Beyond Net Flows: Managing Gross Capital Flows under Collateral Constraints *

Camilo Granados † Kyongjun Kwak ‡

University of Texas at Dallas OECD

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Abstract

The growing importance of capital outflows from emerging economies has led to a disconnect between net and gross inflows, raising the question of whether these quantities should be analyzed separately. We study a framework in which the distinction between foreign borrowing (gross inflows) and residents' overseas investment (gross outflows) is made explicit, in an environment with a collateral constraint where both types of flows are pledgeable. Because private agents do not internalize how their borrowing and investments jointly affect future asset prices and collateral values, their decisions generate substantial pecuniary externalities operating through both domestic and foreign asset price channels. As a result, the implied crisis probability and overborrowing extend beyond those obtained in net-flow models. We show that a set of taxes can correct the externalities, and that the interventions are considerably tighter in our environment than under net-flow regulations. Our results align with empirical evidence suggesting asymmetries in the effects of policies targeting these gross flows, as well as their interactions with global financial conditions. Overall, our setup provides a useful benchmark for assessing the potential benefits of policy prescriptions that manage separately different types of capital flows.

JEL Codes: F32, F38, H21, E44

Key words: Capital Flow Management Measures, Gross Capital Flows, Collateral Constraints, Pecuniary Externalities, Pigouvian Taxation, Sudden Stops.

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†School of Economic, Political and Policy Sciences, University of Texas at Dallas. Richardson, TX, USA. Email: camilo.granados@utdallas.edu.

‡Economics Department, Organisation for Economic Co-operation and Development. 2 rue André Pascal, 75775, Paris, France. Email: kyongjun.kwak@oecd.org.

1 Introduction

Financial crises—large or small—are frequently associated with abrupt reversals in international capital flows. Since the wave of capital-account liberalization in the 1980s, many emerging market economies (EMEs) have experienced episodes of "sudden stops," prompting the adoption of capital flow management measures (CFMs),[1] especially taxes on inflows (e.g., see Rebucci and Ma, 2019). The global financial crisis (GFC) further intensified the debate, as abundant post-crisis liquidity from advanced economies (AEs) flowed into EMEs, and the IMF subsequently shifted toward acknowledging a role for CFMs as a complementary measure to prevent financial crises and promote stable economic growth (IMF, 2012, 2018).

Parallel to these policy developments, the macro–finance literature has highlighted how collateral constraints and pecuniary externalities can generate excessive foreign borrowing and financial instability.[2] In these models, households do not internalize how their borrowing affects future asset prices and therefore the tightness of the collateral constraint. While this framework provides a normative rationale for prudential controls, most canonical formulations model external borrowing in terms of net capital flows (Jeanne and Korinek, 2010; Bianchi, 2011; Benigno et al., 2013; Bianchi and Mendoza, 2018).

A growing empirical literature, however, documents that the distinction between gross capital inflows and gross outflows matters for both measurement and policy (Forbes and Warnock, 2012; Broner, Didier, Erce and Schmukler, 2013; Cavallo, Izquierdo and León, 2017; Davis and van Wincoop, 2018). As resident outflows from EMEs have grown since the mid-2000s, net flows no longer serve as a sufficient statistic for external financing conditions. Gross flows are more volatile, often move in opposite directions, and respond differently to global financial shocks. These features suggest that models relying solely on net flows may understate or misrepresent the underlying mechanisms that drive crisis dynamics and the role of policy.

Motivated by these developments, we extend a canonical three-period model of collateral constraints and external borrowing to incorporate gross capital flows. Domestic agents borrow from foreign investors (gross inflows) while simultaneously investing in foreign assets (gross outflows). Both domestic and foreign assets can serve as collateral. This modification intro-

[1] Throughout this document, we refer to Capital Flow Management as CFM but also to Capital Flow Management Measures or policies as CFMs. Both terms refer to the same type of regulations.

[2] Two strands of externalities are commonly discussed in the macro–finance literature: pecuniary externalities linked to collateral and asset-price channels, and aggregate-demand externalities that arise under nominal rigidities. The latter provide a complementary rationale for macroprudential policy in New Keynesian environments (e.g., Farhi and Werning, 2016).

duces a meaningful amplification channel: foreign-asset prices become sensitive to domestic borrowing decisions through their interaction with the collateral constraint. This channel provides a stylized, micro-founded mechanism consistent with the international feedback effects—or "spillbacks"—emphasized in recent policy discussions, whereby financial stress in EMEs can propagate to AEs through valuation channels and global portfolio rebalancing.[3] In this context, although our model is not a multi-country general equilibrium framework, the foreign-asset price mechanism accounts for how domestic financial conditions can transmit internationally through asset valuations.

This paper makes three contributions to the literature on capital-flow management under financial frictions. First, we generalize the standard net-flow framework by explicitly separating gross borrowing from gross resident outflows within a tractable model with collateral constraints, preserving the core intuition of pecuniary externalities while making explicit the gross positions that underlie them. Second, we reveal a foreign asset price channel through which borrowing decisions amplify externalities: when the collateral constraint tightens, the resulting rise in marginal utility depresses both domestic and foreign asset prices, magnifying the externality relative to net-flow models. Third, we provide a unified framework for analyzing policy mixes that act on both sides of the balance sheet, showing that policies targeting inflows and outflows can have distinct effects on net worth and crisis risk; in particular, subsidizing resident outflows can raise pre-crisis net worth and mitigate sudden stops without the moral hazard problems associated with bailouts.

We begin by motivating our framework with empirical evidence suggesting that CFMs have distinct effects on disaggregated gross flows and that their effectiveness in mediating global financial conditions differs systematically between inflows and outflows. These patterns establish that the conventional focus on net flows may obscure important channels through which CFMs operate, reinforcing the need for models that explicitly incorporate gross positions.

Building on this, we extend the canonical framework of Jeanne and Korinek (2010) to allow for collateralized gross inflows and outflows. This setup incorporates separate price and

[3] During the 2013–14 "taper tantrum," policy discussions noted that monetary tightenings in AEs could trigger capital outflows, currency pressures, and asset fire sales in EMEs. Recent work shows that the effects can also run in the opposite direction: financial stress in EMEs can feed back into AEs through portfolio rebalancing and valuation channels. Emerging-market shocks account for a sizable share of global asset-return variation (IMF, 2016), and EME-to-AE spillovers amount to roughly one-fifth of AE-to-EME spillovers (Arezki and Liu, 2020). These "spillbacks" operate mainly through valuation and balance-sheet channels (Breitenlechner, Georgiadis and Schumann, 2022) and align with policy analyses emphasizing two-way financial transmission (Agénor and Pereira da Silva, 2022) as well as event-study evidence that EM stress raised AE sovereign risk premia during the taper tantrum (Kang and Suh, 2015).

quantity effects from overseas investment positions, revealing a new source of pecuniary externality driven by fluctuations in foreign-asset prices—which we denote as the foreign-asset channel. We characterize the competitive equilibrium under a binding collateral constraint and compare it with the social planner's allocation. Decentralized agents fail to internalize how their borrowing and investment decisions affect asset prices and thereby the tightness of future collateral constraints. This generates overborrowing in normal times, consistent with net-flow models (e.g., Jeanne and Korinek, 2010; Bianchi, 2011; Bianchi and Mendoza, 2018; Jeanne and Korinek, 2019), but the explicit treatment of gross flows reveals that the externality operates through both domestic and foreign asset prices.

We then explore how this externality can be corrected through Pigouvian taxation on borrowing, providing a stylized representation of CFMs in practice. When setting separate controls, the optimal gross-inflows tax is 1.9%, or 0.6 percentage points (44%) above the 1.3% rate optimal under a net-flow specification. This sizable difference reflects stronger externalities arising from foreign-asset price fluctuations, which are now explicitly accounted for in the collateral constraint. These results suggest that optimal policy calls for stricter interventions when gross-flow effects are modeled explicitly. We also examine an extension with asymmetric collateralizability between domestic and foreign assets—an empirically plausible feature—and show that differential pledgeability can further amplify pecuniary externalities, warranting additional policy adjustments.

Finally, we calibrate the model to international gross flows from a panel of emerging economies and compare crisis probabilities and policy prescriptions under the gross-flow framework relative to its net-flow analog. The numerical results confirm that explicitly accounting for the foreign-asset price channel leads to meaningfully higher optimal taxes and lower crisis probabilities, underscoring the quantitative importance of the additional externality introduced by gross positions.

Related literature. This paper relates to the broad literature on international capital flows, financial crises, and pecuniary externalities. Our framework builds on models in which borrowing decisions interact with collateral constraints through asset prices, generating overborrowing in normal times and sudden stops under adverse shocks. Foundational contributions include Jeanne and Korinek (2010), Bianchi (2011), Benigno et al. (2013), Bianchi and Mendoza (2018), and Jeanne and Korinek (2019), which show how private agents fail to internalize the effect of borrowing on future asset prices, leading to inefficient allocations that can be corrected through Pigouvian taxes. These models typically feature net capital flows and emphasize the domestic-asset price channel; our contribution is to extend this logic to a setting with gross inflows and outflows, introducing an additional foreign-asset price channel.

A second strand of the literature highlights the growing empirical importance of gross flows. Work following Forbes and Warnock (2012) and Broner et al. (2013) documents that gross inflows and outflows are large, volatile, and often offsetting, implying that net flows can obscure key underlying dynamics. Related evidence in Cavallo et al. (2017), Davis and van Wincoop (2018), IMF (2013), and Avdjiev et al. (2022), Chang, Fernández and Martinez (2024) shows that resident outflows have become an important stabilizing margin, especially during global shocks. Caballero and Simsek (2020) and Jeanne and Sandri (2020) introduce theoretical environments featuring gross flows, but with different mechanisms—private reserve accumulation in the latter and fickle global investors in the former. Relative to these papers, we model foreign-asset holdings as active overseas investment and show that allowing such assets to serve as collateral amplifies pecuniary externalities rather than offsetting them.

Our framework also relates to recent work on cross-border financial transmission. Empirical evidence shows that global shocks propagate through valuation effects and portfolio rebalancing, and that financial stress in EMEs can feed back into AEs through these channels (IMF, 2016; Arezki and Liu, 2020; Breitenlechner et al., 2022; Agénor and Pereira da Silva, 2022). The inclusion of foreign-asset prices in the collateral constraint provides a micro-founded mechanism consistent with these valuation-based feedback effects.

Finally, our analysis speaks to the literature on the design of capital-flow management policies. Previous work focuses on optimal taxes on net borrowing (e.g., Jeanne and Korinek, 2010; Bianchi and Mendoza, 2018), while policy discussions emphasize that countries often apply distinct measures to gross inflows and outflows (IMF, 2024). By separately modeling both margins, our framework helps rationalize why inflow taxes and outflow regulations (or subsidies) may have different macro-financial effects, and why an optimal policy mix may require acting on both sides of the balance sheet.

The remainder of this paper proceeds as follows. Section 2 presents empirical evidence on CFMs and disaggregated capital flows. Section 3 develops the theoretical framework. Section 4 provides numerical illustrations. Section 5 concludes.

2 Assessing the Impact Capital of Flow Management Measures on Disaggregated Flows

We have witnessed a substantial increase in gross capital outflows from emerging market economies (EMEs) in recent decades, fundamentally altering the relationship between net and gross capital flows (Avdjiev et al., 2022; Kalemli-Ozcan, 2019). While CFMs are not new, their use has become more common in recent years, particularly since the Global Financial Crisis. These developments raise an important question: Does the efficacy of capital flow management policies depend on whether they target net flows or distinguish explicitly between gross inflows and outflows? We explore this empirically in this section by assessing the effect of CFMs on different measures of capital flows, examining both their direct impact and their potential mediating role in the transmission of changes in global financial conditions.

We employ a local projections framework with distributed lags (Jordà, 2005; Coman and Lloyd, 2022) to gauge the direct and mediating effects of CFM policies on capital flows. Our specification follows Kwak and Granados (2025), adapted to focus on the Global Financial Cycle as the primary external factor. The baseline estimation equation is:

$$\begin{aligned} y_{i,t+h} - y_{i,t-1} = \alpha^h + \beta_1^h GFCyc_t + \beta_2^h CFM_{i,t-1} + \beta_3^h (GFCyc_t \times CFM_{i,t-1}) \\ + \gamma^h X_t + \delta^h X_t^{\text{Global}} + \eta^h \sum_{j=1}^{J} Lag_{i,t-j} + \theta^h GFC_{08,t}^{\text{dummy}} + FE_i^h + \epsilon_{i,t+h}, \end{aligned} \tag{1}$$

where $y_{i,t+h}$ denotes capital flows (measured as a share of GDP) for country i at horizon h (after period t), $GFCyc_t$ is the Global Financial Cycle variable from Miranda-Agrippino and Rey (2020), and $CFM_{i,t-1}$ is a dummy variable indicating the presence of capital flow management measures, constructed from the IMF 2019 Taxonomy of Capital Flow Management Measures data (IMF, 2019).[4] The coefficient β_1^h captures the direct effect of global financial conditions on capital flows, β_2^h measures the direct effect of CFMs implementation, and β_3^h captures the interaction effect—that is, how CFMs mediate the transmission of changes in global financial conditions to domestic capital flows.

The vector X_t includes country-specific controls (output growth, CPI inflation, exchange rate depreciation, and domestic interest rates), while X_t^{Global} contains global controls (changes in the

[4]Miranda-Agrippino and Rey (2020) report this variable at a monthly frequency and with an updated longer data vintage that covers our sample. We take quarterly averages for inclusion in our panel. A plot for this variable is shown in Appendix C.

