather than solely examining IR's role during crises.

[3] Similar issues and implications of cyclicality also exist on the government side of policymaking. For instance, Frankel, Vegh, and Vuletin (2013) discuss these issues in the context of fiscal policy, while Fujii (2024) addresses them in relation to sovereign debt denomination policy.

3. Data and the cyclicality measure

3.1. Data

The data utilized in this study primarily originate from the World Bank's World Development Indicators and the IMF's International Financial Statistics. Additionally, we incorporate data on exchange rate regime classifications (Ilzetzki *et al*., 2019), capital account openness indices (Chinn and Ito, 2006), and institutional quality from the International Country Risk Guide compiled by the Political Risk Services Group. The sample includes 179 countries, comprising 155 EMDE and 24 advanced economies. The sample period spans from 1972 to 2022, covering the post-Bretton Woods era. Due to data constraints, shorter sample periods may apply to some countries. All data are presented at an annual frequency.

Our measure of IR is defined as total reserves excluding gold. Aggregate output is measured by real GDP. Detailed definitions of all variables used in the study are provided in Appendix A for reference.

3.2. Measuring the IR Cyclicality

To measure the cyclicality of IR, we used the Hodrick-Prescott filter (HPF) to extract the cyclical components of IR and real GDP.[4] Subsequently, for each country *i*, we calculated the correlation coefficient:

$$cyc_i = \frac{\sum_t r_{i,t} y_{i,t} - T\bar{r}_i\bar{y}_i}{(T-1)s_i^r s_i^y} \qquad (1)$$

for which $r_{i,t}$ and $y_{i,t}$ represent the cyclical components of IR and real GDP, respectively, obtained through the HPF. $\bar{r}_i$ and $\bar{y}_i$ denote the mean, and s_i^r and s_i^y represent the standard deviation of $r_{i,t}$ and $y_{i,t}$, respectively. *T* denotes the number of observations (in the time dimension). Hereafter, we refer to (1) as the *cyclicality coefficient*.

In this paper, we classify IR as counter-cyclical if the cyclicality coefficient cyc_i is significantly positive, indicating that IR tend to rise above (fall below) trend when real GDP deviates upward (downward) from trend.[5] The definition accords with the "leaning against the

[4] The HPF is widely used to extract the cyclical components of fiscal, monetary, and exchange rate policies. See, for instance, Frankel *et al.* (2013), Kaminsky *et al.* (2004), and Cordella and Gupta (2015).
[5] We adopted the 10% level of significance. This definition of IR cyclicality is used also by, for instance, Cordella *et al.* (2014).

wind" counter-cyclical (prudential) policy stance, where additional assets are accumulated (decumulated) during favorable (unfavorable) economic conditions.[6] More specifically, strong economic expansion (i.e., real GDP above trend) invites capital inflow and domestic currency appreciation. To counter the overheating and appreciation pressure, central banks accumulate IR by absorbing part of the capital inflow. Conversely, IR are considered pro-cyclical if $cyc_i < 0$, indicating that IR tend to rise above trend when GDP falls below trend. IR are labeled as a-cyclical if there is no significant association with cyclical fluctuations in GDP.

The adoption of a cyclicality-based IR measure offers several advantages. Unlike conventional measures, such as the ratio of IR to GDP, which do not distinguish between GDP trend growth and deviations from that trend, the cyclicality-based approach provides crucial insights for decision-making regarding asset accumulation and decumulation. Additionally, changes in IR reflect not only active central bank management (e.g., purchases or sales of foreign currency assets) but also interest income on existing securities and deposits.[7] Therefore, even in the absence of active management, IR can exhibit trend growth, while deviations from trend typically indicate deliberate central bank actions. This perspective enhances our understanding of the nature of IR management.

4. The IR cyclicality around the world

4.1. Overview

Figure 1 illustrates the correlations between the cyclical components of IR and real GDP. The cyclicality coefficient estimates over the full sample period vary widely among countries, ranging from -0.78 (Panama) to 0.85 (Lebanon). Among the 179 countries studied, 105 exhibit positive cyclicality coefficients, while 74 show negative ones. Using a 10% level of statistical significance, 59 countries are identified as having CCIR, 19 as pro-cyclical, and 101 as a-cyclical. Viewed over the post-Bretton Woods half-century, CCIR are adopted by only one-third of all countries.

The literature suggests that EMDE and advanced economies have different motives for holding IR.[8] Therefore, we display IR cyclicality of EMDE and advanced economies separately in Figure

[6] Our definition of counter-cyclicality is based on a prudent policy stance in IR management that aims to counter external forces which amplify output fluctuations. It is important to note, however, that positive correlations between IR and output may alternatively be described as pro-cyclical, based solely on the direction of their co-movement.

[7] See Dominguez, Hashimoto, and Ito (2012).

[8] See Goldberg, Kennedy, and Miu (2011), Bussière *et al*. (2015), and Aizenman *et al*. (2024).

2. The red bars highlight statistically significant IR cyclicality at the 10% level. Among EMDE, there are three times more countries with CCIR than those with pro-cyclical IR. The distribution is more balanced for advanced economies: the numbers of countries with CCIR and pro-cyclical IR are six and five, respectively. Thirteen countries have *a*-cyclical IR.

IR are a vital policy tool for countries to intervene in the foreign exchange markets. Thus, we also report the cyclicality coefficients organized by exchange rate arrangements. Using the classification index of Ilzetzki *et al.* (2019), we group the countries by the extent of flexibility of their exchange rates. Figure 3 presents the cyclicality coefficients for the rigid, intermediate, and flexible regimes.[9] Notably, countries with flexible exchange rate arrangements exhibit a higher prevalence of CCIR.[10]

Table 1, a contingency table, presents the distribution of IR cyclicality by exchange rate flexibility and development status (i.e., EMDE or advanced economies). For the analysis, we dichotomize exchange rate regime categories into flexible (free float) and non-flexible (all others). The Chi-square test statistic of 10.47 strongly rejects the null hypothesis of independence between IR cyclicality and exchange rate flexibility.[11] The results suggest the importance of exchange rate flexibility for understanding the differences in IR cyclicality across countries.

The cyclicality of IR has evolved over time. To illustrate this evolution, we divide our sample period into three sub-periods, using the 1997 Asian financial crisis and the 2008 global financial crisis as key milestones. Both crises significantly influenced the IR accumulation patterns. As shown in Figure 5, the 1997 crisis accelerated the pace of IR accumulation, while the 2008 global financial crisis dampened this trend, leading to a stabilization of global IR levels thereafter.

Figure 4 presents the cyclicality coefficients by sub-period. Before the 1997 Asian financial crisis, 42 countries followed CCIR policies. This number increased to 64 after the 1997 crisis, particularly among EMDE. However, the 2008 global financial crisis significantly reversed this

[9] We use the fine classifications of Ilzetzki *et al.* (2019) and define the rigid, intermediate, and flexible regimes by the average index values of less than 4, between 5 and 8, and more than 8, respectively. They correspond to pegged, crawling peg and crawling band, and free float classifications.
[10] As a major exception, the US appears to have pro-cyclical IR. The dollar's status as the world's reserve currency provides unique conditions for reserve management that other advanced economies do not share.
[11] Regarding the economic status, the test statistic is 3.28 failing to reject the null of independence.

trend, reducing the number of CCIR countries to just 28 post-2008. Since then, nearly three-quarters of countries have managed their IR in an *a*-cyclical manner.

Pro-cyclical IR policies were adopted by 14 countries before 1997 and by 13 countries between the 1997 and 2008 crises. Notably, this number increased to 17 after 2008, suggesting a modest rise in pro-cyclical IR management in the post-crisis period.

4.2. Exploring the determinants of CCIR

The results so far indicate that CCIR are not universally adopted and are more prevalent among EMDE, especially those with flexible exchange rate arrangements. In this subsection, we formally investigate the determinants of CCIR adoption. What distinguishes countries that practice CCIR from those that do not? Are there common characteristics? To answer the questions, we follow the theoretical literature that consider CCIR as a part of macroprudential policy tool (Jeanne, 2016; Arce *et al*., 2019) to examine whether adoption of CCIR is significantly associated with the following factors: exchange rate arrangements, monetary independence, capital account openness, months of imports covered by reserves, institutional quality, real GDP per capita, short-term external debt, total external debt, debt service to export income ratio, financial development, M2 (broad money supply), trade openness, and terms of trade. Definitions of these variables are provided in Appendix A.

We estimate cross-country logit regressions to identify factors associated with the likelihood of adopting the CCIR:

$$CCIR_i = \alpha + X_i\Phi + \epsilon_i \qquad (2)$$

where $CCIR_i$ is a binary indicator which is set equal to unity if the cyclicality coefficient cyc_i is significantly positive, and 0 otherwise.[12] X_i is a vector of explanatory variables measured by their mean values over the sample periods, and Φ is the coefficient vector.

Unfortunately, data constraints are significant: the number of observations declines sharply when all explanatory variables in X_i are included, leaving most coefficient estimates indistinguishable from zero (as shown in Table B1, Appendix B). To address this issue and improve degrees of freedom, we progressively removed insignificant variables. This process

[12] We also estimated the OLS regressions using continuous IR cyclical coefficients (instead of the binary indicator CCIR) as the dependent variable. The results are reported in Table B2 in Appendix B.

identified exchange rate flexibility and months of import coverage by reserves as significant determinants of the likelihood of adopting CCIR, as presented in Table 2.[13]

In column [1], the highly significant positive coefficient for exchange rate arrangements indicates that countries with more flexible exchange rates are more likely to adopt CCIR. This result is consistent with the observations in Figure 3 and Table 1. According to the estimated odds ratio (i.e., e^0.239 = 1.27), a country with one standard deviation (3.7) higher flexibility in its exchange rate arrangement index is associated with a 99.9% (=0.27*3.7) higher likelihood of adopting CCIR. The result may seem counter-intuitive if one associates purchase of domestic currency in economic downturns typically with efforts to defend pegged exchange rates. However, under flexible regimes, swift exchange rate adjustments to absorb external shocks generate volatile movements in currency values and related macroeconomic conditions. Under such circumstances, CCIR can come into play a complementary role by mitigating exchange rate volatility to promote macroeconomic stability. This conjecture will be evaluated in Section 5.2, where we estimate the stabilizing effects of CCIR on output volatility.

Columns [2] and [3] present the estimates for EMDE and advanced economies, respectively. The estimates for EMDE closely mirror those of the full sample, reflecting their predominance in the data sample. In contrast, none of the variables considered are significantly associated with CCIR adoption among advanced economies. These findings suggest heterogeneity between EMDE and advanced economies in the conditions and motives driving their adoption of CCIR.

Major market turmoil may significantly reshape the environment in which IR are managed. Some studies suggest that the 1997 Aian currency crisis altered the motives of IR accumulation for EMDE (Aizenman and Marion, 2003; Cheung and Qian, 2009), while others highlight the effects of the 2008 global financial crisis (Aizenman *et al.*, 2015). Using the two crises as thresholds, Figure 4 compares the distributions of the cyclical coefficient estimates for the sub-periods of 1972–1997, 1998–2008, and 2009–2022. The figures imply shifting distributions over time. To capture the dynamics, we estimated Equation (2) for the three sub-periods.

Columns [4], [5], and [6] present estimates for 1972–1997, 1998–2008, and 2009–2022, respectively. Before the Asian crisis, the number of months of imports covered by reserves was

[13] The data constraints reduce the effective number of countries to 149 (126 EMDE and 23 advanced economies).

significantly correlated with CCIR, whereas exchange rate flexibility showed no significant association. However, in the period following the Asian crisis, exchange rate flexibility became significantly associated with CCIR, while the relevance of import coverage diminished. These results highlight the influence of the Asian crisis, which prompted EMDE with flexible exchange rate regimes to adopt CCIR practices. The dynamics shifted again in the aftermath of the 2008 global financial crisis, when many countries transitioned from counter-cyclical to *a*-cyclical IR management. By introducing a cyclicality perspective, our findings contribute to a deeper understanding of the evolving motives for IR accumulation, as discussed by Ghosh *et al.* (2016).

5. Do CCIR help stabilize the economy? Cross-country analyses

The results in the previous section reveal substantial variation in IR cyclicality across countries and by sub-periods. A key question is whether these differences in IR cyclicality have significant welfare implications, particularly in terms of macroeconomic stability. In this section, we examine whether managing IR in a counter-cyclical manner helps mitigate macroeconomic volatility, with a focus on the role of exchange rate regimes. Previous studies (Tower and Courtney, 1974; Dornbusch, 1981; Melvin, 1985; Flood and Rose, 1995; Collard and Dellas, 2002) debate the importance of exchange rate flexibility for achieving macroeconomic stability.[14] In the current context, the observed positive association between IR cyclicality and exchange rate flexibility implies a potential benefit of managing IR counter-cyclically when exchange rates are free to fluctuate. We hypothesize that CCIR policies complement flexible exchange rate regimes by mitigating exchange rate volatility and enhancing macroeconomic stability.

5.1. Benchmark estimates

We first examine if CCIR exert volatility-mitigating effects on output independently of the extent of exchange rate flexibility. Following Frankel *et al.* (2013) and Lane (2003), we use the logged mean square of the cyclical component of real GDP as a proxy for output volatility. Our benchmark specification is:

$$ln(y_i^2) = \alpha + \beta_1\, CCIR_i + \beta_2\, Flexible_i + X_i\Psi + \epsilon_i \qquad (3)$$

[14] The literature has not reached a clear consensus. The issue has also been analyzed in more specific contexts. Heipertz *et al*. (2022) examines the implications of exchange rate flexibility in the context of target choices for monetary policy rule. Csonto and Gudmundsson (2020) discusses the issue for emerging markets, particularly regarding the effects on foreign currency debt.

where $ln\ (y_i^2)$ represents our measure of output volatility, $CCIR_i$ is a binary indicator for countries adopting CCIR policy as defined in Section 4.2.

For the degree of exchange rate flexibility ($Flexible_i$), we use the *de facto* exchange rate arrangement index from Ilzetzki *et al.* (2019). Our primary measure sets $Flexible_i$ to 1 for countries with mean values of Ilzetzki's index in the fine classifications exceeding 8, indicating free-floating exchange rates. For all other countries, the variable is set equal to zero.

As an alternative measure, we use the raw values of Ilzetzki *et al*. (2019) fine index. This approach allows for varying degrees of exchange rate flexibility in estimating its effects on output volatility. However, it assumes that the marginal effect of increasing or decreasing flexibility is constant across adjacent regime categories. The results of this alternative measure are presented in Table B4 of Appendix B.[15]

X_i is a vector of control variables that may influence macroeconomic stability. Specifically, these include months of imports covered by international reserves, representing the level of IR holdings (Krugman, 1979; Mendoza and Quadrini, 2024; Obstfeld *et al*., 2010), monetary independence (Berger and Kißmer, 2013; Stein, 2012), capital account openness (Eichengreen and Mussa, 1998; Prasad *et al.*, 2003), trade openness (Giovanni and Levchenko, 2009; Razin *et al.*, 2003), financial development (Acemoglu and Zilibotti, 1997; Aghion *et al.*, 1999, 2004), and institutional quality (Acemoglu *et al.*, 2003; Duncan, 2014). Definitions of these variables are provided in Appendix A.

Table 3 presents the estimates. Column [1] displays the estimates based on all countries. The coefficients for CCIR and exchange rate flexibility are significantly negative and positive, respectively. In other words, holding exchange rate flexibility and other control variables constant, CCIR exert a significantly mitigating effect on output variability. More specifically, countries practicing CCIR experience approximately 3 percent lower output volatility than those not.

On the other hand, holding all else constant, countries with floating exchange rates are associated with more volatile output. This accords with the conventional argument against flexible exchange rates: erratic exchange rate movements, driven by expectations of future fundamentals,

[15] In addition, Table B5 of Appendix B presents the estimates using the cyclical coefficients of IR in place of CCIR. These alternative estimates are largely consistent with the estimates in Table 3.

often exacerbate macroeconomic stability issues (Dornbusch, 1982). Most control variables are generally insignificant, except for trade openness, which is significant at the 10% level.

The estimates for EMDE and advanced economies reported in columns [2] and [3], respectively, are generally consistent with the full-sample results although the significance level declines. By the point estimates, the effects of CCIR and exchange rate flexibility appear larger for advanced economies compared to EMDE. However, the differences are not significant when considering the size of the standard errors. Among the control variables, the effect of monetary independence is significantly positive for advanced economies (Berger and Kißmer, 2013), while the effect of capital account openness is moderately significant and negative for EMDE.[16]

Overall, the results thus far are consistent with the view that "leaning against the wind" through IR accumulation helps mitigate exchange rate volatility and smooths capital flows, thereby promoting macroeconomic stability (Aizenman *et al.*, 2012; Jeanne, 2016).

5.2. Instrumental variable estimates

Although we find that countries adopting CCIR are associated with lower output volatility, this result may merely reflect a correlation in the data rather than identifying the causal effect of CCIR on output volatility. To establish the causal relation, we estimated Equation (3) using instrumental variable (IV) regressions.

A "leaning against the wind" CCIR policy requires a democratic system with executive constraints to curb excessive spending during economic booms and promote saving for downturns. Thus, to instrument for CCIR, we use the fraction of the population of European descent in 1990 (Acemoglu *et al.*, 2001) and dummy variables for British and French legal origins (La Porta *et al.*, 1997). Acemoglu *et al.* (2001) argue that a higher fraction of European descent in former colonies indicates stronger European settlement development, increasing the likelihood of adopting European-style democracy and institutions with executive constraints. Additionally, implementing CCIR policy may require well-functioning financial markets. La Porta *et al.* (1997) suggest that countries with British legal origins tend to have more developed financial markets than those with French legal origins. Therefore, we include legal origin dummies as additional IVs for CCIR.[17]

[16] The literature provides no conclusive empirical evidence on the effect of capital account liberalization on output stability; see, for example, Eichengreen (2001) and Prasad *et al.* (2003).

[17] The proposed instruments demonstrate strong predictive power for CCIR, as shown in the results of the first-

Column [4] of Table 3 presents the 2SLS-IV estimates for the full sample. The effect of CCIR on output volatility is negative and significant, consistent with the OLS estimates in column [1]. This suggests that countries adopting CCIR policies experience a significant reduction in output volatility. The result remains robust when the sample is restricted to EMDE, as shown in column [5]. However, when the sample is limited to advanced economies, the estimates become statistically insignificant. This finding aligns with the literature, which suggests that CCIR policies are particularly beneficial for EMDE facing strong capital flows. It is also worth noting that the insignificance may partly result from the reduced sample size (n=19) when using the instruments.

Overall, the IV results confirm the effect of CCIR on output volatility found in the OLS regression. However, the coefficient estimates for the CCIR variable are noticeably larger (in absolute terms) than the OLS estimates (i.e., −23.7 vs. −3.1), suggesting that the OLS regression may underestimate the effect of CCIR on output volatility due to endogeneity issues.

5.3. CCIR stabilizes output through the channel of exchange rate flexibility

We examine if the output volatility-mitigating effect of CCIR has a channel specific to flexible exchange rate regimes. To do so, we interact CCIR and exchange rate flexibility and estimate the following augmented specification from Equation (3):

$$\ln(y_i^2) = \alpha + \beta_1\, CCIR_i + \beta_2\, Flexible_i + \beta_3\, CCIR_i \times Flexible_i + X_i\Psi + \epsilon_i \qquad (4)$$

The interaction term $CCIR_i \times Flexible_i$ indicates whether the effect of CCIR on output volatility depends on exchange rate flexibility, and vice versa. The baseline scenario corresponds to $CCIR_i = 0$ and $Flexible_i = 0$, which represents countries with rigid exchange rate regimes that do not adopt CCIR.[18]

Relative to the baseline, β_1 represents the marginal effect of adopting CCIR while maintaining a rigid exchange rate arrangement. Similarly, β_2 measures the marginal effect of transitioning to a flexible exchange rate arrangement without implementing CCIR. The coefficient of the interaction term, β_3, reflects the additional marginal (or difference-in-difference) effect for adopting both CCIR and a flexible exchange rate arrangement. Thus, the overall effect of CCIR on output volatility for countries under flexible exchange rate arrangement is $\beta_1 + \beta_3$, while the total effect

stage regression in Table B3 of Appendix B.