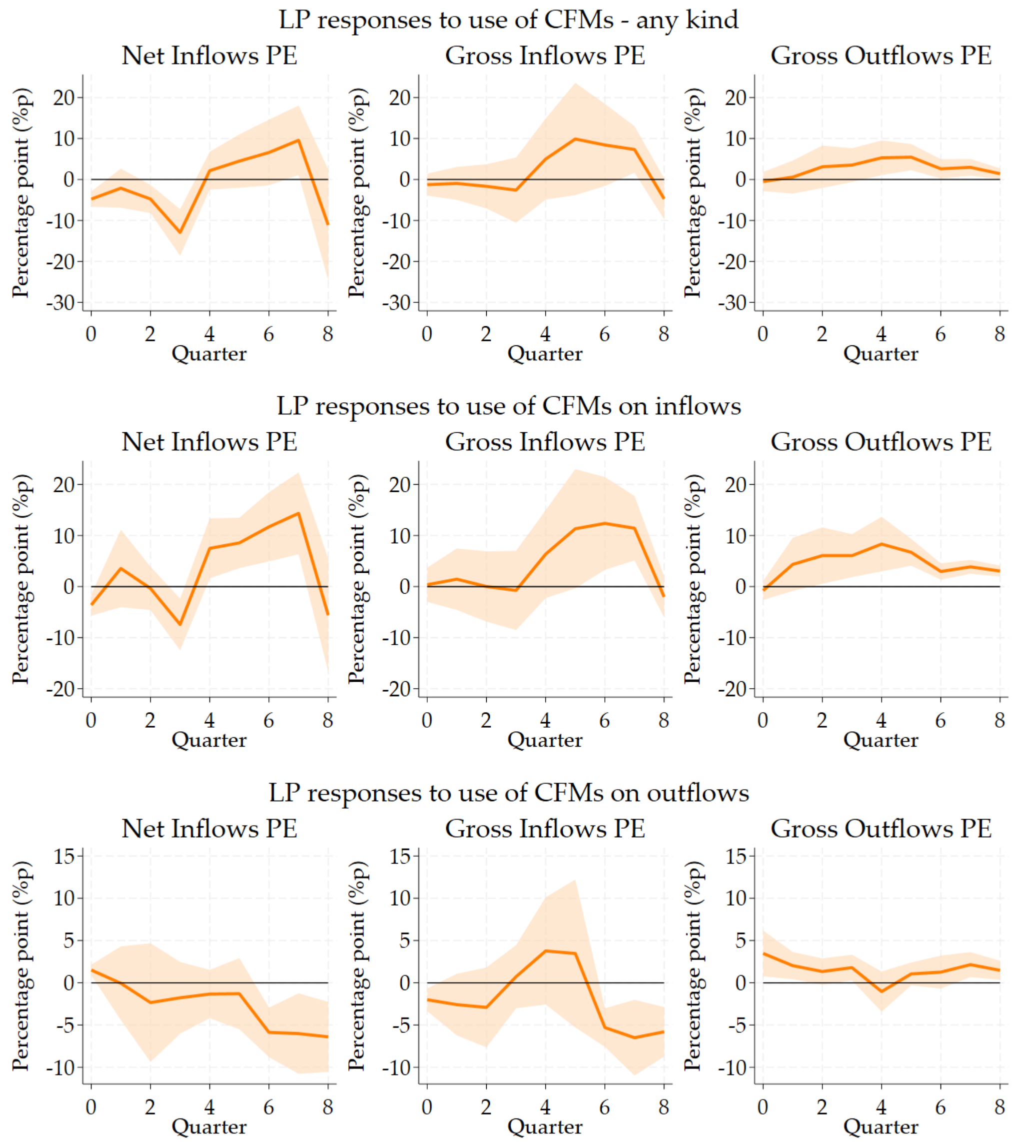
VIX index and US output growth). We include $J = 4$ lags of the dependent and independent variables to capture past dynamics, a post-2008 crisis dummy ($GFC_{08,t}^{\text{dummy}}$) to account for structural changes in international financial markets, and country fixed effects (FE_i^h) to control for time-invariant country characteristics. Our sample covers 13 emerging economies over the period 2000–2018, and standard errors are clustered at the country level.[5]

We estimate Equation (1) separately for net capital flows, gross capital inflows, and gross capital outflows. Our main results focus on portfolio equity flows, as we are interested on risky flows; and within this broader category, portfolio equity represents the riskier component that is most prone to sudden stops (Davis and van Wincoop, 2018; Kwak and Granados, 2025). Additionally, we disaggregate CFM policies into those targeting inflows ($CFM^{in}i, t-1$) and those targeting outflows ($CFM^{out}i, t-1$) to assess whether the type of policy instrument matters for the observed effects. All CFM variables enter the regression with a one-period lag to address potential concerns about contemporaneous reverse causality. Results for total capital flows (aggregating across all investment types or capital flows) are reported in Appendix C.

Figure 1 presents impulse response functions showing the direct effect of CFM policies usage on different measures of portfolio equity flows. Three patterns emerge from the upper panels, which consider all CFM measures jointly. First, CFMs implementation is associated with a reduction in gross capital inflows, consistent with the intended policy objective of managing foreign investment volatility. Second, we observe a decrease in gross capital outflows following CFM implementation. In this case, it is helpful to recall that in the Balance of Payments accounting, outflows (foreign asset acquisitions by residents) are recorded as negative income flows; thus, a positive impulse response indicates reduced outflows. This result suggests that CFMs effectively lower the volatility of short-term investments by domestic agents, complementing their impact on foreign investor behavior. Third, the net effect on capital flows reflects the offsetting of these gross flow movements. Crucially, the impact on net flows is no longer roughly equivalent to the effect on gross inflows, precisely due to the more salient reaction of gross outflows in recent times—a development that distinguishes the current environment from earlier decades when outflows from EMEs were negligible.

[5]The sample includes economies that have employed CFMs during this period according to IMF (2019). Capital flows are constructed following Cavallo et al. (2017) and smoothed as in Forbes and Warnock (2012) by aggregating flows over four quarters and taking year-over-year differences, then scaling by quarterly GDP. The economies included are Australia, Brazil, China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Nigeria, Peru, Russia, Singapore, and Sri Lanka. We report the data sources in the Appendix C.

Figure 1: LP-IRFs: Direct effect of CFM usage on Capital Flows (portfolio equity)



Notes: This figure shows the response of the Portfolio Equity flows (PE) to the CFM dummy variable reported by the IMF taxonomy on capital flows and based on an estimation for Equation (1). We follow the Balance of Payments convention and measure gross outflows as the negative of residents' net acquisition of foreign assets. As a result, an increase in domestic investment abroad appears as a more negative gross outflow (i.e., a downward movement) in the right-hand panels.

The middle and lower panels of Figure 1 reveal important heterogeneity across policy types. CFMs targeting inflows (middle panel) leave gross outflows largely unaffected, particularly in the initial periods, while the effect on gross inflows is less pronounced than might be expected. The reduction in net flows in the upper panel, combined with the absence of increased outflows, suggests that the decline in net flows operates primarily through the inflows component. In contrast, policies targeting outflows (lower panel) leave gross inflows largely unaffected but generate a clearer reduction in gross outflows, which prompts an initial positive response in net flows. These contrasting patterns underscore how the reaction of gross flows may lead to a weaker isomorphism between the dynamics of net flows and gross inflows than is conventionally thought for EMEs.[6] The decomposition highlights that even when CFM measures successfully affect their targeted flow component, the implications for net flows may differ substantially from those for gross flows due to the distinct responses of inflows and outflows, reinforcing the need to analyze these components separately rather than relying solely on net flow measures.

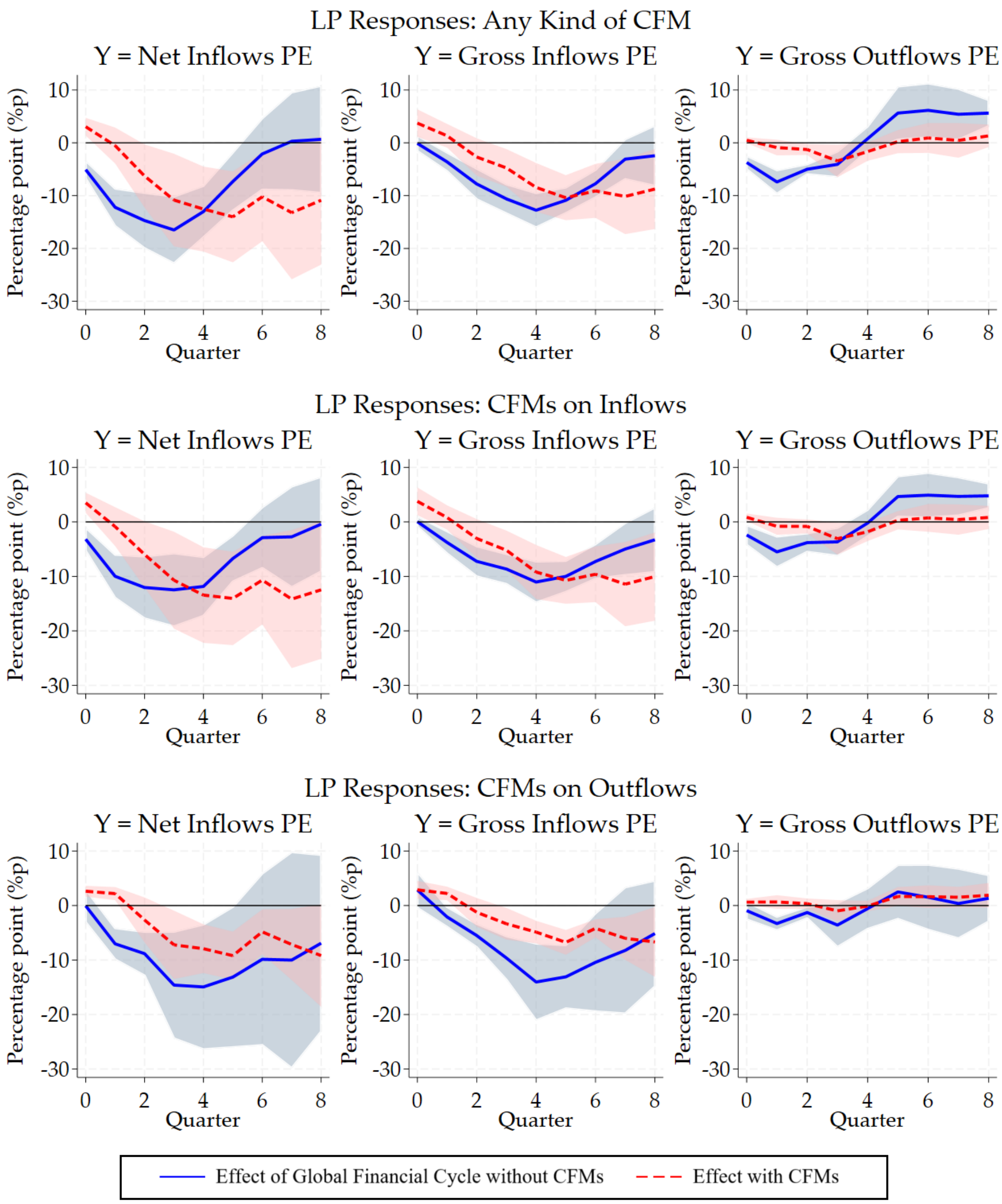
Turning to the mediating role of CFMs in the face of changes in global financial conditions, Figure 2 compares the response of capital flows to an increase in the Global Financial Cycle with and without CFM measures in place. The solid lines show the baseline response without CFMs (β_1^h), while dashed lines incorporate the interaction effect ($\beta_1^h + \beta_3^h$) that captures the modified response when CFMs are active. Two key findings emerge. First, consistent with Rey (2015) and Miranda-Agrippino and Rey (2020), tighter global financial conditions (reflected in higher values of the Global Financial Cycle variable) are associated with capital flow retrenchment—reduced gross inflows. The response of gross outflows shows some initial decrease followed by subsequent dynamics that vary across specifications, reflecting the complex adjustment of domestic investors to changing global conditions. Second, and central to our analysis, CFMs significantly dampen the response to global financial conditions, particularly for gross flows. The dashed lines lie closer to zero than the solid lines, indicating that economies with active CFMs experience smaller fluctuations in both gross inflows and outflows following changes in the Global Financial Cycle.

The insulation effect is most pronounced for gross inflows and outflows considered separately, while the mediating impact on net flows appears more muted. This pattern reflects the fact that CFMs affect both components of net flows—dampening the decrease in inflows and moderating the response of outflows—with effects that partially cancel when aggregated into net measures. Importantly, the degree of insulation varies across policy types (middle and lower panels): CFMs targeting inflows prove more effective at stabilizing gross inflows, while outflow-targeted measures primarily smooth domestic investor behavior. However, both types contribute to overall financial stability by reducing the volatility of their respective targets.[7]

[6] This IRFs interpretation follows the argument in Baumeister (2025) and thus puts stronger weight on the reaction in initial periods with a forecast horizon lower than the lag order of the local projections.

[7] We also report the same exercise for the total capital flows in Appendix C. In that case, however, the picture is significantly more opaque, underscoring the fact that aggregating risky and safe flows may blur the results and

Figure 2: LP-IRFs: Effect of Global Financial Cycle on Capital Flows with and without CFMs (portfolio equity flows)



Notes: This figure shows the response of the Portfolio Equity flows (PE) to the Global Financial Cycle variable with and without CFM measures (dashed line, includes the interaction coefficient). The effect and interaction are based on the estimation of the Equation (1). We follow the Balance of Payments convention and measure gross outflows as the negative of residents' net acquisition of foreign assets. As a result, an increase in domestic investment abroad appears as a more negative gross outflow (i.e., a downward movement) in the right-hand panels.

These empirical patterns carry two important implications analysis in the following sections.

lead to an underestimation of the CFMs effects. We still see some relevant direct and intermediation effects in the aggregate case, even if the argument for strong CFMs effects on long-term investments (such as FDI) is weaker.

First, they confirm that the conventional focus on net capital flows may obscure important policy effects that operate through gross flow channels. The increased importance of gross outflows from EMEs in recent decades (Forbes and Warnock, 2012; Davis and van Wincoop, 2018) implies that models treating net flows as a sufficient statistic for external financing conditions may miss key transmission mechanisms. Second, the effectiveness of CFMs in mediating changes in global financial conditions—particularly for risky portfolio flows—suggests that these policies can meaningfully influence the probability and severity of financial crises. We explore these mechanisms formally in the theoretical model developed in Section 3, where we show how disaggregating gross flows alters the optimal design of capital flow management policies under collateral constraints. Additionally, in Section 4 we compare the policy prescriptions and economic outcomes between policies targeting gross flows relative to those focused on net flows.

3 The Model

Our model consists of an environment similar to Jeanne and Korinek (2010) but extended to explicitly depict gross investment flows. Here, our aim is to retain a relatively simple setup while still allowing for a more nuanced financial flows structure. We assume a small open economy with identical domestic agents (with a mass normalized to one) in a one-good world. The domestic agent borrows from foreign investors in period 0 and make a debt repayment in periods 1 and 2. In period 1, the agents may face a collateral constraint when rolling over debt. For example, if the domestic agent borrows too much (overborrow) and a high volume of capital inflows moves into the economy in period 0, then the substantial corresponding amount of repayment should be returned to foreigners in periods 1 and 2. In addition, we assume endowment shocks that can potentially tighten the collateral constraint to the point that it becomes binding, thereby triggering a sudden reversal of capital flows or a sudden stop.

The domestic agent initially owns one unit of domestic assets, and the price of domestic assets in period t is denoted by P_t. The domestic assets market is assumed to be perfectly competitive but only accessible to the domestic agent. The rationale behind the restriction that foreign investors cannot buy or sell domestic assets is that foreigners may have relative disadvantage in managing them compared to domestic agents who benefit from the ownership of these assets (Jeanne and Korinek, 2019). We make an additional assumption that the domestic agent not only borrows from foreigners but also invests in foreign asset markets. The resident's overseas investment can be rationalized, for example, by an international asset diversification motive.[8] We assume that the domestic agent does not own any foreign asset in period 0, and the price of foreign asset in period t is denoted by Q_t. The foreign assets market is assumed to be accessible to the domestic agent.[9]

An endowment of income e is revealed and obtained in period 1. The long-term, two-period investment on domestic projects yields a fixed return y that materializes in period 2. We assume that only y (but not e) can serve as collateral on borrowing from foreigners in period 1. In this context, a low realization of the endowment shock e may tighten the collateral constraint trigger a sudden stops of capital. The agents' utility lifestream is given by Equation (2) after implementing a unitary discount factor and a linear terminal utility as simplifications. On the other hand, $u(\cdot)$ can correspond to any standard utility function. This preferences' structure allows us to fix the period-2 marginal utility of consumption to one. The normalized riskless world interest rate is set at zero. Given these assumptions, the first-best level of consumption must be the same in periods 0 and 1, which we denote by c^{FB}, and it follows that it generates a unitary marginal utility of consumption $u'(c^{FB}) = 1$. The representative domestic agent maximizes his own lifetime utility subject to the budget constraints in periods 0 to 2 and the collateral constraint in period 1 as follows:

$$\max_{c_0, c_1, c_2, \gamma_1, \gamma_2, \theta_1, \theta_2} \quad U = u(c_0) + u(c_1) + c_2, \tag{2}$$

$$c_0 + \gamma_1 Q_0 = d_1^i + (1 - \theta_1) P_0, \tag{3}$$

$$c_1 + d_1^i = e + d_2^i + (\theta_1 - \theta_2) P_1 + (\gamma_1 - \gamma_2) Q_1, \tag{4}$$

$$c_2 + d_2^i = \theta_2 y + \gamma_2 Q_2, \tag{5}$$

$$d_2^i \leq \theta_1 P_1 + \gamma_1 Q_1. \tag{6}$$

d_t^i is the debt to be repaid at the beginning of period t and this amount corresponds to gross capital inflows in period $t-1$ (hence the superscript 'i').[10] θ_t is the quantity of the domestic collateral held by the domestic agent at the beginning of period t.[11]

[8] As stated in Caballero and Simsek (2020), besides the extensive literature on capital flows and international risk sharing that provides theoretical foundations for cross-border investment by domestic agents, allowing for international investment diversification can also serve other purposes, such as providing valuable liquidity to local banks during fire sales.