[18] Data constraints on the control variables led to reduction of the sample sizes. The sample contains 86 EMDE and 21 advanced economies.

of flexible exchange rate arrangements for countries implementing CCIR is $\beta_2 + \beta_3$. This augmented specification provides valuable insight into the combined effects of these policy choices on macroeconomic stability.

Table 4 presents the estimates of Equation (4). The full sample estimates in column [1] show that β_1, the coefficient for $CCIR_i$, is not significantly different from zero. This suggests that CCIR does not have a significant effect on output volatility unless complemented by flexible exchange rate arrangements. On the other hand, β_2, the coefficient on for exchange rate flexibility is significantly positive, indicating that adopting flexible exchange rate arrangements alone increases output volatility by approximately 5.6% compared to rigid exchange rate arrangements. While flexible regimes absorb external shocks by exchange rate adjustment (Frankel, 2012), variability of exchange rates can contribute to output volatility.

The coefficient of the interaction term $CCIR_i \times Flexible_i$, β_3 is significantly negative. This suggests that CCIR exert a significant volatility-mitigating effect on output for countries with flexible exchange rates. The overall effect of CCIR for countries that simultaneously adopt CCIR and flexible exchange rate arrangements is -5.6 (i.e. $\beta_1 + \beta_3 = 0.39 - 5.99$). To evaluate the significance of this overall effect, we used the Delta method (Oehlert, 1992) to compute the standard error of $\beta_1 + \beta_3 \times CCIR_i$.[19] The result indicates that the effect is statistically significant at the 1% level. By complementing flexible exchange rate regimes with CCIR, these countries effectively neutralize the output volatility effect ($\beta_2 + \beta_3 = -0.39$ with a p-value of 0.87).

Our findings highlight the complementary role of CCIR in enhancing macroeconomic stability in countries with flexible exchange rate regimes. Output volatility is not reduced solely by allowing exchange rates to adjust freely to shocks. Instead, CCIR—when implemented as part of a broader set of macroprudential policy tools—likely needs to work in coordination with flexible exchange rate policies to achieve effective macroeconomic stabilization. In examining the macroeconomic fundamentals of fixed and floating exchange rate regimes, Flood and Rose (1995) found that output volatility does not differ significantly between the two, even though exchange rate volatility does.

[19] The standard error of $\beta_1 + \beta_3 \times CCIR_i$ is computed as $\hat{\sigma} = \left[var(\hat{\beta}_1) + CCIR_i{}^2 var(\hat{\beta}_3) + 2CCIR_i cov(\hat{\beta}_1, \hat{\beta}_3)\right]^{\frac{1}{2}}$. See Oehlert (1992) for details of the method.

Our results provide an explanation for why there is no clear tradeoff between reduced exchange rate volatility and macroeconomic stability, as observed by Flood and Rose (1995).

Columns [2] and [3] of Table 4 present the estimates for EMDE and advanced economies, respectively. The results for EMDE align closely with those of the full sample, indicating that CCIR significantly complements flexible exchange rate regimes in reducing output volatility. In contrast, the estimates for advanced economies reveal notable differences. Specifically, β_1 is significantly negative, suggesting that CCIR independently reduce output volatility. However, when combined with flexible exchange rate arrangements, the volatility-mitigating effect of CCIR diminishes. The overall effect of CCIR on output variability becomes insignificant (i.e. $\beta_1 + \beta_3 = -2.22$, with a *p*-value of 0.29). There is, however, a caveat: Ilzetzki *et al.* (2019) classify euro area countries under rigid exchange rate regimes, and these are the only advanced economies in our sample where $Flexible_i = 0$. Consequently, the estimates in column [3] indicate that the output volatility-reducing effect of CCIR is significantly more pronounced for euro area countries than for other advanced economies.

Our results emphasize that the impact of CCIR on macroeconomic variability is significantly influenced by the exchange rate regime in place. Under flexible exchange rate arrangements, the implementation of CCIR effectively mitigates output volatility, particularly in EMDE. In contrast, for advanced economies, while CCIR generally contribute to output stability, the volatility-mitigating effect is counterbalanced by the opposing effect of flexible exchange rate regimes.

5.4. The implications of the crises

Figure 5 illustrates global IR accumulation over the half-century considered in this study. After the 1997 Asian crisis, the pace of IR accumulation accelerated noticeably. By the eve of the 2008 global financial crisis, IR accumulation had reached an unprecedented level of 15 percent of world GDP[20]. Following this peak, accumulation plateaued before declining in more recent years.[21] Our analyses in Section 4 suggest that CCIR became prevalent during the period between the Asian

[20] Emerging markets developing countries held unprecedently more than 30% of their GDP and reserve assets constitute on average 80% their central banks' assets (BIS 2019).

[21] Aizenman *et al.* (2015) attribute the 2008 shift to changes in financial conditions triggered by the crisis, including factors such as the savings rate, access to swap lines, the implementation of macroprudential policies, the behavior of sovereign wealth funds, and attitudes toward outward foreign direct investment. Bussière *et al.* (2015) suggest that the slowdown in IR accumulation is linked to the deceleration of short-term borrowing after the crisis.

and global financial crises. Additionally, the estimates in Table 2 indicate that the determinants of CCIR differ between the pre- and post-Asian crisis periods. These observations motivate us to estimate Equation (4) separately for the pre- and post-crisis sample periods.

The sub-period estimates reported in the first three columns of Table 5 can be summarized as follows: the significant output-stabilizing effects of CCIR are confined to the 1998–2008 sample period. For other periods, CCIR show no significant impact on output volatility, either independently or in conjunction with exchange rate flexibility. The findings suggest that during the era of rapid IR accumulation, CCIR effectively mitigated output volatility in countries with floating exchange rates. However, the 2008 global financial crisis disrupted both the implementation of CCIR and its volatility-reducing effects. In the aftermath of the global crisis, many countries transitioned from CCIR to *a*-cyclical IR management, and the pace of IR accumulation slowed considerably.

For additional insight, we present the 1998–2008 estimates separately for EMDE and advanced economies. The estimates in columns [4] and [5] of Table 5 indicate that the significant output-stabilizing effect of CCIR is specific to EMDE with flexible exchange rate regimes. This finding identifies the group that derives the greatest benefit from implementing CCIR.

6. Panel data analyses of the counter cyclical IR behavior

Thus far, we have analyzed the cyclical behavior of IR and their effects on output variability using cross-country variation. However, the notable differences between the pre- and post-crisis estimates discussed in Sections 4.2 and 5.4 underscore the importance of examining the dynamics over time. In this section, we conduct panel data analyses to incorporate time-varying information.

The literature suggests several approaches to capturing cyclicality while accounting for time variation in panel data. The first approach is to estimate panel data regressions that directly link cyclical economic factors to the business cycle (Frankel *et al.*, 2013; Lane, 2003). The sign of the estimated coefficient associated with the cyclical component of real GDP is then interpreted as an indicator of counter- or pro-cyclicality. Although this method is useful for estimating the intensity of cyclicality, it does not indicate the probability that a country will adopt, for example, a CCIR policy each year.

The second approach is to run rolling regressions and use the correlation coefficients to reveal shifts in cyclicality over time (Cordella and Gupta, 2015; Frankel *et al.*, 2013). While intuitive, this method poses issues with serial correlation due to overlapping observations between the rolling windows.

Finally, de Haan and Gootjes (2023) propose a different metric to capture the cyclicality of policy: they consider fiscal policy to be pro-cyclical if the change in the budget balance and the output gap have opposite signs, and the absolute change in the budget balance exceeds 0.2% of GDP. Although inventive, the cut-off standard of 0.2% of GDP is arbitrary.

For the current analysis, we divide the 50 years of data into 10 non-overlapping 5-year windows, using 1997 and 2008 as split points to control for the impact of the crises. This approach helps us address the issue of serial correlation and allows for adjustments in the estimates due to shifts caused by the crises.[22] In principle, the panel data consists of 179 countries × 10 periods. However, due to data limitations for some countries or years, the panel is unbalanced.

6.1. The determinants of CCIR

We begin by running fixed-effects panel logistic regressions to identify the factors that influence the likelihood of implementing CCIR policy. The regression is specified as follows:

$$CCIR_{i,t} = \alpha + c_i + w_t + X_{i,t}\Phi + \varepsilon_{i,t} \qquad (5)$$

where $CCIR_{i,t}$ indicates whether country *i* implemented CCIR policy in time window *t* (*t*=1 to 10). $CCIR_{i,t}$ is set to 1 if the cyclical components of *i*'s real GDP and IR are positively correlated at 10% level during the 5-year window, and 0 otherwise. In addition to the country fixed effect (c_i), we include the time-window-specific effect (w_t) to control for global shocks that impact output volatility across all countries simultaneously (Miranda-Agrippino and Rey, 2020). The vector $X_{i,t}$ contains the independent variables introduced in section 4.2, each measured as the average values of the corresponding 5-year window.

In Table 6, columns [1] to [3] present the panel estimates for all countries, EMDE, and advanced economies, respectively. Many independent variables have missing observations. To

[22] We also experimented with the approach of de Haan and Gootjes (2023). Since we lacked prior information on what percentages of IR to GDP constitute an appropriate standard, we used 2%, 1%, 0.5%, 0.2%, and 0.1% of GDP as cut-offs. The results varied depending on which cut-off was used.

address this, we take a pragmatic approach by discarding the least significant variables, which allows us to substantially increase the number of observations.[23]

The estimates in column [1] confirm the finding from the cross-country analysis: exchange rate flexibility is positively associated with the likelihood of adopting CCIR policy. Specifically, the adoption of flexible exchange rate arrangements is associated with a 9.1% higher likelihood (odds ratio = 1.10) of pursuing CCIR management. In addition, trade openness has a significantly positive association with CCIR. In column [2], IR in months of imports and monetary independence also exhibit modest positive association with CCIR by EMDE. However, for advanced economies, the results in column [3] identify no variables that increase the likelihood of adopting CCIR.

Columns [4] to [6] of Table 6 provide the sub-period estimates. They also corroborate the findings of the cross-sectional results reported in Table 2. Following the Asian crisis, exchange rate arrangement replaced IR in months of imports as a significant determinant of CCIR. By incorporating the time variational information, we additionally find that monetary independence and trade openness are significant factors in the pre- and post-global financial crisis periods, respectively. The results in columns [1], [2], and [6] jointly suggest that EMDE with greater degrees of trade openness are inclined toward CCIR practice, especially in the post-global financial crisis environment. In other words, it is structural exposure to real external transactions, irrespective of exchange rate arrangement, that underlies the post-crisis CCIR.

6.2. The effects on output volatility

We next estimate the effects of CCIR on output volatility using a fixed-effects panel data regression:

$$\ln\left(y_{i,t}^2\right) = \alpha + c_i + w_t + \beta_1\, CCIR_{i,t} + \beta_2\, Flexible_{i,t} + \beta_3\, CCIR_{i,t} \times Flexible_{i,t} + X_{i,t}\Psi + \epsilon_{i,t} \qquad (6)$$

Equation (6) parallels Equation (4) in a panel framework. c_i and w_t are the intercepts for the country and (five-year) time widow effects. The variables are measured in average terms of the corresponding window *t*.

[23] The results including all explanatory variables, with considerably smaller samples, are reported in Appendix Table B6.

Table 7 displays the results. Column [1] reports the full sample estimates, without including the interaction term between CCIR and a flexible exchange rate regime. This specification yields only modestly significant estimates. For a given country, output volatility is approximately 0.55% lower during periods when CCIR management is implemented compared to other periods. The impact of a flexible exchange rate regime is not significant, unlike the cross-sectional results in Table 3. Among the control variables, financial development has a positive effect, suggesting that a highly developed domestic financial market is associated with higher output volatility (Aghion *et al*., 2004). This "trade-off" between financial development and output stability appears to be specific to EMDE, as revealed in the sub-sample estimates in columns [3] and [4], which we discuss below.

The remainder of Table 7 reports the estimates when we include $CCIR_{i,t} \times Flexible_{i,t}$, allowing CCIR and flexible exchange rate regimes to interact in affecting output volatility. Consistent with the cross-sectional results in Table 3, the all-country estimates in column [2] suggest a significant complementary effect of CCIR and a flexible exchange rate regime in reducing output volatility. Specifically, although CCIR alone do not significantly reduce output volatility, practicing CCIR with a flexible exchange rate regime significantly reduces output volatility.

Columns [3] and [4] display the estimates for the EMDE and advanced economies samples, respectively. Similarly to the all-country estimates, the estimates for EMDE suggest that CCIR significantly reduce output volatility when combined with flexible exchange rate arrangements. The estimates for advanced economies also indicate the output reducing effect of the interaction term $CCIR_{i,t} \times Flexible_{i,t}$, although of modest significance. Meanwhile, a few control variables exhibit significant effects on output volatility of advanced economies: IR months of imports (Mendoza and Quadrini, 2024) and institutional quality (Acemoglu *et al.*, 2003) exhibit positive effects, while monetary independence (Stein, 2012) exerts negative effects.

Comparison of the results in columns [2] to [4] suggests that the volatility-increasing effect of financial development is specific to EMDE. In other words, for EMDE, financial development (presumably aimed at growth) comes at the cost of compromised output stability (Ranciere *et al*., 2008). This trade-off does not exist for advanced economies, as shown in column [4].

Columns [5], [6], and [7] compare the estimates for the pre-Asian crisis, between-crises, and post-global financial crisis periods. In corroboration with the cross-sectional sub-period results of Table 4, the panel estimates also point to 1998-2008 as the key period for the output volatility-mitigating effect of $CCIR_{i,t} \times Flexible_{i,t}$. In also accord with Table 5, a negative effect of IR months of import is found specific to the pre-Asian crisis period estimates. In contrast to the cross-country estimates, the panel data coefficient estimates for $Flexible_{i,t}$ are generally insignificant except for the post-global financial crisis estimates.

Overall, by leveraging time-varying information, the panel data analyses provide additional evidence of the volatility-reducing effects of CCIR. Our main finding—that CCIR complements flexible exchange rate regimes in reducing output volatility and enhancing macroeconomic stability—remains robust.

7. Conclusions

As important public assets and policy tools, IR have been extensively studied in both academic research and policy discussions. Recent literature particularly highlights their potential as macroprudential policy tools in the era of globalized financial markets, especially for EMDE. These countries face challenges such as volatile capital flows, vulnerable exchange rates, and macroeconomic instability, which require complex policy decisions.

While conventional macroeconomic stabilization policies are effective in advanced economies, they may not be as suitable for EMDE. For instance, during periods of economic overheating or downturns, traditional interest rate policies can exacerbate the situation by amplifying international capital flows. In this context, CCIR could serve as a vital alternative to counter-cyclical capital controls.

In this study, we empirically examine the prevalence of CCIR management and its effectiveness in mitigating output volatility. Our findings suggest that CCIR policies are more the exception than the norm. Additionally, we observe that their effectiveness in reducing volatility is closely linked to the degree of exchange rate flexibility. Specifically, the significant dampening effects of CCIR on output volatility are evident in countries with flexible exchange rate regimes. This specificity may help explain why CCIR are not widely adopted globally. According to the IMF (2022), only about 20% of countries worldwide operate under free-floating exchange rate

systems. Given that CCIR are most effective in mitigating volatility in countries with flexible exchange rates, their adoption remains naturally limited on a global scale.

To the best of our knowledge, this paper is the first empirical study to explicitly examine the "leaning against the wind" approach within the context of CCIR management. We investigate the global prevalence of CCIR policies, the factors driving their adoption, the rationale behind their implementation, and their role in enhancing macroeconomic stability. These inquiries place this paper uniquely at the intersection of several key strands of literature: international reserve hoarding under real and financial integration (Aizenman and Riera-Crichton, 2008); cyclical economic policy (Kaminsky *et al.*, 2004; Frankel *et al.*, 2013); exchange rate regimes and macroeconomic stability (Dornbusch, 1981; Flood and Rose, 1995); and macroprudential policy within the framework of the impossible trinity (Arce *et al.*, 2019; Jeanne, 2016; Rey, 2015).

In the era of globalization, maintaining macroeconomic stability through independent monetary policies often requires flexible exchange rate regimes. While flexible exchange rates can absorb external shocks, excessive volatility can spill over into the broader economy, potentially becoming a source of instability. Our findings suggest that CCIR policies complement flexible exchange rate regimes in sustaining macroeconomic stability. This implies that adopting CCIR can be an effective tool for countries with flexible exchange rate arrangements in addressing the challenges posed by the trilemma.

While this study provides a comprehensive analysis of CCIR policy behavior, several important issues remain unexplored and warrant further investigation. For example, a non-negligible number of countries adopt pro-cyclical IR policies. What factors drive the adoption of such pro-cyclical policies, and what are their broader macroeconomic implications? Furthermore, we observe notable differences in CCIR adoption patterns and their role before and after the 1997 Asian crisis and the 2008 global financial crisis. Delving into the underlying mechanisms behind these regime shifts could offer valuable insights and serve as an important avenue for future research.

Appendix A: Variable definitions and summary statistics

CCIR: a dichotomous index to measure a country's counter-cyclical behavior of international reserves (IR). In cross section regressions, we define CCIR = 1 if the correlation between the cyclical components of IR and real GDP from 1972 to 2022 is positive and significant at 10% p-value level. If it's insignificant, we assign Counter IR a zero. The cyclical components of IR and real GDP are obtained using HP filter. In panel data regressions, we divide the 50-year sample period into 10 sub-sample periods and define CCIR = 1 in a country-subperiod observation if the cyclical components of real GDP and IR correlated at 10% level during the subperiod.
PCIR: a dichotomous index of a country's pro-cyclical behavior of IR. The definition process is identical to CCIR, except that we assign PCIR 1 if the calculated cyclical correlation is negative and significant 10% level.
ACIR: an indicator for countries adopting neither counter-cyclical nor pro-cyclical IR.
Exchange rate arrangement: the *de facto* measure for exchange rate regime from Ilzetzki, Reinhart and Rogoff (2019)'s fine index that classified exchange rate flexibility into 15 categories. High index indicates more *de facto* exchange rate flexibility.
Monetary independence: the monetary independence index of Aizenman, Chinn and Ito (2010).
Capital account openness: the Chinn-Ito capital account openness index.
Institutional quality: the average of the indices of bureaucracy quality, corruption, investment profile, and law and order from ICRG country risk database.
Real GDP per capita: the logarithm of real GDP per capita, PPP (constant 2017 international $).
Financial development: the domestic credit to private sectors to GDP ratio, %.
M2/GDP: the broad money (M2) to GDP ratio, %.
IR months of imports: Total reserves in months of imports.
Short-term external debt: the short-term external debt to GDP ratio, %.
Long-term external debt: the long-term external debt to GDP ratio, %.
External debt: the total external debt to GDP ratio, %
Debt service to exports income: Total debt service (% of exports of goods, services and primary income)
Trade openness: the total trade to GDP ratio, %.
Term of trade: the term of trade index; Y2000 = 100.
Euro1900: The fraction of the population of European descent (Acemoglu *et al.*, 2001).
Legal Origin: The French legal origin of company and commercial law from Acemoglu *et al.* (2001) and La Porta *et al.* (1997).
Output variability: the variability of real GDP, measured by the squared of HP filtered cyclical component of real GDP, in logarithm value (Frankel *et al.*, 2013).