[9] This assumption is consistent with the increased ability of EME residents to invest in AE financial markets as financial openness has risen over time (Lane and Milesi-Ferretti, 2007; Kalemli-Ozcan, 2019).

[10] Similarly, $d_t^o = \gamma_t Q_{t-1}$ is the amount of gross capital outflows, and the corresponding net capital inflows in period $t-1$ can be denoted as $d_t \equiv d_t^i - d_t^o$. Notice that by using a notation in terms of net capital flows the budget constraints are analogous to those in previous studies such as Jeanne and Korinek (2010).

[11] Since the domestic collateral asset cannot be sold to foreigners, θ_t must be equal to 1 in a symmetric equilibrium, which we assume and focus on in our numerical illustration

On the other hand, γ_t is the quantity of the foreign asset held by the domestic agent at the beginning of period t. We assume this foreign asset is purchased by the domestic agent in period $t-1$ at the price Q_{t-1}. Therefore, d_t^o is the amount of gross capital outflows at the end of the period $t-1$, and equals $\gamma_t Q_{t-1}$. Since foreign assets can be sold to domestic agents, there is no restriction that γ_t must be one in a symmetric equilibrium. The domestic agent faces the collateral constraint shown in Equation (6), which is micro-founded by the assumption that, in the event of default, the foreign agent can seize the asset pledged as collateral and resell it in the domestic asset market at price P_t. We make an additional assumption that the foreign asset held by the domestic agent can also be pledged as collateral, and analogously, foreigners can seize the foreign asset and liquidate it in the international asset market at price Q_t.[12]

3.1 Competitive Equilibrium (Laissez-faire)

The competitive (laissez-faire) equilibrium is solved using backward induction. A decentralized domestic agent makes decisions in periods 0 and 1 by determining the amount of borrowing (gross capital inflows), domestic asset holdings, and foreign asset holdings (gross capital outflows) for each period. The net worth is denoted by m_1 and equals the endowment, minus debt (gross inflows), plus foreign assets (gross outflows), i.e., $m_1 \equiv e - d_1^i + \gamma_1 Q_1 \equiv m_1^i + \gamma_1 Q_1$. This variable is taken as given by the domestic agent who solves for the period-1 equilibrium as follows:[13]

$$V_{ce}(m_1) = \max_{d_2^i,\, \gamma_2,\, \theta_2, c_1} u(c_1) + c_2 + \lambda^{ce}\left(\theta_1 P_1 + \gamma_1 Q_1 - d_2^i\right), \tag{7}$$
$$\text{s.t.} \quad (4), (5),$$

where λ^{ce} is the shadow cost of the collateral constraint. The first-order condition (FOC) with respect to θ_2 gives an asset pricing equation for the domestic asset, $P_1 = y/u'(c_1)$. This implies that the domestic asset price in period 1 equals the expected return of the domestic asset times the stochastic discount factor, where the marginal utility of consumption in period 2 is equal to 1 due to the assumed utility function. Similarly, the FOC with respect to γ_2 provides a foreign asset pricing equation, $Q_1 = Q_2/u'(c_1)$. Thus, the foreign asset price in period 1 is determined as the expected period-2 price times the same discount factor.[14] Finally, the FOC

[12]The collateralizability of assets can be different between domestic and foreign assets. This asymmetry is analyzed in detail in an extension in Section 3.5.

[13]Note that the value of holding the foreign asset is evaluated with the current period-1 price, Q_1, not Q_0.

[14]Although the domestic country is a small open economy, the domestic agent's overseas investment determines the price of foreign assets in this model, which may not be the case empirically. It is more reasonable to assume that the foreign asset price is partially, not solely, affected by domestic investors. To reflect this concern, we

for d_2^i implies $u'(c_1) = 1 + \lambda^{ce}$, where we can see that if the financial constraint doesn't bind (i.e., $\lambda^{ce} = 0$), $c_1 = c^{FB}$, and thus, $P_1 = y$ and $Q_1 = Q_2$.[15] Now, in what follows, we focus on the constrained equilibrium where the collateral constraint binds (i.e., $\lambda^{ce} > 0$). By substituting out $d_2^i = \theta_1 P_1 + \gamma_1 Q_1$, the budget constraint in period 1 becomes:

$$c_1 = m_1 + (2\theta_1 - \theta_2)P_1 + (\gamma_1 - \gamma_2)Q_1, \tag{8}$$

where, as before, $m_1 \equiv e - d_1^i + \gamma_1 Q_1$. In the symmetric equilibrium case, which we consider for simplicity, $\theta_t = 1$. Thus, the equations above can be rewritten by substituting the domestic and foreign asset pricing equations:[16]

$$c_1 = m_1 + \frac{y + (\gamma_1 - \gamma_2)Q_2}{u'(c_1)}. \tag{9}$$

This is consistent with the simplified notion that an environment with disaggregated gross flows is structurally analogous or even isomorphic to one with net capital flows. However, we argue that this equivalence holds only in the specific case of full reinvestment ($\gamma_1 = \gamma_2$), whereas in the more general case we consider, the foreign asset price plays a distinctive role in shaping the potential pecuniary externalities of borrowing.

Hereafter, we focus on the more general case where γ_1 may differ from γ_2 as in Equation (9). As c_1 increases, the left-hand side of Equation (9) increases linearly, while the right-hand side does so non-linearly (as a factor of $u'(c)$), which could be troublesome and lead to equilibria multiplicity issues; to circumvent this, we assume that the slope on the right-hand side is lower than one (See Jeanne and Korinek, 2010). This restricts the range of values of the variables to a region where both sides of the equation intersect only once (without affecting the validity and generality of the setup).[17] In this setup, a small decrease in the endowment e in period 1

can incorporate some exogenous parameters (e.g., an EME's share in AE's asset market or financial openness) that restrict the range of γ_t, thus weakening the impact on the foreign asset price. Or, we can also incorporate an foreign asset endogenous premium. In this setup, if domestic agents increase overseas investment, due to the ensuing high demand, they are charged a premium ($\tilde{Q} = \bar{Q} +$ premium). This setup aligns with the basic premise that a small, open economy takes world prices as given and does not affect them. While keeping in mind this limitation in our baseline, we still assume that foreign asset pricing depends mainly on the resident's overseas investment for the sake of simplicity. This may be analogous to "semi-small" open economy models in the international trade literature, with monopolistically competitive domestic producers (e.g., Justiniano and Preston, 2010), or the finance literature, which introduces an endogenous risk premium (e.g., Lubik, 2007).

[15] According to Jeanne and Korinek (2010), this can happen "if and only if the value of collateral (or net worth) is high enough to cover period-2 debt" (p. 404).

[16] One point worth noting here is that in the knife-edge case that $\gamma_1 = \gamma_2$, i.e., when the domestic agent invests in foreign assets and re-invests them all in period 1 (and holds them until period 2), the Equation (9) reduces exactly to the same expression as in Jeanne and Korinek (2010), i.e., $c_1 = m_1 + y/u'(c_1)$.

[17] $(y + (\gamma_1 - \gamma_2)Q_2)\,\frac{d(1/u'(c))}{dc} < 1$. Since $Q_2 > 0$, a larger value of $(\gamma_1 - \gamma_2)$ increases the slope of the right-hand

will tighten the collateral constraint, thereby reducing consumption in period 1. This means that the current marginal utility of consumption in period 1 increases relative to the next period, which in turn will affect both domestic and foreign asset prices. The domestic agent becomes less likely to invest since the agent highly values (current) period-1 consumption compared to period 2. Thus, both asset prices in period 1, $P_1 = y/u'(c_1)$ and $Q_1 = Q_2/u'(c_1)$, will decrease, ultimately leading to a tightening of the collateral constraint. This is the standard "debt-deflation" mechanism in which tighter collateral raises the current marginal utility, depresses asset prices, and further tightens the constraint (Fisher, 1933; Kiyotaki and Moore, 1997; Bernanke, Gertler and Gilchrist, 1999; Jeanne and Korinek, 2010).

In period 0, anticipating the period-1 equilibrium, the representative domestic agent solves:

$$L_{ce} = \max_{d_1^i,\, \gamma_1,\, \theta_1 | \bar{P}_1,\, \bar{Q}_1} \; u(c_0) + E_0 V_{ce}(m_1) \quad \text{s.t.} \quad (7), \tag{10}$$

where m_1 is decided in period 1, and thus prices for that period are taken as given in the constraint – we denote this with upper bars as $\bar{P}_1$ and $\bar{Q}_1$. One essential feature of models of pecuniary externalities is that decentralized agents treat asset prices as given. Following this, we also assume that the agent does not internalize the impact of his period 0 borrowing decision or overseas investment on the collateral constraint in period 1 via changes in asset prices. The FOC with respect to d_1^i equalizes the (expected) marginal utility of consumption across periods ($u'(c_0) = E_0[u'(c_1)]$) and determines the period-0 equilibrium borrowing, d_1^i. Since the left-hand side decreases and the right-hand side increases in d_1^i, a unique solution can be derived (without further assumptions). The FOCs for θ_1 and γ_1 provide the main asset pricing equations.[18] As already noted, by assumption $\theta_t = 1$ in equilibrium, implying that domestic agents always invest in long-term domestic projects and hold them until period 2.

3.2 Social Planner Allocation

A constrained social planner faces the same lifetime utility function and constraints as decentralized domestic agents. However, by contrast, she internalizes the endogeneity of the asset pricing equations to her allocation choices. That is, she will consider the impact of borrowing—or assets' holdings—decisions in period 0 on the collateral constraint in the next period stemming from changes in asset prices. We also solve the social planner's problem by backward induction. To begin, we can notice that—as there is no role for collateral in the ter-

side, making the uniqueness condition more stringent relative to the case with $\gamma_1 = \gamma_2$.

[18] $P_0 = E_0\left[\left(2u'(c_1) + \lambda^{ce}\right)\bar{P}_1\right]/u'(c_0),\; Q_0 = E_0\left[\left(2u'(c_1) + \lambda^{ce}\right)\bar{Q}_1\right]/u'(c_0).$

minal period—the problem faced by the planner in period 1 is analogous to that of the private agents (in the competitive equilibrium), and thus, she will choose the same allocation for this period ($t = 1$). Then, denoting λ^{sp} as the shadow cost of the collateral constraint for the social planner, the FOC with respect to d_2^i in period 1 can be expressed as $u'(c_1) = 1 + \lambda^{sp}$. By drawing from the previous (private equilibrium) results, we can express the period-1 consumption and asset prices in reduced form, as increasing functions of net worth—$c(m_1)$, $P_1(m_1)$ and $Q_1(m_1)$. Anticipating this period-1 equilibrium, the social planner solves the following problem in period 0:

$$L_{sp} = \max_{d_1^i, \gamma_1, \theta_1} u(c_0) + E_0 V_{sp}(m_1) \quad \text{s.t.} \quad (3)\text{–}(5), \tag{11}$$

where V_{sp} is defined along the lines of (7) but with an explicit internalization of the effect of m_1 on c_1, P_1, and Q_1—i.e., for her, these quantities are instead gauged as functions $c(m_1)$, $P_1(m_1)$, and $Q_1(m_1)$ with $P_1(m_1) = y/u'(c(m_1))$ and $Q_1(m_1) = Q_2/u'(c(m_1))$ as determined in the FOC with respect to the assets' holdings. This adjustment is crucial and contrasts with the features of the private agents decisions. As a result, the FOC for d_1^i yields $u'(c_0) = E_0 \left[u'(c_1) + \lambda^{sp} \left\{\theta_1 P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right]$, and since both asset prices increase with the net worth (i.e., $P_1', Q_1' > 0$), and the collateral constraint binds ($\lambda^{sp} > 0$), the social planner chooses a lower consumption and borrowing allocation in period 0 relative to the decentralized economy. In other words, private agents who do not internalize the impact of their indebtedness will overborrow in period 0 (i.e., during normal times). This aligns with the standard overborrowing result found in the literature employing net-flow models with pecuniary externalities (e.g., Bianchi, 2011; Bianchi and Mendoza, 2018; Jeanne and Korinek, 2019), but here it is obtained within a framework that explicitly accounts for gross flows.

Furthermore, the FOC with respect to d_1^i—which determines the social planner's allocation—depends on both domestic and foreign asset prices. This creates an additional source of pecuniary externalities operating through the foreign-asset price. Intuitively, when a decentralized agent borrows more in period 0, the associated repayment in period 1 reduces consumption and raises the marginal utility of consumption, lowering the agent's willingness to hold both domestic and foreign assets. This depresses both asset prices, tightening the collateral constraint.

This additional foreign-asset price channel can be interpreted as helping to micro-found the type of international feedback mechanisms. When EMEs residents liquidate foreign safe assets under stress, the resulting decline in the foreign-asset price $Q_1(m_1)$ further tightens the domestic collateral constraint and can propagate back into AEs' financial conditions through global valuation and balance-sheet channels. This is consistent with empirical evidence documenting that emerging-market shocks account for a substantial share of global asset-return variation (IMF, 2016) and that EMEs-to-AEs spillovers have strengthened over time (Arezki and Liu, 2020). In this way, our framework clarifies how gross positions can generate cross-border pecuniary externalities that are absent in net-flow models.

3.3 Pigouvian Tax on Gross Capital Inflows (Borrowing)

We now introduce a Pigouvian taxation framework on foreign borrowing to implement the social planner's allocation in a private equilibrium setting and to connect the theoretical model to the empirical analysis on CFMs presented earlier in Section 2. Externalities arising from borrowing decisions can be corrected through such a tax, as widely established in models focusing on net capital flows (e.g., Jeanne and Korinek, 2010; Bianchi and Mendoza, 2018). Following this approach, we represent CFMs in the model as a state-contingent tax on external borrowing.[19] This "variable tax" formulation is commonly used because it provides analytical tractability while allowing the intensity of intervention to adjust with financial conditions. Moreover, its implications extend naturally to other policy instruments (e.g., Davis, Fujiwara, Huang and Wang, 2021). This flexible specification provides a unified interpretation of diverse instruments—ranging from price-based to quantity-based controls—within the same analytical framework. In what follows, we first study taxation on borrowing, and subsequently a tax (or subsidy) on overseas investment.