Summary statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
CCIR	177	0.31	0.47	0	1
PCIR	177	0.13	0.34	0	1
ACIR	177	0.56	0.5	0	1
Exchange rate arrangement	161	6.44	3.7	1	13.05
IR month of imports	151	3.93	2.6	0.03	15.89
Financial development	161	46.59	37.79	3.21	188.22
Short-term external debt	107	5.8	5	0.02	25.1
External debt	107	49.3	24.47	9.06	168.39
Monetary independence	154	0.43	0.11	0.13	0.66
Institutional quality	120	0.58	0.17	0.21	0.92
Capital account openness	160	0.44	0.29	0.01	1
Trade openness	157	83.3	49.98	21.77	342.53
Term of trade	162	112.27	23.33	66.72	194.77
M2/GDP	142	54.86	48.58	0.04	446.41
Debt service to export income ratio	107	15.91	8.58	2.12	45.66
GDP per capita	163	8.15	1.42	5.26	11.08
Output volatility	163	11.08	7.19	-4.07	31.78

Appendix B: Additional results

Table B1: The determinants of the likelihood of adopting counter-cyclical IR– the logit estimates with all explanatory variables

	[1] All	[2] EMDE	[3] 1998-2008	[4] 2009-22
Exch rate arrangement	0.278**	0.384**	0.275**	0.062
	(0.111)	(0.150)	(0.108)	(0.108)
IR month of imports	0.028	-0.070	-0.014	-0.19
	(0.099)	(0.122)	(0.100)	(0.154)
Monetary independence	-0.680	-5.394	-0.317	-3.718
	(3.585)	(5.678)	(3.533)	(3.347)
Institutional Quality	-1.235	2.749	-0.002	0.086
	(3.254)	(5.057)	(0.119)	(0.155)
Real GDP per capita	0.052	0.229	0.118	-0.086
	(0.343)	(0.479)	(0.345)	(0.447)
M2/GDP	-0.010	0.005	-0.006	0.021
	(0.011)	(0.018)	(0.009)	(0.015)
Financial development	0.004	-0.017	-0.001	-0.012
	(0.013)	(0.022)	(0.012)	(0.024)
Capital openness	-0.147	0.814	-0.185	-0.021
	(0.963)	(1.284)	(0.962)	(1.036)
Trade openness	0.003	0.019	0.001	-0.008
	(0.007)	(0.014)	(0.006)	(0.010)
Term of trade	-0.008	-0.019	-0.003	0.012
	(0.010)	(0.013)	(0.010)	(0.009)
Debt service to export income ratio		-0.005		
		(0.043)		
ST debt/GDP		0.035		
		(0.089)		
Total debt/GDP		-0.003		
		(0.015)		
Psudo R^2	0.094	0.169	0.097	0.133
Obs.	89	65	89	72

Notes: The table reports logistic regression estimates of Equation (2) in the main text with CCIR as the dependent variable. Pre-1998 and Advanced economy sample estimates are not available due to insufficient sample size. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance level.

Table B2: The determinants of IR cyclicality– the OLS estimates with all explanatory variables

	[1] All	[2] EMDE	[3] 1998-2008	[4] 2009-2022
Exchange rate arrangement	0.038***	0.033***	0.058***	0.023**
	(0.011)	(0.011)	(0.021)	(0.011)
IR month of imports	-0.004	-0.010	-0.007	0.033**
	(0.015)	(0.016)	(0.023)	(0.016)
Monetary independence	0.516	-0.198	-0.219	0.088
	(0.414)	(0.775)	(0.716)	(0.477)
Institutional Quality	-0.091	0.134	-0.004	-0.002
	(0.459)	(0.510)	(0.027)	(0.014)
Real GDP per capita	0.05	0.085*	0.035	0.019
	(0.039)	(0.048)	(0.082)	(0.049)
M2/GDP	0.000	0.001	0.000	-0.001
	(0.001)	(0.002)	(0.001)	(0.001)
Financial development	-0.002	-0.003	-0.001	0.001
	(0.002)	(0.002)	(0.003)	(0.002)
Capital openness	-0.085	0.079	-0.039	-0.329*
	(0.119)	(0.117)	(0.210)	(0.183)
Trade openness	0.000	0.001	0.000	0.002***
	(0.001)	(0.002)	(0.002)	(0.001)
Term of trade	0.000	-0.002	0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.002)
Debt service to export income		-0.004		
		(0.006)		
ST debt/GDP		0.011		
		(0.010)		
Total debt/GDP		0.000		
		(0.002)		
R^2	0.140	0.073	0.130	0.093
Obs.	89	65	89	72

Notes: The table shows OLS regressions estimates of modified Equation (2). The IR cyclical coefficients are used as the dependent variable. Pre-1998 and Advanced economy sample estimates are not available due to an insufficient sample size. ***, **, and * indicate 1%, 5%, and 10% significance level.

Table B3: The first stage regression results in IV regressions of Table 2

	[1] All	[2] EMDE	[3] Advanced
Euro1900	0.004**	0.005**	0.001
	(0.002)	(0.002)	(0.008)
British legal origin	0.190	0.269	0.206
	(0.155)	(0.210)	(0.476)
British legal origin	0.116	0.206	-0.145
	(0.138)	(0.185)	(0.464)
Exch rate arrangement	0.305***	0.280**	0.181
	(0.109)	(0.122)	(0.438)
IR month of imports	0.010	0.003	-0.056
	(0.020)	(0.022)	(0.103)
Monetary independence	0.181	-0.007	0.251
	(0.631)	(0.753)	(1.719)
Capital account openness	-0.125	-0.058	-1.520
	(0.216)	(0.238)	(1.356)
Trade openness	0.001	0.000	0.004
	(0.001)	(0.002)	(0.006)
Financial development	0.000	-0.001	0.011
	(0.002)	(0.002)	(0.006)
Institutional quality	-0.868	-0.22	-0.182
	-0.665	-0.834	-3.505
R^2	0.072	0.035	0.039
Obs.	99	80	19

Notes: The first stage estimates of the IV regression (Table 3) are reported. The dependent variable is CCIR. Euro1900 (fraction of the population of European decent in 1900) (Acemoglu *et al.*, 2001) and the legal origin of British and French dummy variables (La Porta *et al.*, 1997) are used to instrument CCIR. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance level.

Table B4: The effect of counter-cyclical IR on output volatility using the exchange rate arrangement index

	[1] All	[2] EMDE	[3] Advanced	[4] 1972-97	[5] 1998-2008	[6] 2009-22
CCIR	1.312	2.191	-12.297***	6.841	3.904	0.018
	(3.384)	(3.885)	(2.795)	(12.170)	(3.524)	(3.044)
Exchange rate arrangement	0.634**	0.690*	0.397	-0.128	0.525**	0.083
	(0.301)	(0.365)	(0.374)	(0.200)	(0.242)	(0.272)
CCIR × Exchange rate arrangement	-0.506	-0.604*	0.882*	-1.215	-0.575*	-0.125
	(0.370)	(0.349)	(0.405)	(0.975)	(0.309)	(0.374)
IR month of imports	0.168	0.173	0.012	-0.553**	0.220*	0.076
	(0.200)	(0.242)	(0.565)	(0.255)	(0.125)	(0.236)
Monetary independence	5.870	0.322	15.195	17.877*	0.928	9.925
	(8.074)	(9.230)	(10.305)	(8.856)	(4.766)	(7.476)
Capital account openness	-3.783	-4.681	11.512	-5.569	-3.238	-3.887
	(2.659)	(3.051)	(8.048)	(3.900)	(2.070)	(3.344)
Trade openness	-0.021	-0.020	-0.031	-0.036**	-0.028**	-0.034**
	(0.013)	(0.020)	(0.022)	(0.016)	(0.011)	(0.014)
Financial development	0.006	0.009	0.019	0.075**	0.025	0.007
	(0.024)	(0.033)	(0.044)	(0.032)	(0.019)	(0.023)
Institutional Quality	-0.810	0.372	-24.268	0.011	0.051	0.248
	(6.504)	(8.505)	(20.201)	(0.158)	(0.198)	(0.188)
R^2	0.172	0.092	0.631	0.220	0.176	0.079
Obs.	107	86	21	50	104	88

Notes: The table reports the cross-country regression estimates of modified Equation (4) in the main text. The dummy variable *Flexible* in the equation is replaced by "Exchange rate arrangement" which is the index value of Ilzetzki *et al.* (2019). The dependent variable is output variability. Columns [1], [2], and [3] are for all economies, emerging market and developing economies, and advanced economies samples, respectively. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance level.

Table B5: The effect of IR cyclicality on output volatility using the cyclical coefficients and the exchange rate arrangement index

	[1] All	[2] EMDE	[3] Advanced	[4] 1972-97	[5] 1998-2008	[5] 2009-22
IR cyclicality	-0.308	0.799	-10.054	-0.958	2.186	-2.992
	(3.594)	(4.613)	(7.324)	(7.640)	(3.723)	(3.289)
Exchange rate arrangement	0.521*	0.573*	0.520	-0.364	0.406**	-0.138
	(0.270)	(0.311)	(0.611)	(0.263)	(0.200)	(0.235)
IR cyclicality × Exchange rate arrangement	-0.570	-0.766*	1.016	0.397	-0.540	0.440
	(0.487)	(0.422)	(1.192)	(0.784)	(0.482)	(0.425)
IR month of imports	0.165	0.152	0.229	-0.593**	0.211*	0.053
	(0.210)	(0.252)	(0.737)	(0.232)	(0.126)	(0.222)
Monetary independence	6.937	1.633	11.519	22.697**	2.747	10.764
	(7.927)	(9.312)	(12.043)	(10.813)	(4.598)	(7.635)
Capital account openness	-3.742	-4.580	17.014**	-4.202	-3.23	-3.240
	(2.753)	(3.208)	(7.175)	(3.845)	(2.065)	(3.169)
Trade openness	-0.021	-0.020	-0.025	-0.043**	-0.028**	-0.035***
	(0.013)	(0.020)	(0.022)	(0.017)	(0.012)	(0.013)
Financial development	0.004	0.006	-0.025	0.072**	0.021	0.007
	(0.024)	(0.034)	(0.052)	(0.036)	(0.019)	(0.023)
Institutional Quality	-0.068	1.493	-32.297	0.073	0.089	0.221
	(6.885)	(9.100)	(19.873)	(0.208)	(0.190)	(0.191)
R^2	0.154	0.078	0.504	0.129	0.170	0.076
Obs.	107	86	21	50	104	88

Notes: The table reports the cross-country regression estimates of modified Equation (4) in the main text. The dummy variable *CCIR* in the equation is replaced by "IR cyclicality" measured by the correlation coefficients of the cyclical components of IR and real GDP. Similarly, *Flexible* is replaced by "Exchange rate arrangement" measured by the index value of Ilzetzki *et al.* (2019). The dependent variable is output variability. Columns [1], [2], and [3] are for all economies, developing and emerging economies, and advanced economies samples, respectively. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

Table B6: The determinants of counter-cyclical IR– the fixed effects panel estimates

	[1] All	[2] EMDE	[3] Advanced	[4] 1972-97	[5] 1998-2008	[5] 2009-22
Exch rate arrangement	0.020	-0.011	-0.083	-0.173	0.117	0.034
	(0.054)	(0.059)	(0.412)	(0.136)	(0.101)	(0.099)
IR month of imports	0.024	0.032	0.189	0.174**	0.001	0.005
	(0.030)	(0.030)	(0.203)	(0.086)	(0.083)	(0.047)
Monetary independence	1.746	2.334	-1.102	4.833	4.783	-1.75
	(1.478)	(1.831)	(14.687)	(5.323)	(3.871)	(1.928)
Institutional Quality	0.013	0.018	-1.615	0.222	0.005	-0.107
	(0.072)	(0.078)	(1.458)	(0.196)	(0.149)	(0.122)
Real GDP per capita	-0.015	-0.024	-4.686*	-0.802	0.016	0.196
	(0.238)	(0.246)	(2.710)	(0.870)	(0.422)	(0.321)
M2/GDP	0.000	-0.005	0.002	-0.019	0.019	-0.005
	(0.005)	(0.007)	(0.025)	(0.051)	(0.012)	(0.008)
Financial development	0.011	0.010	-0.021	-0.055	0.006	0.015
	(0.007)	(0.009)	(0.045)	(0.072)	(0.011)	(0.011)
Capital openness	-0.504	-0.817	22.116	-1.46	-0.758	-0.198
	(0.812)	(0.943)	(16.260)	(4.744)	(1.503)	(1.093)
Trade openness	0.000	0.002	0.025	-0.014	-0.003	0.005
	(0.002)	(0.003)	(0.024)	(0.015)	(0.008)	(0.006)
Term of trade	-0.002	-0.003	0.058	-0.002	-0.001	-0.004
	(0.006)	(0.006)	(0.045)	(0.019)	(0.018)	(0.007)
Log Likelihood	-111.51	-94.27	-9.96	-17.82	-33.98	-48.21
Obs.	460	368	31	94	140	226

Notes: The table reports fixed effect logistic regression estimates with CCIR as the dependent variable. Year-specific constants are included as a control for the effects of global factors. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

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Table1: Exchange rate flexibility and IR cyclicality

Exchange rate flexibility	IR cyclicality	EMDE	Advanced	All countries
Flexible regimes	counter-cyclical	42	4	46
	pro-cyclical	7	2	9
	a-cyclical	49	6	55
Non-flexible regimes	counter-cyclical	11	2	13
	pro-cyclical	7	3	10
	a-cyclical	39	7	46

Notes: The entries denote the number of countries in the corresponding categories. Flexible regimes and non-flexible regimes are freely floating exchange rate regimes and all other regimes, respectively. EMDE and Advanced denote emerging markets and developing economies and advanced economies, respectively. The Chi-square test statistic (10.47 with two degrees of freedom) rejects the hypothesis of independence between IR cyclicality and exchange rate flexibility at the 1 % level of statistical significance.

Table 2: The determinants of the likelihood of adopting counter-cyclical IR– the cross-country logit estimates

	[1] All	[2] EMDE	[3] Advanced	[4] 1972-97	[5] 1998-2008	[6] 2009-22
Exchange rate arrangement	0.239***	0.246***	0.295	0.064	0.163***	0.132*
	(0.063)	(0.066)	(0.217)	(0.051)	(0.058)	(0.070)
IR months of imports	0.008	0.012	-0.067	0.285***	0.019	-0.071
	(0.076)	(0.083)	(0.163)	(0.097)	(0.053)	(0.098)
Pseudo R^2	0.113	0.116	0.139	0.086	0.062	0.041
Number of observations	149	126	23	132	146	145

Notes: The table reports the cross-country logit regression estimates of Equation (2) in the main text. The dependent variable is the dichotomous variable for the counter-cyclical IR (CCIR) behavior. The entries of the first three columns are the estimates for all countries, emerging and developing economies, and advanced economies, respectively. The entries of the last three columns are the estimates for 1972-1997, 1998-2008, and 2009-2022 sub-periods. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively. As a preliminary step, we estimated equation (2) in the main text with all explanatory variables. We then sequentially dropped insignificant explanatory variables to preserve sufficient degrees of freedom. The estimates with all explanatory variables are attached in Table B1 Appendix B. Table B2 shows the results using IR cyclical coefficients as the dependent variable.

Table 3: The effect of counter-cyclical IR on output volatility

	[1] OLS All	[2] OLS EMDE	[3] OLS Advanced	[4] IV All	[5] IV EMDE	[6] IV Advanced
CCIR	-3.112**	-2.942*	-5.096*	-23.782**	-24.296**	-19.946
	(1.366)	(1.595)	(2.404)	(10.727)	(11.481)	(28.710)
Flexible	3.409**	3.254*	4.591*	10.042**	9.711**	9.355
	(1.508)	(1.681)	(2.288)	(4.230)	(4.492)	(10.319)
IR month of imports	0.218	0.217	-0.286	0.214	0.122	-1.517
	(0.200)	(0.237)	(0.452)	(0.454)	(0.560)	(2.668)
Monetary independence	8.181	3.054	18.392**	8.867	4.902	22.503
	(6.607)	(8.058)	(6.625)	(14.684)	(18.831)	(28.484)
Capital account openness	-3.954	-4.996*	10.578	-6.176	-4.428	-6.964
	(2.567)	(2.908)	(7.346)	(5.238)	(5.867)	(43.465)
Trade openness	-0.020*	-0.018	-0.024	-0.002	-0.026	-0.010
	(0.012)	(0.019)	(0.020)	(0.028)	(0.038)	(0.110)
Financial development	0.009	0.007	0.044	0.023	0.008	0.212
	(0.023)	(0.031)	(0.036)	(0.046)	(0.062)	(0.346)
Institutional Quality	-1.168	0.037	-28.804	-8.931	8.288	-25.268
	(6.443)	(8.657)	(19.033)	(14.055)	(19.610)	(38.573)
Over-identification test				1.48	1.07	0.92
Weak instrument test				1.92	2.38	1.33
R^2	0.194	0.109	0.627	0.167	0.157	0.572
Obs.	107	86	21	99	80	19

Notes: The table reports the OLS and IV estimates of Equation (3) in the text. The dependent variable is output variability. Columns [1] – [3] report results of OLS and Column [4] – [6] report IV regression results. Euro1900 (fraction of the population of European decent in 1900) (Acemoglu *et al.*, 2001) and the legal origin of British and French dummy variables (La Porta *et al.*, 1997) are used as instruments for CCIR. The over-identification test is the Wald statistic; the null hypothesis is that the instruments are exogenous (i.e., uncorrelated with the error term). The weak-identification test is the first-stage F test of excluded instruments; the null hypothesis is that the model is weakly identified. First stage IV regression results are reported in Table B3 of Appendix B. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance level.

Table 4: The complementary effects of counter-cyclical IR and flexible exchange rate on output volatility

	[1] All	[2] EMDE	[3] Advanced
CCIR	0.399	1.185	-8.483***
	(2.121)	(2.278)	(1.203)
Flexible	5.597***	6.031***	3.094
	(1.715)	(2.036)	(2.481)
CCIR × Flexible	-5.991**	-7.128**	6.259**
	(2.810)	(3.227)	(2.265)
IR month of imports	0.151	0.159	-0.015
	(0.212)	(0.258)	(0.510)
Monetary independence	7.613	3.821	17.483**
	(6.395)	(7.654)	(6.933)
Capital account openness	-3.837	-4.372	11.820
	(2.559)	(2.938)	(6.804)
Trade openness	-0.023*	-0.024	-0.028
	(0.012)	(0.018)	(0.022)
Financial development	0.015	0.019	0.022
	(0.025)	(0.033)	(0.043)
Institutional quality	-2.212	-0.638	-30.122
	(6.630)	(8.435)	(19.745)
R^2	0.228	0.158	0.666
Obs.	107	86	21

Notes: The table reports cross-country OLS regression estimates of Equation (4) in the main text. The dependent variable is output variability. *Flexible* is a dichotomous variable for flexible exchange regime (=1) if the respective Ilzetzki *et al.* (2019) index is greater than 8; rigid exchange regime (=0), otherwise. Column [1], [2], [3] are for all economies, developing and emerging economies, and advanced economies samples, respectively. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance level. Results using continuous measures for exchange rate regime and IR cyclicality coefficient are presented in Table B4 and B5 of Appendix B.