The optimal level of borrowing (gross inflows) can be implemented in a decentralized economy by introducing a tax rate τ_1^i on period-0 borrowing d_1^i, with revenues rebated as a lump-sum transfer. Recall that d_1^i denotes the debt to be repaid at the beginning of period 1, which corresponds to the gross inflows received in period 0. The tax is levied when these inflows enter the domestic economy, thereby reducing the borrowing undertaken by domestic agents. Because the endowment shock is realized only in the following period, this timing implies that the tax operates as an ex-ante policy in normal times. The resulting budget constraints for periods 0 and 1 are therefore modified as follows:

$$c_0 + \gamma_1 Q_0 = (1 - \tau_1^i) d_1^i + (1 - \theta_1) P_0, \tag{12}$$

$$c_1 + d_1^i \quad = e + d_2^i + (\theta_1 - \theta_2) P_1 + (\gamma_1 - \gamma_2) Q_1 + \text{Transfer}. \tag{13}$$

[19] In practice, CFMs encompass a range of operational instruments, including price-based measures (e.g., taxes or levies on inflows and outflows), administrative or quantity-based controls (e.g., limits on foreign borrowing or nonresident holdings), and differential reserve requirements on foreign-currency liabilities (see IMF, 2024).

Anticipating the same period-1 equilibrium, the representative domestic agent under the Pigouvian tax scheme solves the following problem in period 0:

$$L_{ce} = \max_{d_1^i,\,\gamma_1,\,\theta_1} u\left((1-\tau_1^i)d_1^i + (1-\theta_1)P_0 - \gamma_1 Q_0\right) + E_0 V_{ce}(m_1), \tag{14}$$

$$\text{where} \quad V_{ce}(m_1) = \max_{d_2^i,\,\gamma_2,\,\theta_2} u(c_1) + c_2 + \lambda^{ce}\left(\theta_1\bar{P}_1 + \gamma_1\bar{Q}_1 - d_2^i\right) \quad \text{s.t.} \quad (13),(5).$$

The first-order condition with respect to d_1^i now includes the tax, modifying the standard intertemporal Euler equation, $u'(c_0) = E_0[u'(c_1)]/(1-\tau_1^i)$. The optimal tax can then be pinned down by equating this tax-distorted condition to the social planner's counterpart:

$$u'(c_0) = E_0[u'(c_1)](1-\tau_1^i) = E_0[u'(c_1) + \lambda^{sp}\{\theta_1 P_1'(m_1) + \gamma_1 Q_1'(m_1)\}].$$

The resulting optimal tax rate on borrowing is:[20]

$$\tau_1^{i,*} = \frac{E_0\left[\lambda^{sp}\left\{\theta_1 P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right]}{E_0\left[u'(c_1) + \lambda^{sp}\left\{\theta_1 P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right]} \tag{15}$$

In Section 4, we use a numerical exercise to illustrate how this policy compares with a setup that only focuses on taxing the net inflows.

3.4 Taxation on Gross Capital Outflows (Overseas Investment)

In addition to a tax on gross capital inflows (borrowing), one might consider a tax (or subsidy) on gross capital outflows (foreign investments by domestic agents).[21] Analogously to the case of inflows, we assume a tax is levied when gross outflows enter the foreign asset market in period 0 and increase the amount of expenditure on overseas investment for domestic agents from $\gamma_1 Q_0$ to $(1+\tau_1^o)\gamma_1 Q_0$.[22] With this, a tax rate τ_1^o on period-0 overseas investment $d_1^o(=\gamma_1 Q_0)$ can be included in the budget constraint for the initial period along with the tax on borrowing

[20] If we abstract from foreign assets (i.e., $\gamma_1 Q_1'(m_1) = 0$), the optimal tax rate in Equation (15) coincides with that in Jeanne and Korinek (2010): $\tau = \frac{E_0[\lambda^{sp} P_1'(m_1)]}{E_0[u'(c_1)]}$, where $1+\tau \equiv 1/(1-\tau^i)$. Hence, $\tau^{i,*} = \frac{E_0[\lambda^{sp} P_1'(m_1)]}{E_0[u'(c_1)+\lambda^{sp} P_1'(m_1)]}$.

[21] Domestic countries have policy tools to control its domestic residents' overseas investment. Those regulations that deter the overseas investment can be replaced with tax on gross capital outflows, or in contrast, policy encouragements can be modeled as subsidies (negative tax).

[22] We could also consider alternative timing of taxation on gross outflows. Since domestic tax authorities can impose a tax on domestic residents' earnings from foreign asset market when returned, period 1 (ex-post) taxation can also be a feasible way to tax gross outflows. Moreover, since foreign asset prices in periods 0 and 1 are different, the timing of taxation on gross outflows could be a relevant factor in making an investment decision.

(τ_1^i) as follows:

$$c_0 + (1+\tau_1^o)\gamma_1 Q_0 = (1-\tau_1^i)d_1^i + (1-\theta_1)P_0, \tag{16}$$

and the period-1 constraint will be identical to Equation (13), but the rebate now incorporates fiscal revenue from both instruments.

In period 0, the domestic agent solves the problem below:

$$L_{ce} = \max_{d_1^i,\,\gamma_1,\,\theta_1} u\left((1-\tau_1^i)d_1^i + (1-\theta_1)P_0 - (1+\tau_1^o)\gamma_1 Q_0\right) + E_0 V_{ce}(m_1), \tag{17}$$

$$\text{where} \quad V_{ce}(m_1) = \max_{d_2^i,\,\gamma_2,\,\theta_2} u(c_1) + c_2 + \lambda^{ce}\left(\theta_1 \bar{P}_1 + \gamma_1 \bar{Q}_1 - d_2^i\right) \quad \text{s.t.} \quad (13), (5).$$

Introducing a tax on outflows does not alter the first-order condition with respect to d_1^i, which remains identical to the single-instrument case: $u'(c_0) = E_0[u'(c_1)]/(1-\tau_1^i)$. Thus, although the tax on gross outflows reduces overseas investment (as expected), it does not affect gross inflows in this setup.[23] The resulting decrease in gross outflows lowers net worth in period 1, potentially triggering a downward spiral through the collateral constraint. Conversely, a subsidy can raise net worth in period 1, operating in the opposite direction. Hence, a subsidy on gross outflows, combined with a tax on gross inflows, can effectively correct pecuniary externalities, implying that a country may optimally employ two separate CFMs on inflows and outflows.

This type of policy intervention, which raises net worth in period 1, has also been discussed in the literature—for example, by Jeanne and Korinek (2010), who analyze bailouts during crises, noting that these policies are akin to instruments that transfer resources to constrained agents. However, they raise important concerns: their implementation may be infeasible due to limited fiscal resources, and they can generate moral-hazard distortions, as agents increase borrowing in anticipation of being insured by future bailouts. By contrast, an ex-ante subsidy on gross outflows in normal times can operate in a similar way without raising moral-hazard concerns.[24]

Our results are also closely related to Jeanne and Sandri (2020), who develop a model with

[23] The foreign asset price in period 0 is affected by the tax on outflows: $Q_0 = E_0\left[(2u'(c_1) + \lambda^{ce})\bar{Q}_1\right] / \left[(1+\tau_1^o)u'(c_0)\right]$. An increase in τ_1^o therefore reduces Q_0. Even if γ_1 is fixed, the value of gross capital outflows, $\gamma_1 Q_0$, falls accordingly, while the total tax-inclusive expenditure on overseas investment, $(1+\tau_1^o)\gamma_1 Q_0$, remains unchanged.

[24] The concern over resources for subsidization remains. However, this issue can be alleviated by also using Pigouvian taxation on gross inflows. This may raise distributional issues between borrowers (taxpayers) and investors (subsidy recipients), which is not the case in this model with a representative domestic agent.

gross capital flows but where foreign assets consist mainly of foreign reserves, as opposed to active overseas investments as in our study. In their framework, the accumulation of private reserves raises domestic asset prices and relaxes collateral constraints during crises. However, because individual agents do not internalize these positive externalities, they hold too few foreign reserves, implying underborrowing in normal times. In contrast, in our model, residents' overseas investments generate positive externalities that partially offset the negative externalities from borrowing, yet the net effect still leads to overborrowing in normal times.[25]

3.5 Asymmetry of Collateralizability

So far, we have assumed that both domestic and foreign assets can serve as collateral. Similarly, our baseline implicitly assumes that their role as collateral is the same as long as they have the same market value. In reality, one type of asset can possess hidden perks compared to another. For instance, suppose a country holds two types of foreign assets that have the same market value—one being the export proceeds payable under specific sales contracts and the other US Treasury Bills; then even if the assets have the same market value, their pledgeability as collateral can differ. Foreign creditors would prefer a US Treasury Bill since it is safe, highly tradable, and easily seized and sold in case of default. Similarly, domestic assets may also differ in their pledgeability depending on type. Thus, in general, there can be an asymmetry in the "relative" ability of domestic and foreign assets as collateral that could be incorporated into the model.

In this spirit, we extend the model by adjusting the collateral constraint to allow for this asymmetry between domestic and foreign assets. In contrast with net flows setups, the asymmetry can be incorporated explicitly in our environment with separate gross flows. Specifically, we add pledgeability parameters κ^d and κ^f for domestic and foreign assets, respectively, to the collateral constraint. With this, the collateral constraint—previously in Equation (6)— now becomes:

$$d_2^i \leq \kappa^d \theta_1 P_1 + \kappa^f \gamma_1 Q_1, \tag{18}$$

[25] According to Jeanne and Sandri (2020)'s model, public foreign reserves can also work to correct positive externalities. Public foreign reserves as well as currency swaps can complement or substitute the subsidy on overseas investment by relaxing collateral constraints in a crisis. A related underborrowing result is discussed in Schmitt-Grohé and Uribe (2021) who show an open-economy collateral-constraint model where, under feasible calibrations, agents may borrow less than the socially optimal level due to precautionary motives and the presence of multiple equilibria.

If we impose $\kappa^d = \kappa^f \equiv \tilde{\kappa}$, the collateral constraint becomes $d_2^i \leq \tilde{\kappa}(\theta_1 P_1 + \gamma_1 Q_1)$, indicating partial pledgeability of both domestic and foreign collateral assets. Partial pledgeability of assets is a standard feature in the literature (e.g., Benigno, Chen, Otrok, Rebucci and Young, 2013; Fornaro, 2015; Jeanne and Sandri, 2020). Allowing $\kappa^d \neq \kappa^f$ further generalizes this idea to account for asymmetry in the collateralizability of domestic and foreign assets.[26] To simplify further, and without loss of generality, we normalize κ^d to one, so that $\kappa^f \equiv \kappa$ captures the relative degree of asymmetry reflected in the collateral constraint as follows:

$$d_2^i \leq \theta_1 P_1 + \kappa \gamma_1 Q_1 \tag{19}$$

where κ is assumed to be greater than 0. $\kappa = 1$ (i.e., no asymmetry) provides the same collateral constraint as in our baseline model. If κ is less than 1, foreign assets are less valuable to foreign creditors as collateral compared to domestic assets (e.g., export proceeds payable under the sales contract). If κ is greater than 1, foreign assets are worth more to foreign creditors as collateral compared to domestic assets (e.g., US Treasury Bills). Other than this new collateral constraint, the rest of the model remains the same as in our baseline.

With the new collateral constraint in period 1, the equilibrium level of consumption is now:[27]

$$c_1 = m_1 + \frac{y + (\kappa\gamma_1 - \gamma_2)\, Q_2}{u'(c_1)} \tag{20}$$

To understand further the role of κ, we can notice that the implied slope of the right-hand side of Equation (20) with respect to consumption increases with the relative pleadgeability and if $\kappa > 1$, we would have that the increase in consumption in equilibrium after an endowment shock would be larger than in our baseline with symmetric assets in the collateral. Intuitively, when foreign assets gain a better ability as collateral, the collateral constraint is loosened, and consumption can be increased.

As before, we consider the Euler equation following from the optimality condition with respect to d_1^i. However, now the consumption in period 1 reflects the relative pledgeability,

$$c_1 = (e - d_1^i) + (2\theta_1 - \theta_2)P_1 + ((1+\kappa)\gamma_1 - \gamma_2)Q_1,$$

As before, after substituting the consumption terms into the optimality condition, we find that

[26] Bianchi (2011) also introduces separate parameters, κ^T and κ^N, for tradable and non-tradable incomes in the collateral constraint.

[27] The derivation is provided in Appendix A.

both sides of the expression decrease in d_1^i, allowing us to uniquely determine the equilibrium level of borrowing. Moreover, we can obtain that the borrowing increases with κ.[28] Implying that the agents perceived increases in the relative pledgeability (κ) as indicative of looser financial conditions and act by increasing borrowing in period 0.

Similarly, the social planner condition associated with this asymmetric case is:

$$u'(c_0) = E_0 \left[u'(c_1) + \lambda^{sp} \left\{ \theta_1 P_1'(m_1) + \kappa \gamma_1 Q_1'(m_1) \right\} \right]. \tag{21}$$

From the right-hand side, it follows that with higher relative pledgeability ($\kappa > 1$), the planner implements a lower consumption profile relative to the baseline setup with symmetric collateral assets. This result can be interpreted as an increase in the externality effects from borrowing, which prompt the social planner to impose stricter restrictions (a Pigouvian tax) on borrowing. As a consequence, the optimal tax rate on borrowing ($\tau_1^{i,*}$) is an increasing function of κ, as shown below.[29]

$$\tau_1^{i,*} = \frac{E_0 \left[\lambda^{sp} \left\{ \theta_1 P_1'(m_1) + \kappa \gamma_1 Q_1'(m_1) \right\} \right]}{E_0 \left[u'(c_1) + \lambda^{sp} \left\{ \theta_1 P_1'(m_1) + \kappa \gamma_1 Q_1'(m_1) \right\} \right]} \tag{22}$$

4 Numerical Illustration

To assess the quantitative relevance of the externality, we solve the model numerically under the calibration detailed in Appendix B. We adopt a log-utility specification with uniformly distributed endowment shocks on $[\bar{e} - \varepsilon, \bar{e} + \varepsilon]$ and parameter values $\bar{e} = 1.3$, $y = 0.8$ as in Jeanne and Korinek (2010). For tractability, we assume $\gamma_1 = \gamma_2$ and $Q_2 = Q_0 = y$, which eliminates the search-for-yield motive of domestic agents.

The quantity of foreign assets, $\gamma_1 = 0.03$, is estimated from the model's equilibrium uniqueness condition and the average ratio of gross capital outflows to GDP between 2011 and 2023 for 36 economies employing capital flow management measures.[30] We focus on the range $0.1 \leq \varepsilon \leq 0.28$, where the collateral constraint binds with positive probability.[31] The

[28] The optimal level of d_1^i satisfies the following condition: $u'(d_1^i + (1 - \theta_1)P_0 - \gamma_1 Q_0) = E_0 \left[u'((e - d_1^i) + (2\theta_1 - \theta_2)P_1 + ((1+\kappa)\gamma_1 - \gamma_2)Q_1) \right]$. Thus, κ is positively related to d_1^i.