Table 5: The effect of counter-cyclical IR on output volatility by sub-periods

	[1] 1972-97	[2] 1998-2008	[3] 2009-22	[4] 98-08 EMDE	[5] 98-08 Advanced
CCIR	-1.870	2.551	-0.647	3.177	-1.522
	(8.918)	(2.113)	(1.457)	(2.116)	(2.923)
Flexible	0.115	4.109***	1.238	5.173***	-1.923
	(1.336)	(1.437)	(1.636)	(1.657)	(4.878)
CCIR × Flexible	-5.483	-5.792**	-0.807	-7.078**	0.000
	(9.200)	(2.691)	(2.294)	(2.942)	(0.001)
IR month of imports	-0.516**	0.249*	0.061	0.275*	0.296
	(0.251)	(0.129)	(0.233)	(0.146)	(0.372)
Monetary independence	14.521	4.159	8.536	17.432***	12.424
	(9.451)	(3.715)	(6.647)	(5.721)	(13.822)
Capital account openness	-5.756	-3.615*	-3.789	-3.965*	14.639*
	(4.174)	(2.044)	(3.210)	(2.128)	(8.017)
Trade openness	-0.033**	-0.031***	-0.033**	-0.033*	-0.026
	(0.015)	(0.011)	(0.014)	(0.017)	(0.015)
Financial development	0.069**	0.022	0.009	0.029	-0.013
	(0.034)	(0.019)	(0.022)	(0.022)	(0.036)
Institutional quality	0.022	0.142	0.217	0.266	0.049
	(0.178)	(0.195)	(0.183)	(0.273)	(0.339)
R^2	0.161	0.210	0.084	0.246	0.417
Obs.	50	104	88	84	20

Notes: The table displays cross-section OLS regression estimates of Equation (4) for the sub-periods denoted in the top row. The dependent variable is output variability. *Flexible* is a dichotomous variable that is set equal to one for flexible exchange regimes, and 0 for rigid exchange rate regimes. Exchange rate regimes are considered flexible if the index of Ilzetzki *et al.* (2019) is on average equal to or greater than 8. Columns [4] and [5] report the 1998-2008 estimates for EMDE and advanced economies, respectively. Robust standard errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

Table 6: The determinants of counter-cyclical IR – the panel logit estimates

	[1] All	[2] EMDE	[3] Advanced	[4] 1972-97	[5] 1998-2008	[6] 2009-22
Exch rate arrangement	0.091**	0.125**	-0.088	0.072	0.144**	0.122
	(0.038)	(0.050)	(0.159)	(0.081)	(0.071)	(0.079)
IR month of imports	0.015	0.049*	-0.124	0.127*	-0.055	0.012
	(0.026)	(0.029)	(0.143)	(0.066)	(0.095)	(0.039)
Monetary independence	1.262	2.948*	1.889	-1.314	4.826***	0.088
	(1.109)	(1.522)	(2.376)	(2.485)	(1.836)	(1.579)
Trade openness	0.007***	0.008**	0.003	0.007	0.004	0.008***
	(0.003)	(0.004)	(0.005)	(0.007)	(0.004)	(0.003)
Log Likelihood	-250.02	-188.62	-49.12	-105.03	-61.53	-67.66
Obs.	1045	862	161	406	259	380

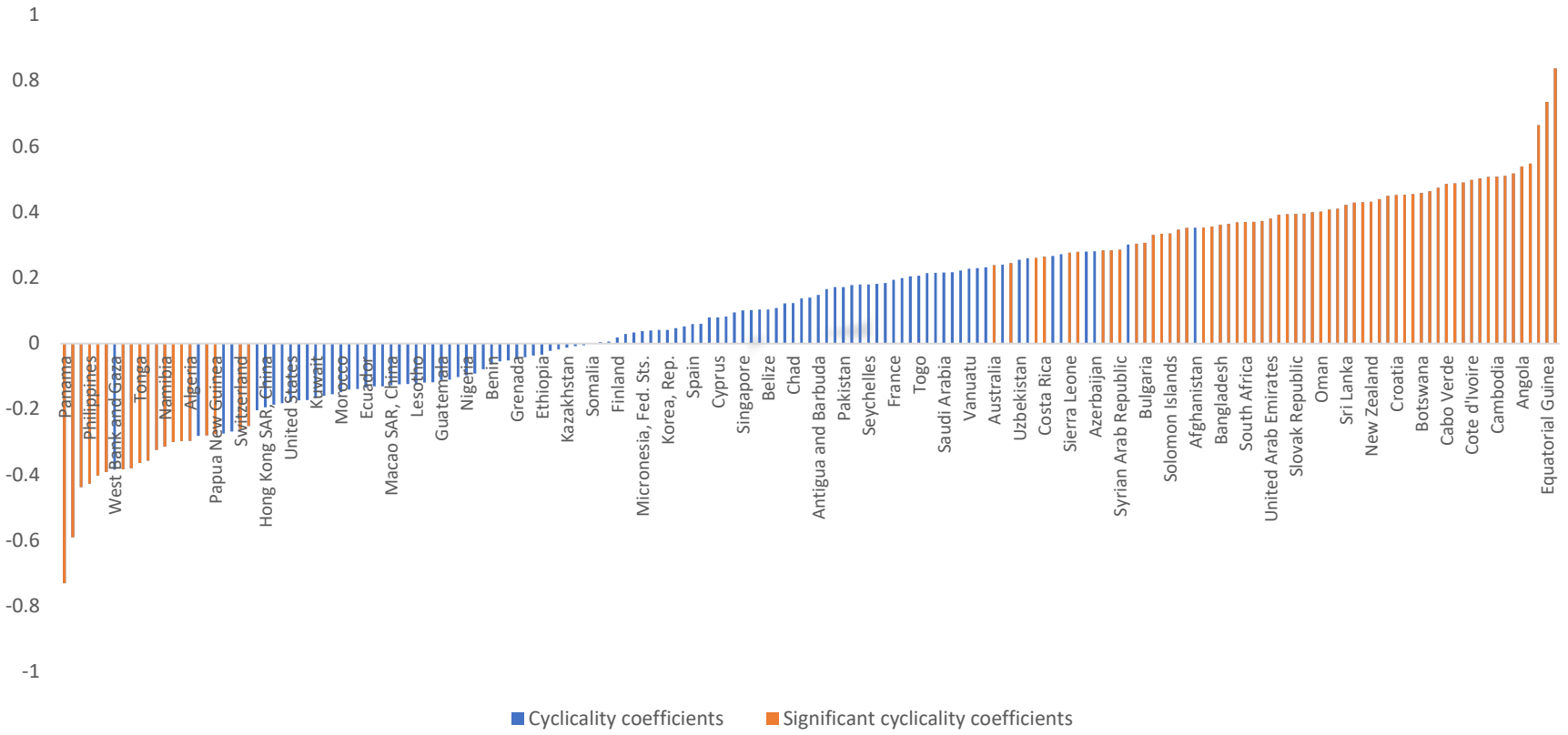
Notes: The table reports the fixed effect panel data logistic regressions estimates of Equation (5) in the main text. CCIR is the dependent variable. Insignificant variables are dropped to increase the sample size from 460 to 1045. The results with all independent variables are in Appendix B6. Year-specific constants are included as a control for the effects of global factors. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

Table 7: The effect of counter-cyclical IR on output volatility – the panel estimates

	[1] All	[2] All	[3] EMDE	[4] Advanced	[5] 1972-97	[6] 1998-2008	[7] 2009-2022
CCIR	-0.549*	0.114	0.306	-0.126	-0.639	1.750	-0.241
	(0.306)	(0.435)	(0.495)	(0.591)	(1.108)	(1.251)	(0.604)
Flexible	0.286	0.411	0.425	0.821	-1.556	0.162	1.657**
	(0.341)	(0.344)	(0.362)	(0.910)	(1.013)	(1.115)	(0.763)
CCIR × Flexible		-1.319**	-1.400**	-1.848*	-1.161	-2.773*	-1.116
		(0.616)	(0.685)	(0.976)	(1.505)	(1.557)	(0.943)
IR month of imports	-0.010	-0.010	-0.023	0.343***	-0.293*	-0.108	-0.079
	(0.037)	(0.037)	(0.038)	(0.105)	(0.157)	(0.122)	(0.083)
Monetary independence	-0.476	-0.310	1.225	-6.172***	-1.388	-1.282	-1.018
	(0.826)	(0.826)	(0.933)	(1.818)	(3.099)	(2.530)	(1.139)
Capital account openness	-0.053	-0.038	-0.049	0.732	4.768**	-1.973	1.536
	(0.622)	(0.620)	(0.652)	(2.148)	(2.257)	(2.227)	(2.164)
Trade openness	-0.008	-0.008	-0.006	0.023	0.002	-0.017	-0.013
	(0.006)	(0.006)	(0.007)	(0.016)	(0.019)	(0.021)	(0.015)
Financial development	0.010*	0.010*	0.013*	0.009	0.047	0.033	0.028***
	(0.006)	(0.006)	(0.008)	(0.007)	(0.030)	(0.023)	(0.010)
Institutional quality	0.036	0.030	0.009	0.343**	-0.166	0.033	0.135
	(0.066)	(0.066)	(0.071)	(0.152)	(0.152)	(0.240)	(0.165)
With-in R^2	0.076	0.086	0.096	0.675	0.208	0.163	0.161
Obs.	585	585	481	104	131	167	287

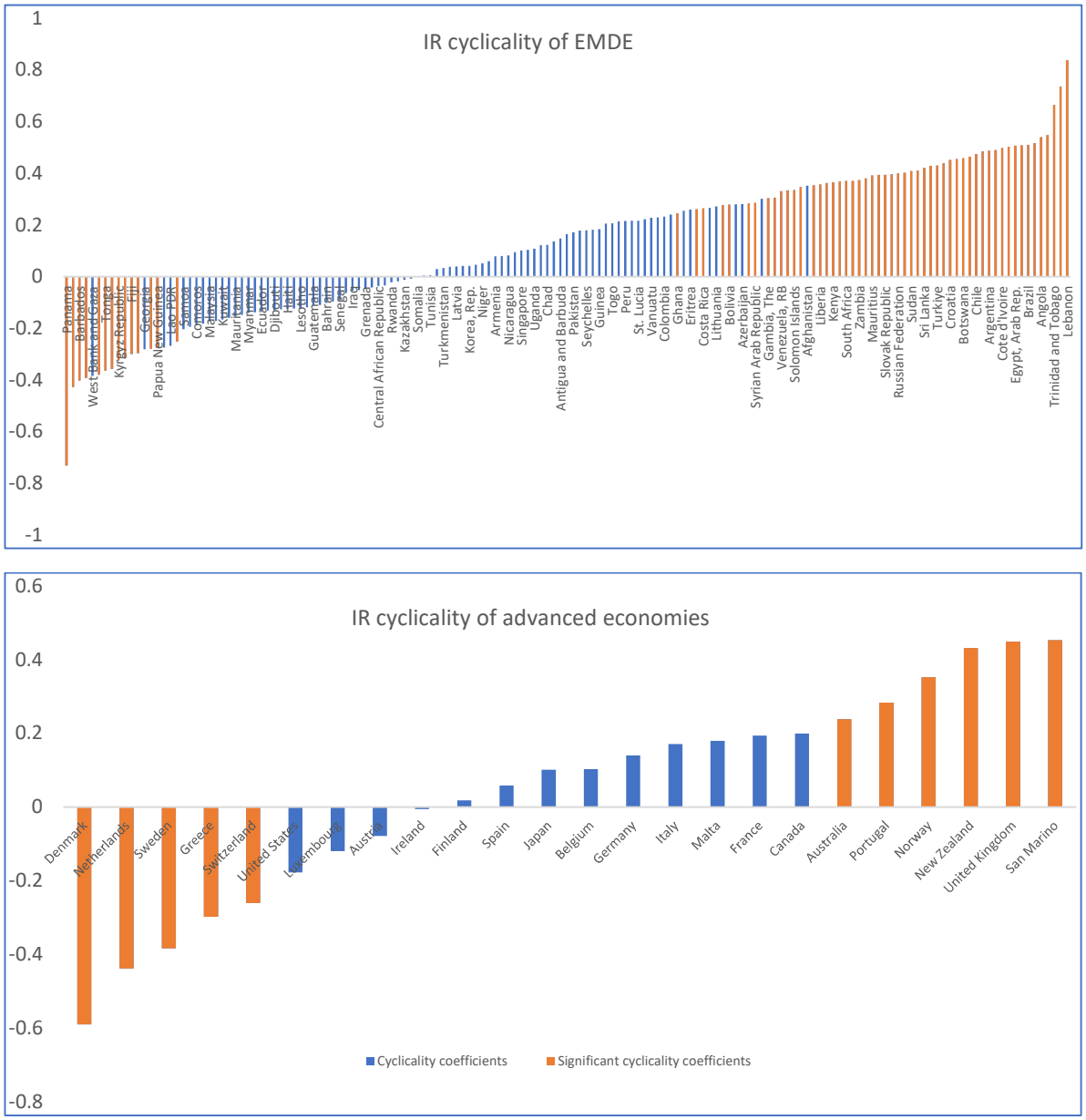
Notes: The table reports the fixed effect panel data regression estimates of Equation (6) in the main text. The dependent variable is output variability. Year-specific constants are included as a control for the effects of global factors. Columns [1] and [2] report full sample results. Columns [3] and [4] are for developing and emerging economies and advanced economies samples. Columns [5] - [7] reports results for samples of pre-1997 crisis, 98-08, and post 2008 crisis. Robust errors are in parentheses. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

Figure 1: The cyclicality of the international reserves (IR) by country



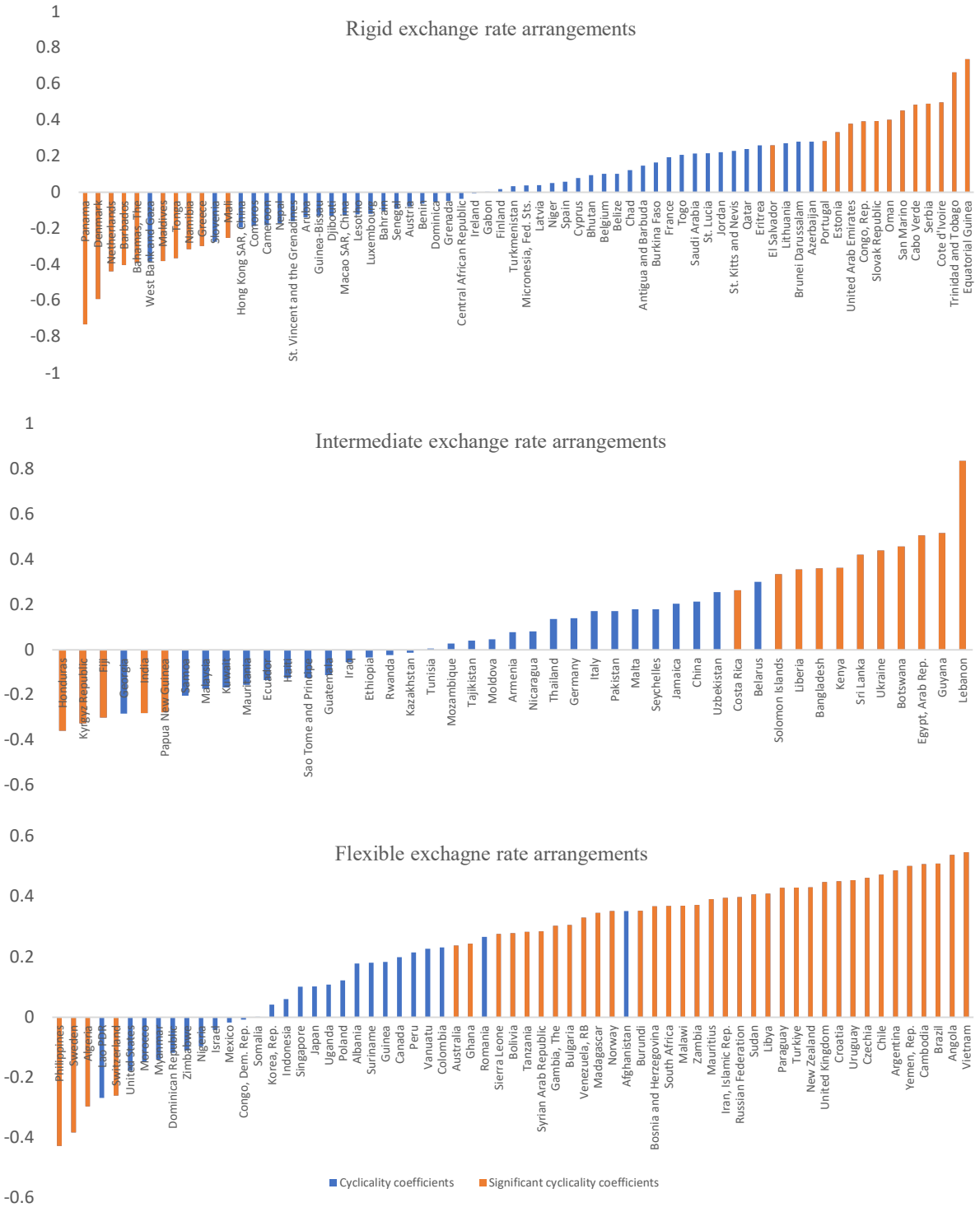
Notes: The cyclicality coefficient estimates of Eq. (1) in the main text are reported. A positive (negative) value indicates counter-cyclical (pro-cyclical) IR. Orange bars show only statistically significant correlations at the 10 % level.

Figure 2: The cyclicality of IR for emerging market and developing economies and advanced dconomies



Notes: The cyclicality coefficient estimates of Eq. (1) in the main text are reported. A positive (negative) value indicates counter-cyclical (pro-cyclical) IR. Orange bars show only statistically significant correlations at the 10 % level.

Figure 3: The cyclicality of IR by exchange rate flexibility

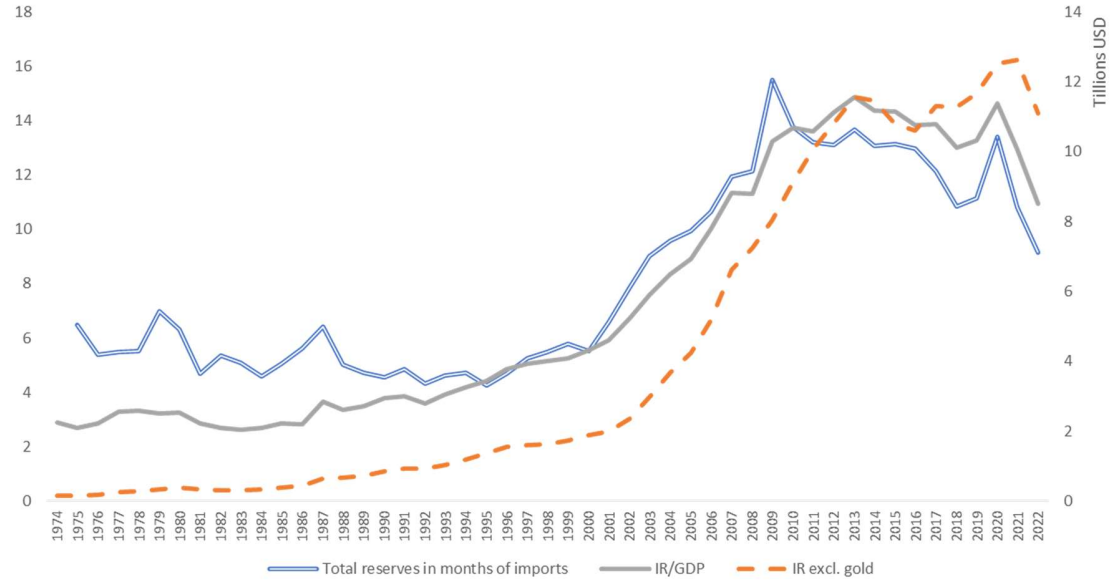


Notes: The cyclicality coefficient estimates of Eq. (1) in the main text are reported. A positive (negative) value indicates counter-cyclical (pro-cyclical) IR. Orange bars show only statistically significant correlations at the 10 % level.

Figure 4: The IR cyclicality during the pre-Asian Crisis, 1998-2008, and post-2008 Crisis periods

Notes: The cyclicality coefficient estimates of Eq. (1) in the main text are reported. A positive (negative) value indicates counter-cyclical (pro-cyclical) IR. Orange bars show only statistically significant correlations at the 10 % level.

Figure 5: The world IR accumulation



Notes: The total reserves to GDP ratio (IR/GDP, %) and total reserves in months of imports are measured on the left scale. Total IR excluding gold (trillion USD) is on the right scale. Data source: World Bank, WDI.