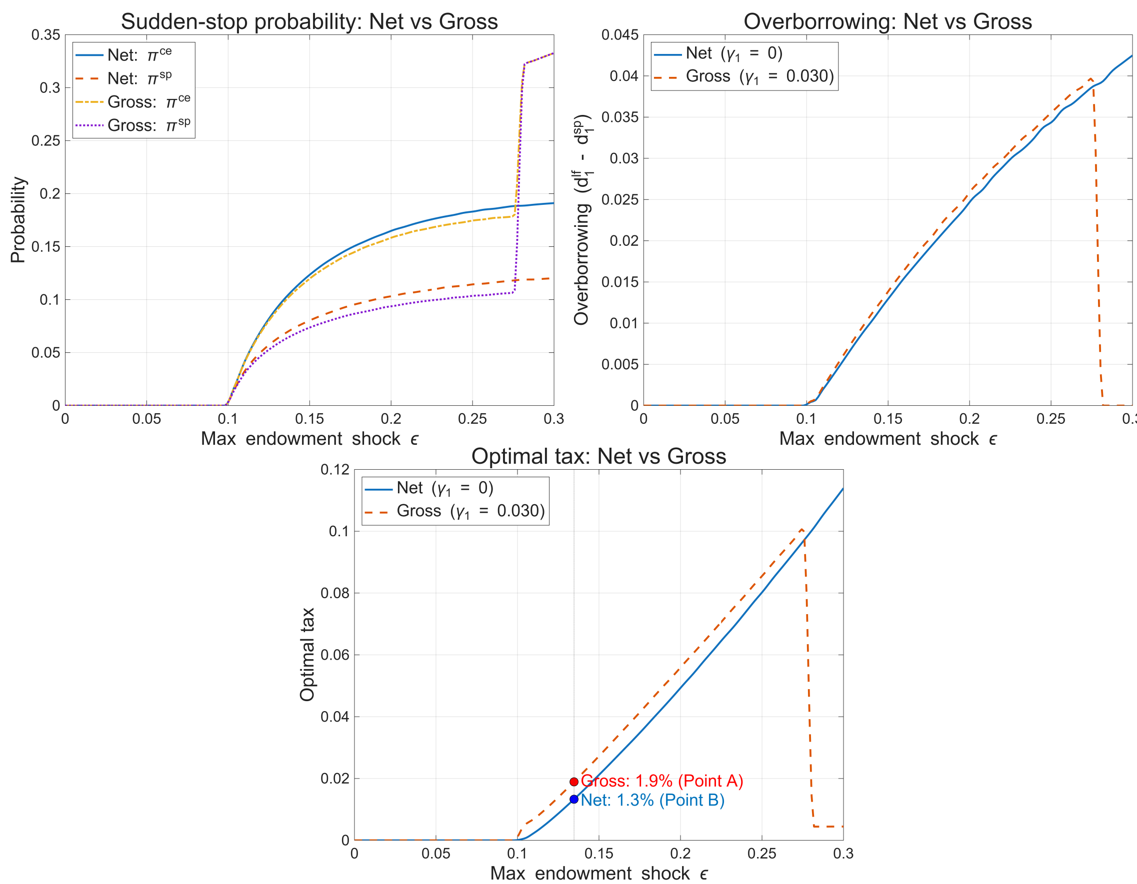
[29] More specifically, the tax increases in κ as long as $Q_1'(m_1)$ and the shadow value of the collateral constraint, λ^{sp}, are both positive—as is standard. In the case of $\kappa = 1$, the tax reduces to the baseline analog in Equation (15) (no asymmetry), and with $\gamma_1 = 0$ (no overseas investment) it becomes $\tau^{i,*} = \frac{E_0[\lambda^{sp} P_1'(m_1)]}{E_0[u'(c_1) + \lambda^{sp} P_1'(m_1)]}$.

[30] See Table B.1 for summary statistics.

[31] See Appendix B. The constraint in (B.1) becomes binding for $\varepsilon > \bar{e} - 1 - m_1^{i*} - \gamma_1 Q_0 \approx 0.1$, and borrowing reaches its upper bound $d_1^i < 1 + \gamma_1 Q_0 = 1.032$ at $\varepsilon \approx 0.28$.

benchmark case with a 10 percent maximum deviation from the mean ($\varepsilon \approx 0.13$) serves as the baseline reference point.

Figure 3: Numerical simulations results - baseline calibration ($\gamma_1 = 0.03$)



Notes: Net vs. gross specifications are shown across panels; overborrowing is the difference between borrowing under competitive equilibrium and the social planner's allocation ($d_1^{ce} - d_1^{sp}$). The bottom panel compares optimal tax rates under the gross (Point A, red) and net (Point B, blue) specifications at $\varepsilon \approx 0.13$, where the planner's optimal inflow tax is 1.9% versus 1.3%, respectively.

Figure 3 summarizes the main quantitative results under the baseline calibration ($\gamma_1 = 0.03$). The upper-left panel shows the probability of default for the private equilibrium allocation and the social planner solution, both for our setup with gross flows and the net flows analog. First, we can see that the probability of sudden stops increases with ε, and that the social planner's policy mitigates this risk by curbing excessive borrowing, at the same time, for all shock values we obtain a lower probability of default when separate gross flows instruments become available. The upper-right panel plots borrowing levels under the competitive equilibrium (CE) and the social planner's allocation (SP), with the vertical gap representing the magnitude of overborrowing ($d_1^{ce} - d_1^{sp}$). At $\varepsilon \approx 0.13$, the planner's intervention meaningfully reduces borrowing and lowers the probability of a sudden stop by roughly 3–4 percentage points.

The bottom panel illustrates how the optimal inflow tax varies with ε under the gross and net specifications. Points A and B correspond to the optimal taxes in our calibration ($\varepsilon \approx 0.13$), which yield a value of 1.9 percent under the gross specification (Point A), compared with 1.3 percent under the net flows case (Point B). In other words, the net measure understates the required intervention by about 0.6 percentage points—or roughly one third of the gross tax. This 44 percent higher rate under the gross specification reflects the additional externality introduced by the foreign-asset channel. At the same time,when the size of the endowment shock becomes larger (e.g., $\varepsilon \approx 0.27$), the optimal tax rises to 9.7 percent under the gross specification versus 8.5 percent under the net benchmark. These results indicate that accounting for gross outflows amplifies the extent of overborrowing and strengthens the case for a tighter corrective tax.

Overall, the patterns in Figure 3 are consistent with the comparative-statics results in Appendix B (Figures B.1–B.3) where we report these measures for different values of the foreign asset quantity (γ_1). Increasing γ_1 expands the external buffer by reducing crisis probabilities but simultaneously intensifies private incentives to borrow, thereby magnifying the welfare-relevant externality. For additional calibration details, functional forms, and robustness checks, see Appendix B.

5 Conclusion

Motivated by the rising importance of capital outflows from emerging economies, this paper develops an open-economy framework that distinguishes between gross capital inflows (borrowing from abroad) and gross outflows (domestic investment in foreign assets) in an environment with financial frictions arising from a collateral constraint. Extending Jeanne and Korinek (2010), our model features domestic agents who simultaneously borrow from and invest overseas, yet fail to internalize the external effects of these decisions on collateral values. This pecuniary externality generates excessive borrowing consistent with net-flow models, but the explicit treatment of gross flows reveals additional channels through which financial conditions propagate. When setting separate controls, the optimal gross inflows tax is 1.9%, or 0.6 percentage points (44%) above the optimal rate of a planner restricted to net-flow instruments (1.3%). This sizable difference stems from stronger externalities operating through foreign-asset price fluctuations, which are now explicitly accounted for in our framework with separate gross flows.

Once foreign-asset prices enter the collateral constraint, gross positions introduce international feedback mechanisms—or "spillbacks"—that are absent in net-flow models. When global shocks lead emerging-market residents to liquidate foreign safe assets, the resulting decline in asset prices (Q_1 in our setup) tightens domestic collateral constraints and can affect financial conditions in advanced economies, consistent with empirical evidence (see IMF, 2016; Arezki and Liu, 2020; Breitenlechner et al., 2022; Agénor and Pereira da Silva, 2022). This foreign-asset price channel underscores the importance of managing both sides of the balance sheet rather than focusing solely on net positions. The externalities can be corrected through a Pigouvian tax on borrowing combined with a subsidy on overseas investment, providing new policy insights for capital-flow management—particularly for countries employing asymmetric measures or seeking an optimal mix of instruments to regulate gross flows.

Future research should extend the model to an infinite-horizon setting that enables welfare-based evaluation and quantitative generalization of these policies, allowing for comprehensive comparisons across alternative regimes.[32] Another promising avenue would explore the heterogeneous composition of capital flows—distinguishing foreign direct investment from portfolio flows—to capture the long-term productivity and growth benefits associated with specific flow types, particularly FDI, as documented in Borensztein, De Gregorio and Lee (1998), Alfaro, Chanda, Kalemli-Ozcan and Sayek (2004), Davis, Fujiwara, Huang and Wang (2021), and Ghironi and Ozhan (2020). Such extensions would deepen understanding of financial amplification mechanisms and inform the design of policies that mitigate crises while preserving the benefits of international capital mobility.

References

Agénor, Pierre-Richard and Luiz A Pereira da Silva, "Financial spillovers, spillbacks, and the scope for international macroprudential policy coordination," *International Economics and Economic Policy*, 2022, *19* (1), 79–127.

Alfaro, Laura, Areendam Chanda, Sebnem Kalemli-Ozcan, and Selin Sayek, "FDI and economic growth: the role of local financial markets," *Journal of international economics*, 2004, *64* (1), 89–112.

[32] For approaches of this type with net flows, see Jeanne and Korinek (2019), Benigno et al. (2013), Bianchi and Mendoza (2018). For frameworks using gross flows, see Davis and van Wincoop (2024, 2025).

Arezki, Rabah and Yang Liu, "On the (Changing) asymmetry of global spillovers: Emerging markets vs. advanced economies," *Journal of International Money and Finance*, 2020, *107*, 102219.

Avdjiev, Stefan, Bryan Hardy, Şebnem Kalemli-Özcan, and Luis Servén, "Gross Capital Flows by Banks, Corporates, and Sovereigns," *Journal of the European Economic Association*, 2022, *20* (5), 2098–2135.

Baumeister, Christiane, "Discussion of "Local Projections or VARs? A Primer for Macroeconomists" by José Luis Montiel Olea, Mikkel Plagborg-Møller, Eric Qian, and Christian K. Wolf," NBER Summer Institute Discussion, National Bureau of Economic Research June 2025.

Benigno, Gianluca, Huigang Chen, Christopher Otrok, Alessandro Rebucci, and Eric R. Young, "Financial crises and macro-prudential policies," *Journal of International Economics*, 2013, *89* (2), 453–470.

Bernanke, Ben S, Mark Gertler, and Simon Gilchrist, "The financial accelerator in a quantitative business cycle framework," *Handbook of macroeconomics*, 1999, *1*, 1341–1393.

Bianchi, Javier, "Overborrowing and Systemic Externalities in the Business Cycle," *American Economic Review*, 2011, *101* (7), 3400–3426.

— **and Enrique G Mendoza**, "Optimal time-consistent macroprudential policy," *Journal of Political Economy*, 2018, *126* (2), 588–634.

Borensztein, Eduardo, Jose De Gregorio, and Jong-Wha Lee, "How does foreign direct investment affect economic growth?," *Journal of international Economics*, 1998, *45* (1), 115–135.

Breitenlechner, Max, Georgios Georgiadis, and Ben Schumann, "What goes around comes around: How large are spillbacks from US monetary policy?," *Journal of Monetary Economics*, 2022, *131*, 45–60.

Broner, Fernando, Tatiana Didier, Aitor Erce, and Sergio L. Schmukler, "Gross capital flows: Dynamics and crises," *Journal of Monetary Economics*, 2013, *60* (1), 113–133.

Caballero, Ricardo J. and Alp Simsek, "A Model of Fickle Capital Flows and Retrenchment," *Journal of Political Economy*, 2020, *128* (6), 2288–2328.

Cavallo, Eduardo A., Alejandro Izquierdo, and John Jairo León, "Domestic Antidotes to Sudden Stops," IDB Publications (Working Papers) 8528, Inter-American Development Bank 2017.

Chang, Roberto, Andrés Fernández, and Humberto Martinez, "Capital Controls on Outflows: New Evidence and a Theoretical Framework," Technical Report, National Bureau of Economic Research 2024.

Coman, Andra and Simon P. Lloyd, "In the face of spillovers: Prudential policies in emerging economies," *Journal of International Money and Finance*, 2022, *122*, 102554.

Davis, J. Scott and Eric van Wincoop, "A theory of capital flow retrenchment," *Journal of Monetary Economics*, 2018, *100*, 83–100.

— **and** — , "A theory of capital flow retrenchment," *Journal of International Economics*, 2024, *150*, 103952.

— **and** — , "A theory of net capital flows over the global financial cycle," *Journal of Monetary Economics*, 2025, *149*, 103662.

— **, Ippei Fujiwara, Kevin X.D. Huang, and Jiao Wang**, "Foreign exchange reserves as a tool for capital account management," *Journal of Monetary Economics*, 2021, *117*, 473–488.

Farhi, Emmanuel and Iván Werning, "A theory of macroprudential policies in the presence of nominal rigidities," *Econometrica*, 2016, *84* (5), 1645–1704.

Fisher, Irving, "The Debt-Deflation Theory of Great Depressions," *Econometrica*, 1933, *1* (4), 337–357.

Forbes, Kristin J. and Francis E. Warnock, "Capital flow waves: Surges, stops, flight, and retrenchment," *Journal of International Economics*, 2012, *88* (2), 235–251. NBER Global.

Fornaro, Luca, "Financial crises and exchange rate policy," *Journal of International Economics*, 2015, *95* (2), 202–215.

Ghironi, Fabio and G. Kemal Ozhan, "Interest Rate Uncertainty as a Policy Tool," NBER Working Papers 27084, National Bureau of Economic Research, Inc May 2020.

IMF, "The Liberalization and Management of Capital Flows: An Institutional View," 2012.

— , "The Yin and Yang of Capital Flow Management: Balancing Capital Inflows with Capital Outflows," *World Economic Outlook*, 2013, *2* (4), 113–132.

— , "The Growing Importance of Financial Spillovers from Emerging Market Economies," in "Global Financial Stability Report: Potent Policies for a Successful Normalization" April 2016, chapter 2.

—, "The IMF's Institutional View on Capital Flows in Practice," 2018.

—, "IMF 2019 Taxonomy of Capital Flow Management Measures," 2019.

—, "IMF 2023 Taxonomy of Capital Flow Management Measures," 2024.

Jeanne, Olivier and Anton Korinek, "Excessive Volatility in Capital Flows: A Pigouvian Taxation Approach," *American Economic Review*, 2010, *100* (2), 403–07.

— **and** —, "Managing credit booms and busts: A Pigouvian taxation approach," *Journal of Monetary Economics*, 2019, *107*, 2–17.

— **and Damiano Sandri**, "Global Financial Cycle and Liquidity Management," 2020, (27901).

Jordà, Oscar, "Estimation and Inference of Impulse Responses by Local Projections," *American Economic Review*, March 2005, *95* (1), 161–182.

Justiniano, Alejandro and Bruce Preston, "Can structural small open-economy models account for the influence of foreign disturbances?," *Journal of International Economics*, 2010, *81* (1), 61–74.

Kalemli-Ozcan, Sebnem, "U.S. Monetary Policy and International Risk Spillovers," NBER Working Papers 26297, National Bureau of Economic Research, Inc September 2019.

Kang, Hyunju and Hyunduk Suh, "Reverse spillover: Evidence during emerging market financial turmoil in 2013–2014," *Journal of International Financial Markets, Institutions and Money*, 2015, *38*, 97–115.

Kiyotaki, Nobuhiro and John Moore, "Credit cycles," *Journal of political economy*, 1997, *105* (2), 211–248.

Kwak, Kyongjun and Camilo Granados, "Dissecting capital flows: Do capital controls shield against foreign shocks?," *Journal of Financial Stability*, 2025, *79*, 101433.

Lane, Philip R. and Gian Maria Milesi-Ferretti, "The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970–2004," *Journal of International Economics*, 2007, *73* (2), 223–250.

Lubik, Thomas, "Non-stationarity and instability in small open-economy models even when they are'closed'," *FRB Richmond Economic Quarterly*, 2007, *93* (4), 393–412.

Miranda-Agrippino, Silvia and Hélène Rey, "U.S. Monetary Policy and the Global Financial Cycle," *The Review of Economic Studies*, 05 2020, *87* (6), 2754–2776.

Monnet, Eric and Damien Puy, "One Ring to Rule Them All? New Evidence on World Cycles," IMF Working Papers 2019/202, International Monetary Fund September 2019.

Rebucci, Alessandro and Chang Ma, "Capital Controls: A Survey of the New Literature," 2019, (26558).

Rey, Hélène, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence," NBER Working Papers 21162, National Bureau of Economic Research, Inc May 2015.

Schmitt-Grohé, Stephanie and Martín Uribe, "Multiple equilibria in open economies with collateral constraints," *The Review of Economic Studies*, 2021, *88* (2), 969–1001.

A Model Derivation with Asymmetry Parameter

In this appendix, we illustrate the solution of the model with asymmetric collaterizability of the assets in the collateral constraint.

Budget Constraints and Collateral Constraint.

$$c_0 + \gamma_1 Q_0 = d_1^i + (1-\theta_1)P_0 \tag{A.1}$$

$$c_1 + d_1^i = e + d_2^i + (\theta_1 - \theta_2)P_1 + (\gamma_1 - \gamma_2)Q_1 \tag{A.2}$$

$$c_2 + d_2^i = \theta_2 y + \gamma_2 Q_2 \tag{A.3}$$

$$d_2^i \leq \theta_1 P_1 + \kappa\gamma_1 Q_1 \tag{A.4}$$

where κ is a coefficient indicating the level of pledgeability of the foreign asset. In relative terms, we would say that the foreign asset has higher pledgeability than the domestic one if $\kappa > 1$.

Competitive Equilibrium (Laissez-faire). Taking net worth $m_1 (\equiv e - d_1^i + \gamma_1 Q_1 \equiv m_1^i + \gamma_1 Q_1)$ as given, the domestic agent solves for the period-1 equilibrium first:

$$\begin{aligned} V_{ce}(m_1) = & \max_{d_2^i, \gamma_2, \theta_2, c_1} \; u(c_1) + c_2 + \lambda^{ce}\left(\theta_1 P_1 + \kappa\gamma_1 Q_1 - d_2^i\right) \\ \text{s.t.} \quad & (\text{A.2}), (\text{A.3}) \end{aligned} \tag{A.5}$$

or analogously:

$$\begin{aligned} V_{ce}(m_1) = \max_{d_2^i, \gamma_2, \theta_2} \; & u\left(e - d_1^i + d_2^i + (\theta_1 - \theta_2)P_1 + (\gamma_1 - \gamma_2)Q_1\right) \\ & + \theta_2 y + \gamma_2 Q_2 - d_2^i + \lambda^{ce}\left(\theta_1 P_1 + \kappa\gamma_1 Q_1 - d_2^i\right) \end{aligned} \tag{A.6}$$

By substituting $d_2^i = \theta_1 P_1 + \kappa\gamma_1 Q_1$ and reorganizing the expressions, the budget constraint in period 1 becomes as follows:

$$c_1 = m_1 + (2\theta_1 - \theta_2)P_1 + (\kappa\gamma_1 - \gamma_2)Q_1 \tag{A.7}$$

where $m_1 \equiv e - d_1^i + \gamma_1 Q_1$.

As before, and with out loss of generality, we assume $\theta_t = 1$ in equilibrium. Then, the equations above can be re-written for the equilibrium allocation case by substituting the domestic and foreign asset pricing equations as follows:

$$c_1 = m_1 + \frac{y + (\kappa\gamma_1 - \gamma_2)Q_2}{u'(c_1)} \tag{A.8}$$

In period 0, anticipating the period-1 equilibrium, the representative domestic agent solves:

$$L_{ce} = \max_{d_1^i,\, \gamma_1,\, \theta_1 | \bar{P}_1,\, \bar{Q}_1} \; u(c_0) + E_0 V_{ce}(m_1) \quad \text{s.t.} \quad \text{(A.1), (A.3), (A.8)} \tag{A.9}$$

where the upperbars denote that the agent is taking the variables as given. After substituting the constraints, the problem becomes:

$$\begin{aligned} L_{ce} = \max_{d_1^i,\, \gamma_1,\, \theta_1 | \bar{P}_1,\, \bar{Q}_1} \; & u\left(d_1^i + (1-\theta_1)P_0 - \gamma_1 Q_0\right) \\ & + E_0\left[u(c_1) + \theta_2 y + \gamma_2 Q_2 - d_2^i + \lambda^{ce}\left(\theta_1 \bar{P}_1 + \kappa\gamma_1 \bar{Q}_1 - d_2^i\right)\right] \end{aligned} \tag{A.10}$$

where $c_1 = m_1 + (2\theta_1 - \theta_2)\bar{P}_1 + (\kappa\gamma_1 - \gamma_2)\bar{Q}_1$.

The FOC with respect to d_1^i is $u'(c_0) = E_0\left[u'(c_1)\right]$, and this expression can pin down the period-0 borrowing, d_1^i. Furthermore, since the left-hand side decreases and the right-hand side increases in d_1^i, a unique solution can be derived. The FOCs for θ_1 and γ_1 provide the asset pricing equations.[33]

Social Planner Allocation and Pigouvian Tax. We solve this case as in our baseline (symmetric parameter case). First, we can write reduced form expressions—increasing in net worth—for period-1 equilibrium consumption and asset prices. Anticipating the period-1 equilibrium, the social planner solves (in period 0):

$$L_{sp} = \max_{d_1^i,\, \gamma_1,\, \theta_1} \; u(c_0) + E_0 V_{sp}(m_1) \quad \text{s.t.} \quad \text{(A.1), (A.3), (A.8)} \tag{A.11}$$

$$\text{where} \quad V_{sp}(m_1) = \max_{d_2^i,\, \gamma_2,\, \theta_2} \; u(c(m_1)) + c_2 + \lambda^{sp}\left(\theta_1 P_1(m_1) + \kappa\gamma_1 Q_1(m_1) - d_2^i\right) \tag{A.12}$$

$$\text{with} \quad P_1(m_1) = \frac{y}{u'(c_1)}, \quad Q_1(m_1) = \frac{Q_2}{u'(c_1)}$$

[33] $P_0 = E_0\left[(2u'(c_1) + \lambda^{ce})\bar{P}_1\right]/u'(c_0)$, $Q_0 = E_0\left[((1+\kappa)u'(c_1) + \kappa\lambda^{ce})\bar{Q}_1\right]/u'(c_0)$.

Notice the latter price expressions hold because the planner considers the private agents FOCs. After substituting the constraints and simplifying, the problem becomes:

$$
\begin{aligned}
L_{sp} = \max_{d_1^i,\gamma_1,\theta_1} \; & u\left(d_1^i + (1-\theta_1)P_0 - \gamma_1 Q_0\right) \\
& + E_0\left[u(c(m_1)) + \theta_2 y + \gamma_2 Q_2 - d_2^i + \lambda^{sp}\left(\frac{\theta_1 y + \kappa\gamma_1 Q_2}{u'(c_1)} - d_2^i\right)\right] \qquad \text{(A.13)}
\end{aligned}
$$

where $c(m_1) = m_1 + (2\theta_1 - \theta_2)P_1(m_1) + (\kappa\gamma_1 - \gamma_2)Q_1(m_1)$.

The social planner, who internalizes the impact of borrowing on asset prices in the collateral constraints, will decide the optimal level of borrowing based on the following FOC for d_1^i:

$$
u'(c_0) = E_0\left[u'(c(m_1)) + \lambda^{sp}\{\theta_1 P_1'(m_1) + \kappa\gamma_1 Q_1'(m_1)\}\right] \qquad \text{(A.14)}
$$

Focusing on a constrained equilibrium with a binding collateral constraint ($\lambda^{sp} > 0$), it can be inferred that in the case of large κ (> 1), the social planner will make the agents consume and borrow less in period 0 than in the laissez-faire allocation (competitive equilibrium) in the baseline model ($\kappa = 1$).

The mismatch between allocations and their associated externalities can be corrected by Pigouvian taxation on borrowing. The planner can seek to implement the optimal level of borrowing (gross capital inflows) in a decentralized economy with a tax rate τ_1^i on period-0 borrowing d_1^i and a lump-sum tax rebate. In that case, the budget constraints in periods 0 and 1 are modified as follows:

$$
c_0 + \gamma_1 Q_0 = (1-\tau_1^i)d_1^i + (1-\theta_1)P_0 \qquad \text{(A.15)}
$$

$$
c_1 + d_1^i = e + d_2^i + (\theta_1 - \theta_2)P_1 + (\gamma_1 - \gamma_2)Q_1 + \text{Transfer} \qquad \text{(A.16)}
$$

Anticipating the same period-1 equilibrium (since the lump-sum transfer does not change the agent's choices), the representative domestic agent solves in period 0:

$$
\begin{aligned}
L_{ce} &= \max_{d_1^i,\gamma_1,\theta_1} \; u\left((1-\tau_1^i)d_1^i + (1-\theta_1)P_0 - \gamma_1 Q_0\right) + E_0 V_{ce}(m_1) \\
\text{where} \quad V_{ce}(m_1) &= \max_{d_2^i,\gamma_2,\theta_2} \; u(c_1) + c_2 + \lambda^{ce}\left(\theta_1 \bar{P}_1 + \kappa\gamma_1\bar{Q}_1 - d_2^i\right) \quad \text{s.t.} \quad \text{(A.3), (A.16)} \qquad \text{(A.17)}
\end{aligned}
$$

where upperbars denote that the variable is taken as given by the agents.

The FOC with respect to d_1^i implies $u'(c_0) = E_0\left[u'(c_1)\right]/(1-\tau_1^i)$. The optimal tax rate can be obtained by equating the two FOCs for d_1^i under the laissez-faire equilibrium with tax and the social planner's allocation: $u'(c_0) = E_0\left[u'(c_1)\right]/(1-\tau_1^i) = E_0\left[u'(c_1) + \lambda^{sp}\left\{\theta_1 P_1'(m_1) + \kappa\gamma_1 Q_1'(m_1)\right\}\right]$.

The associated optimal tax is:

$$\tau_1^{i,*} = \frac{E_0\left[\lambda^{sp}\left\{\theta_1 P_1'(m_1) + \kappa\gamma_1 Q_1'(m_1)\right\}\right]}{E_0\left[u'(c_1) + \lambda^{sp}\left\{\theta_1 P_1'(m_1) + \kappa\gamma_1 Q_1'(m_1)\right\}\right]}. \tag{A.18}$$

The results should be compared in our baseline model with Equation (15). Two features are noticeable, the tax grows with κ. Second, if $\kappa > 1$—when the foreign asset is more pledgeable relative to the domestic one—the optimal tax on borrowing is higher than in our baseline with symmetric collateralizability.

B Analytical Derivations and Calibration for Numerical Illustration

This appendix complements the main text by providing the analytical derivations of the social planner model and the calibration details underlying both the Pigouvian tax analysis in Section 3.3 and the numerical illustration in Section 4.

Assumptions. We consider log utility functions for periods 0 and 1, so that lifetime utility of the representative agent becomes: $U = \log(c_0) + \log(c_1) + c_2$. The endowment shock in period 1 is uniformly distributed in $[\bar{e} - \varepsilon, \bar{e} + \varepsilon]$. We assume $\theta_t = 1$ and $\gamma_1 = \gamma_2$ in equilibrium. As in previously, the domestic agent holds its endowed domestic asset until period 2, he will also invest in foreign assets in period 0, and re-invests these in period 1 (holding these until period 2).

Building on the setup in Section 3.1, we have that Equation (9), $c_1 = m_1 + \frac{y}{u'(c_1)}$ can be rewritten as $c_1 = m_1^i + \frac{(y+\gamma_1 Q_2)}{u'(c_1)}$, where $m_1 \equiv m_1^i + \gamma_1 Q_1$. Then, the equation has a non-negative solution $c_1 \geq 0$ if and only if $m_1^i = e - d_1^i \geq 0$. Thus, for the lowest realization of e $(= \bar{e} - \varepsilon)$, this inequality should also hold. This implies the condition that $\varepsilon < \bar{e} - d_1^i$. At the same time, to ensure the uniqueness of equilibrium, we require that the slope of the right-hand side with respect to c_1 is below one. Using the log-utility specification $u(c) = \log c$ so that $u'(c) = 1/c$ and $1/u'(c) = c$, we have $\frac{d(1/u'(c))}{dc} = 1$, and the slope is given by: $(y + \gamma_1 Q_2)\frac{d(1/u'(c))}{dc} = y + \gamma_1 Q_2 < 1$.[34] Furthermore, by defining $m_1^{i*} \equiv 1 - y - \gamma_1 Q_2 > 0$,[35] the equilibrium level of consumption is $c_1 = m_1^i / m_1^{i*}$, and given our previous assumption of a stable consumption path, this solution cannot exceed the consumption in the first-best allocation, thus: $c_1 = \min\left(\frac{m_1^i}{m_1^{i*}}, c^{FB}\right)$. The domestic asset pricing equation $P_1 = \frac{y}{u'(c_1)}$ implies that $P_1 = yc_1 = y \cdot \min\left(\frac{m_1^i}{m_1^{i*}}, 1\right)$.[36]

We focus on the situation where the economy is constrained with a non-zero probability, which occurs when $\bar{e} < 1 + m_1^{i*} + \gamma_1 Q_0 + \varepsilon$. Moreover, the constraint binds if and only if $m_1^i < m_1^{i*}$, or equivalently, $e < m_1^{i*} + d_1^i$.[37] As a result, the calibration of parameters should

[34] Note that $y + \gamma_1 Q_2$ appears here because the equation is expressed in terms of (m_1^i, γ_1). This is fully consistent with the main-text expression in terms of m_1, since $m_1 = m_1^i + \gamma_1 Q_1$ already absorbs the gross-outflow term.

[35] Here, m_1^{i*} denotes the collateral threshold: the minimum own resources required per unit of borrowing. Actual resources are $m_1^i \equiv e - d_1^i$, and the constraint binds if $m_1^i < m_1^{i*}$. The superscript "$*$" indicates a threshold value, not a foreign variable.

[36] By construction, the first-best consumption in this setup is one, given that we assume linear utility in the last period, log utility in the other periods, and, as illustrated in Section 3.1, that in the first-best case, all periods' marginal utilities are equalized.

[37] To see this, note that consumption under the collateral constraint is $c_1 = m_1^i / m_1^{i*}$. The constraint binds whenever $c_1 < C^{FB} = 1$, i.e. $m_1^i < m_1^{i*}$. Substituting $m_1^i = e - d_1^i$ gives the equivalent condition $e < m_1^{i*} + d_1^i$.

satisfy the following condition in Equation (B.1) so that the economy will not be constrained without uncertainty ($\varepsilon = 0$), but becomes constrained for significantly large endowment shocks:

$$1 + m_1^{i*} + \gamma_1 Q_0 < \bar{e} < 1 + m_1^{i*} + \gamma_1 Q_0 + \varepsilon \tag{B.1}$$

Competitive Equilibrium. Suppose that the economy is constrained in period 1 with a positive probability. The first-order condition (FOC), $u'(c_0) = E_0\left[u'(c_1)\right]$, can determine the period-0 equilibrium level of borrowing, d_1^i. This level, denoted as $d_1^{i,ce}$, can be solved by using the uniform distribution of endowment shocks.

$$\begin{aligned}
\text{LHS} &= u'(c_0) = \frac{1}{c_0} = \frac{1}{d_1^i - \gamma_1 Q_0}, \\
\text{RHS} &= E_0\left[u'(c_1)\right] = E_0\left[\frac{1}{c_1}\right] = E_0\left[\frac{1}{\min\left(\frac{m_1^i}{m_1^{i*}}, 1\right)}\right] \\
&= E_0\left[\frac{1}{\min\left(\frac{e-d_1^i}{m_1^{i*}}, 1\right)}\right] \\
&= \frac{1}{2\varepsilon}\int_{\bar{e}-\varepsilon}^{m_1^{i*}+d_1^i} \frac{m_1^{i*}}{e-d_1^i}\, de + \frac{1}{2\varepsilon}\int_{m_1^{i*}+d_1^i}^{\bar{e}+\varepsilon} 1\, de \\
&= \frac{1}{2\varepsilon}\left[m_1^{i*}\log\left(\frac{m_1^{i*}}{\bar{e}-\varepsilon-d_1^i}\right) + \bar{e} + \varepsilon - m_1^{i*} - d_1^i\right].
\end{aligned} \tag{B.2}$$

Since $c_1 < 1$ in the constrained region—i.e., for realizations of the endowment shock such that the collateral constraint binds—and $c_1 = 1$ in the unconstrained region, we have $E_0\left[u'(c_1)\right] \geq 1$ under log utility (and analogously for any strictly concave utility forms). Restricting attention to the constrained region, $E_0\left[u'(c_1)\right] > 1$, which implies $d_1^i < 1 + \gamma_1 Q_0$. Moreover, requiring that the economy be constrained with non-zero probability yields $d_1^i > \bar{e} - \varepsilon - m_1^{i*}$. In the range of $[\bar{e} - \varepsilon - m_1^{i*}, 1 + \gamma_1 Q_0]$, LHS above is strictly decreasing and RHS is strictly increasing in d_1^i ($\frac{\partial \text{RHS}}{\partial d_1^i} = \frac{1}{2\varepsilon}\left[\frac{m_1^{i*}}{\bar{e}-\varepsilon-d_1^i} - 1\right]$). This means there is a unique solution d_1^i in this range. The solution can be numerically solved given the parameters $m_1^{i*}, \bar{e}, \varepsilon$, and $\gamma_1 Q_0$.

Social Planner Allocation and Pigouvian Tax. From the optimality condition associated to the problem in Equation (11), $u'(c_1) = 1 + \lambda^{ce}$, it can be shown that $\lambda^{ce} = \frac{1}{c_1} - 1 = \left(\frac{m_1^{i*}}{m_1^i} - 1\right)^+$. From the asset pricing equations for domestic and foreign assets, $P_1(m_1) = y \cdot \min\left(\frac{m_1^i}{m_1^{i*}}, 1\right)$ and $Q_1(m_1) = Q_2 \cdot \min\left(\frac{m_1^i}{m_1^{i*}}, 1\right)$, and thus, $P_1'(m_1) = \frac{y}{m_1^{i*}}$ and $Q_1'(m_1) = \frac{Q_2}{m_1^{i*}}$ in the region ($m_1^i < m_1^{i*}$) and $P_1'(m_1) = Q_1'(m_1) = 0$ in the region ($m_1^i > m_1^{i*}$).

From here, the period-0 equilibrium level of borrowing, d_1^i, can be obtained with the period-0 FOC for the social planner's problem, $u'(c_0) = E_0\left[u'(c_1) + \lambda^{sp}\left\{P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right]$. This level, denoted as $d_1^{i,sp}$, is pinned down analogously to the private equilibrium case as a single crossing point.

$$\begin{aligned}
\text{LHS} &= u'(c_0) = \frac{1}{c_0} = \frac{1}{d_1^i - \gamma_1 Q_0}, \\
\text{RHS} &= E_0\left[u'(c_1) + \lambda^{sp}\left\{P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right] \\
&= E_0\left[\frac{1}{\min\left(\frac{e-d_1^i}{m_1^{i*}}, 1\right)} + \lambda^{sp}\left\{P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right] \\
&= \frac{1}{2\varepsilon}\int_{\bar{e}-\varepsilon}^{m_1^{i*}+d_1^i}\left(\frac{1}{e-d_1^i} + 1 - \frac{1}{m_1^{i*}}\right) de + \frac{1}{2\varepsilon}\int_{m_1^{i*}+d_1^i}^{\bar{e}+\varepsilon} 1\, de \\
&= 1 + \frac{1}{2\varepsilon}\left[\log\left(\frac{m_1^{i*}}{\bar{e}-\varepsilon-d_1^i}\right) - 1 - \frac{d_1^i - \bar{e} + \varepsilon}{m_1^{i*}}\right].
\end{aligned} \tag{B.3}$$

Given these assumptions, the level of debt will sastify:

$$\bar{e} - \varepsilon - m_1^{i*} < d_1^{i,sp} < d_1^{i,ce} < 1 + \gamma_1 Q_0 \tag{B.4}$$

This suggest the presence of overborrowing by private agents, as the borrowing chosen by the social planner is lower than in the competitive equilibrium. We verify this outcome numerically in the numerical exercise in Section 4.

Therefore, the social planner can impose a tax on borrowing to mitigate the debt mismatch. From Equation (15), the associated optimal tax rate on borrowing (gross inflows) satisfies

$$\begin{aligned}
\tau_1^{i,*} &= \frac{E_0\left[\lambda^{sp}\left\{P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right]}{E_0\left[u'(c_1) + \lambda^{sp}\left\{P_1'(m_1) + \gamma_1 Q'(m_1)\right\}\right]}, \text{ or} \\
\frac{1}{1-\tau_1^{i,*}} &= \frac{E_0\left[u'(c_1) + \lambda^{sp}\left\{P_1'(m_1) + \gamma_1 Q_1'(m_1)\right\}\right]}{E_0\left[u'(c_1)\right]} = \frac{1}{(d_1^i - \gamma_1 Q_0)E_0\left[u'(c_1)\right]}
\end{aligned} \tag{B.5}$$

From Equation (B.2) evaluated at $d_1^{i,sp}$ and (B.3),

$$E_0\left[u'(c_1)\right] = \frac{1}{2\varepsilon}\left[m_1^{i*}\log\left(\frac{m_1^{i*}}{\bar{e}-\varepsilon-d_1^{i,sp}}\right) + \bar{e} + \varepsilon - m_1^{i*} - d_1^{i,sp}\right] = m_1^{i*}\left(\frac{1}{d_1^{i,sp}} - 1\right) + 1 \tag{B.6}$$

This implies

$$\tau_1^{i,*} = 1 - \left(1 - \frac{\gamma_1 Q_0}{d_1^{i,sp}}\right) \cdot \left(m_1^{i*} + \left(1 - m_1^{i*}\right) d_1^{i,sp}\right), \quad \text{or}$$

$$\frac{1}{1-\tau_1^{i,*}} = 1 + \frac{\tau_1^{i,*}}{1-\tau_1^{i,*}} = \frac{1}{(d_1^i - \gamma_1 Q_0)} \cdot \frac{1}{m_1^{i*}\left(\frac{1}{d_1^{i,sp}} - 1\right) + 1} = \frac{1}{\left(1 - \frac{\gamma_1 Q_0}{d_1^{i,sp}}\right) \cdot \left(m_1^{i*} + (1 - m_1^{i*})\, d_1^{i,sp}\right)} \tag{B.7}$$

Calibration. Following Jeanne and Korinek (2010), we set the mean endowment shock at $\bar{e} = 1.3$ and the return on domestic assets at $y = 0.8$. For simplicity, we assume $Q_2 = Q_0 = y$, which rules out search-for-yield motives. Numerical solutions therefore depend on $\{y, \bar{e}, \varepsilon, \gamma_1\}$. We solve for $d_1^{i,ce}$, $d_1^{i,sp}$, and $\tau_1^{i,*}$ over $\varepsilon \in [0, 0.3]$ on a 50-point grid. To ensure uniqueness of equilibrium, $\gamma_1 Q_2 < 1 - y$, implying $\gamma_1 < 0.25$.

Estimation of γ_1. We estimate γ_1 using cross-country data on gross capital outflows to GDP, following IMF (2024) and Cavallo et al. (2017). Our dataset covers economies that had at least one CFM in place as of end-2023, as identified in the IMF 2023 Taxonomy of Capital Flow Management Measures. After excluding CEMAC due to missing data, the final sample consists of 36 economies. We use annual data over 2011–2023 (baseline) and 2011–2020 (pre-pandemic window). Nominal GDP in U.S. dollars is taken from the IMF International Financial Statistics, and gross capital outflows are computed as the sum of the net acquisition of financial assets across direct investment, portfolio investment, and other investment in the Balance of Payments.[38]

We proceed in three steps. First, at the country–year level we normalize gross outflows by nominal GDP. Second, we compute the median ratio for each country over the sample window. Third, we take the cross-country median of those country medians as our baseline measure, which we denote $r \equiv \gamma_1 Q_0$. Imposing $Q_0 = y = 0.8$ yields $\gamma_1 = \frac{r}{Q_0}$.

Using this procedure, the cross-country median ratio is $r = 2.4\%$ over 2011–2023 and $r = 2.1\%$ over 2011–2020, which imply

$$\gamma_1 \approx \frac{0.024}{0.8} \approx 0.030 \quad \text{and} \quad \gamma_1 \approx \frac{0.021}{0.8} \approx 0.026. \tag{B.8}$$

[38] We follow the IMF Balance of Payments convention: gross outflows correspond to the assets side (net acquisition of financial assets), while gross inflows correspond to the liabilities side (net incurrence of liabilities). For the calibration of γ_1, we use only gross outflows (assets side). When a component is missing for a country-year, we sum over the available components.

Summary statistics are reported in Table B.1.

Table B.1: Gross capital outflows-to-GDP ratios: country-level medians and means (%)

Economy	Median (2011–2023)	Mean (2011–2023)	Median (2011–2020)	Mean (2011–2020)
Argentina	1.9	2.7	1.7	2.8
Australia	5.5	5.9	5.5	5.4
Bahamas, The Commonwealth of	-10.3	-52.7	-20.2	-66.6
Barbados*	4.8	6.3	4.8	6.3
Bolivia	1.5	2.8	2.1	3.3
Brazil	1.4	1.3	0.7	1.0
Canada	9.4	9.3	8.5	8.3
China	2.9	3.1	2.9	3.3
Democratic Republic of Congo*	1.0	2.0	1.2	2.2
Ecuador	4.1	4.3	4.9	4.5
Fiji	0.6	0.8	0.5	0.6
Georgia	3.9	4.0	3.7	3.7
Ghana	2.0	1.6	2.1	1.8
Hong Kong SAR, China	57.8	63.4	62.7	65.5
India	2.7	2.7	2.7	2.7
Indonesia	1.7	1.5	1.8	1.5
Kazakhstan	4.6	4.6	4.0	4.3
Korea	6.2	5.9	5.9	5.7
Liberia*	-5.5	-5.4	-7.1	-7.9
Macao SAR, China	47.2	44.0	50.7	47.2
Madagascar*	1.8	1.9	1.9	2.2
Malawi	0.3	0.0	0.2	-0.1
Malaysia	5.6	7.3	6.0	7.7
New Zealand	1.7	1.4	2.0	1.9
Nigeria	1.9	1.9	1.9	2.0
Pakistan	0.1	0.2	0.1	0.1
Peru	1.7	1.9	1.6	1.7
Qatar	10.2	8.9	11.6	9.3

(continued)

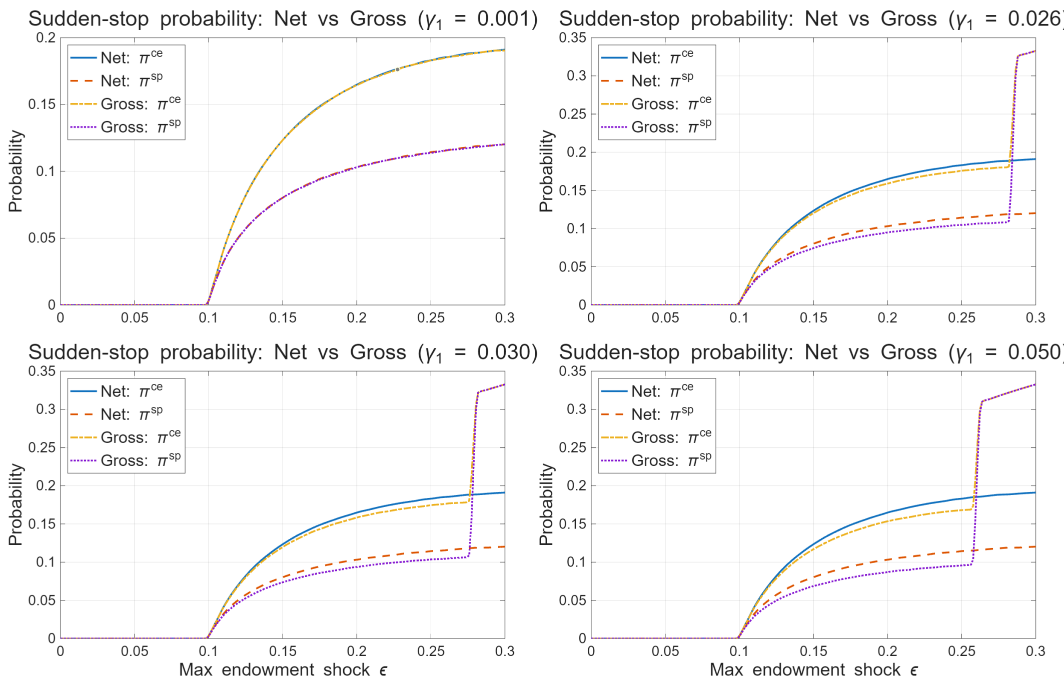
Economy	Median (2011–2023)	Mean (2011–2023)	Median (2011–2020)	Mean (2011–2020)
Seychelles	12.4	9.1	4.2	7.6
Singapore	47.7	51.2	46.8	49.9
Sri Lanka	0.5	0.5	0.3	0.3
Thailand	5.0	5.0	5.3	5.2
Türkiye	1.2	1.1	1.1	1.0
Ukraine	4.1	3.6	1.6	2.2
Zambia	8.5	9.6	8.8	10.1
Zimbabwe	-0.1	0.1	-0.1	0.1
Cross-country summary (36 economies)				
Median of country medians (%)	2.4		2.1	
Median of country means (%)		2.8		2.8
Implied γ_1 (%)	3.0	3.4	2.6	3.5

Notes: Ratios are percentages of nominal GDP. Sample consists of 36 economies with at least one CFM in place as of end-2023 (IMF, 2024). CEMAC is excluded due to missing data. Ratios are medians of annual country values. Country entries report medians or means of annual outflows-to-GDP ratios over the indicated coverage window. An asterisk (*) marks economies with nonstandard data coverage: Barbados (2011–2017), Democratic Republic of Congo, Liberia, and Madagascar (2011-2022). Cross-country rows compile the median across countries of those country-specific statistics. Implied γ_1 converts $r \equiv \gamma_1 Q_0$ to γ_1 under Q_0=0.8 (values shown in percent for readability). Sources: IMF Balance of Payments (BOP) and International Financial Statistics (IFS) databases.

Numerical Illustration. With these parameter values, we focus on $\varepsilon \in [0.1, 0.28]$, where the collateral constraint binds with positive probability. Borrowing d_1^i increases with ε but is capped by $d_1^i < 1 + \gamma_1 Q_0$. At $\varepsilon \approx 0.13$, the optimal tax rate on borrowing (gross inflows) is 1.9% in the baseline estimation of γ_1 (i.e., 3%), compared with 1.3% when $\gamma_1 = 0$, which is the same as Jeanne and Korinek (2010)'s result. Thus, the conventional net-flow measure understates the corrective tax by about 0.6 percentage points (44%). At $\varepsilon \approx 0.27$, the optimal tax rises to 9.7%, versus 8.5% under the no-foreign-asset benchmark. Figure 3 in Section 4 shows these results with the baseline estimation when γ_1 is around 0.3%.

Figure B.1 illustrates that an increase in γ_1 expands the external buffer, thereby reducing the probability of a sudden stop.[39] This reflects the stabilizing role of stronger precautionary borrowing capacity in mitigating crisis risk.

Figure B.1: Probability of sudden-stop under gross versus net flow measures with varying γ_1

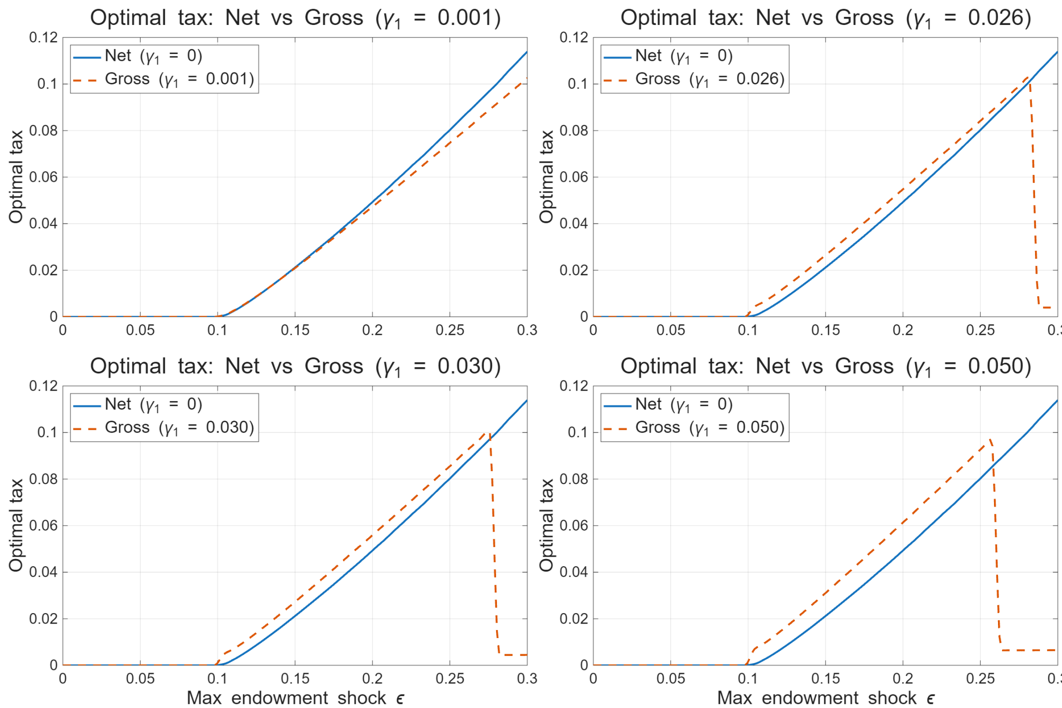


Notes: Each panel corresponds to a different calibration of γ_1 $(0.001, 0.026, 0.03, 0.05)$. The solid line shows the probability of sudden stops under gross flows, the dashed line under net flows.

Figure B.2 shows, however, that the same mechanism simultaneously amplifies private incentives to borrow more. The result is an aggravation of the excess borrowing problem, which in turn raises the level of the optimal corrective tax.

[39]The probability of a sudden stop is calculated using the uniform distribution: $\text{Prob}^{ce} = \frac{1}{2\varepsilon}\int_{\bar{e}-\varepsilon}^{m_1^{i*}+d_1^i} 1\,de = \frac{1}{2} - \frac{\bar{e}-m_1^{i*}-d_1^{i,ce}}{2\varepsilon}$ and $\text{Prob}^{sp} = \frac{1}{2\varepsilon}\int_{\bar{e}-\varepsilon}^{m_1^{i*}+d_1^i} 1\,de = \frac{1}{2} - \frac{\bar{e}-m_1^{i*}-d_1^{i,sp}}{2\varepsilon}$.

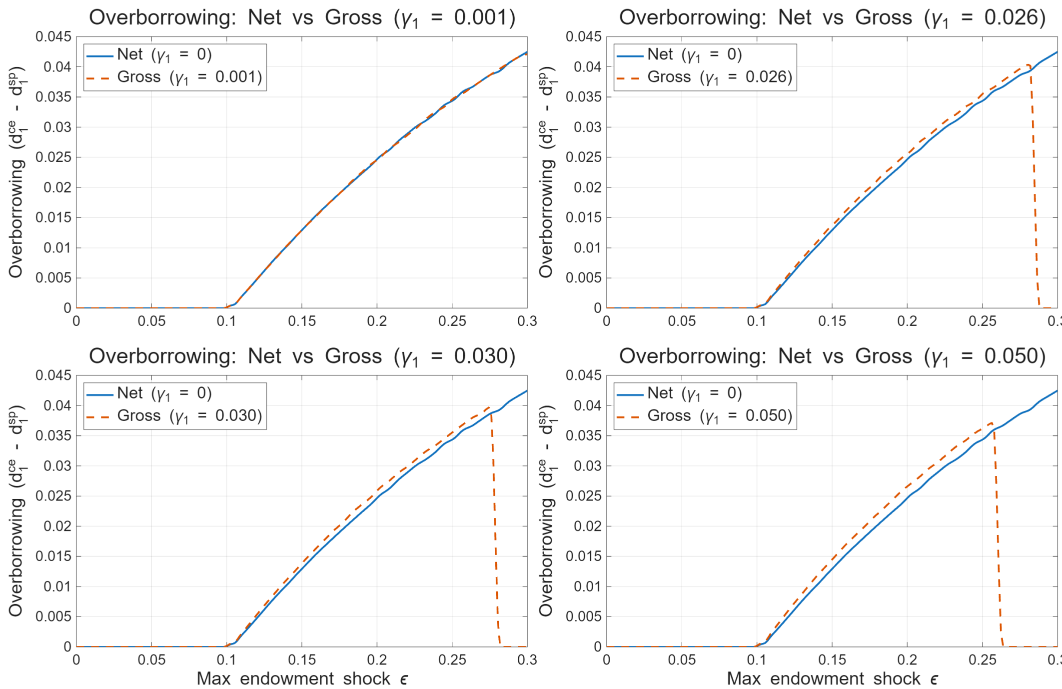
Figure B.2: Optimal tax rate under gross versus net flow measures with varying γ_1



Notes: Each panel corresponds to a different calibration of γ_1 (0.001, 0.026, 0.03, 0.05). The solid line shows the optimal tax rate under gross flows, the dashed line under net flows.

Figure B.3 directly corroborates this mechanism by comparing the degree of overborrowing. As γ_1 increases, the extent of overborrowing rises systematically. The effect is particularly pronounced under gross borrowing, where the deviation from the net benchmark widens and even displays discontinuities at higher values of γ_1.

Figure B.3: Overborrowing under gross versus net flow measures with varying γ_1

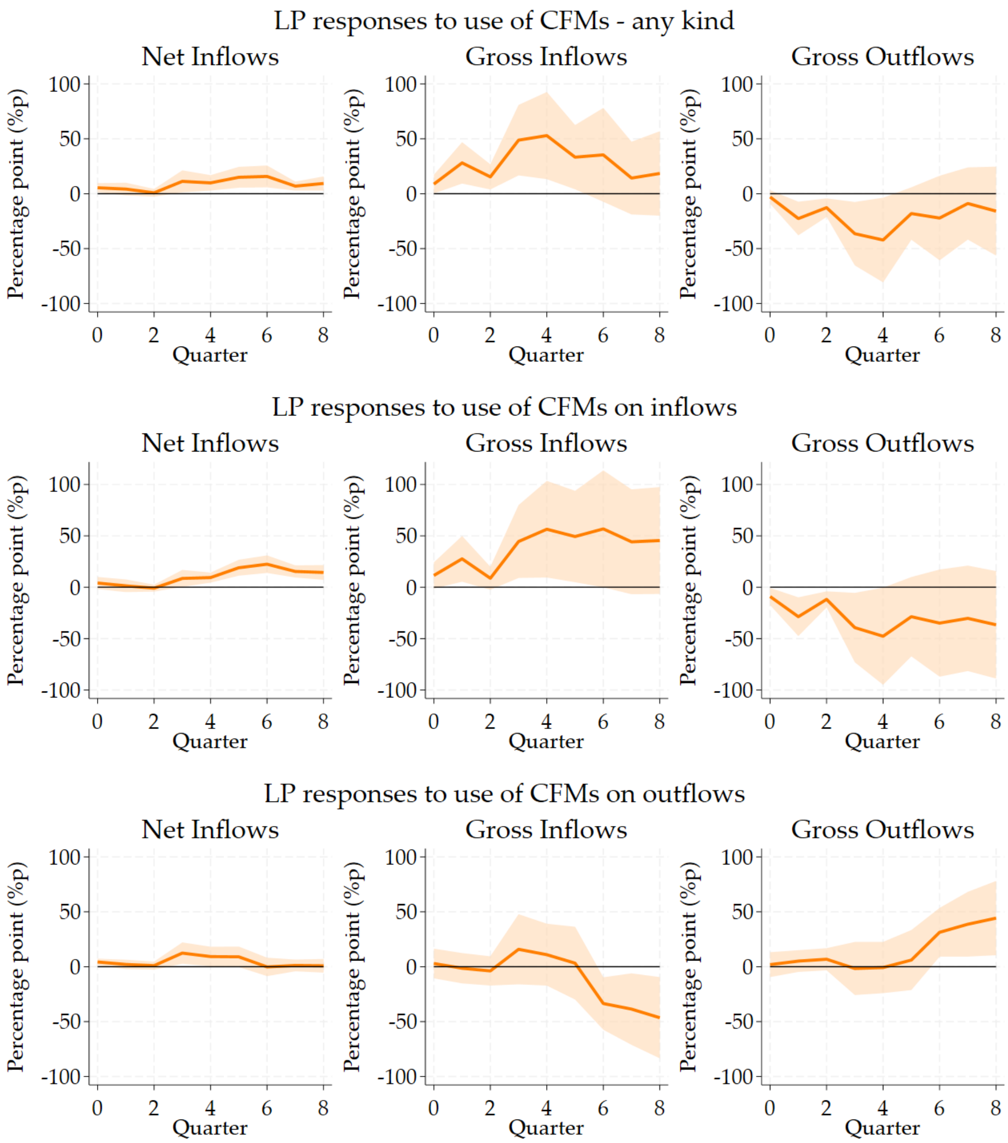


Notes: Each panel corresponds to a different calibration of γ_1 $(0.001, 0.026, 0.03, 0.05)$. The solid line shows overborrowing under gross flows, the dashed line under net flows.

Taken together, the three figures B.1– B.3 present a consistent narrative of the trade-off: while stronger external buffers reduce crisis probability, they simultaneously strengthen private incentives to overborrow, thereby increasing the need for corrective taxation.

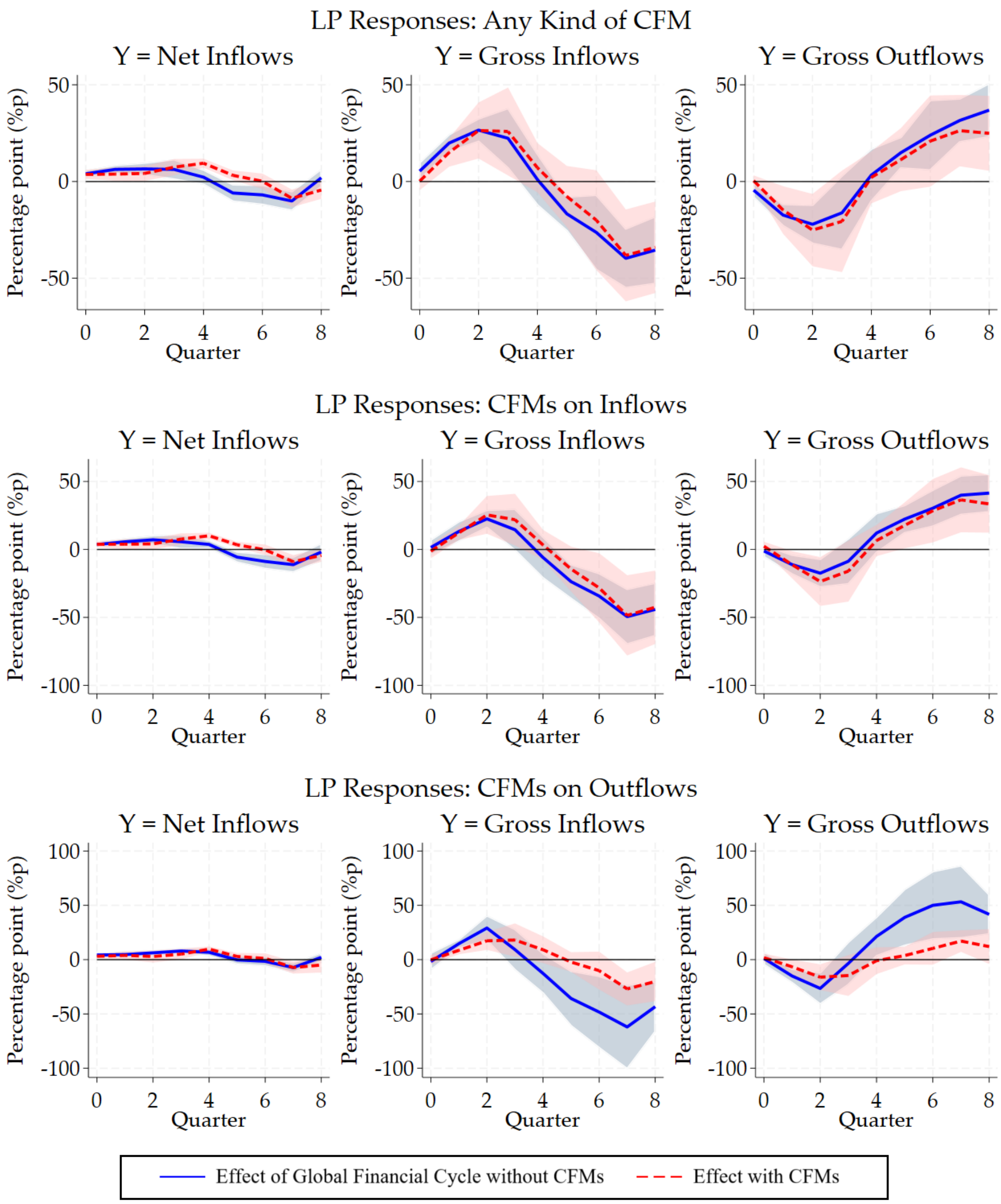
C Additional LP estimations results

Figure C.1: LP-IRFs: Direct effect of CFM usage on Capital Flows (All flows)



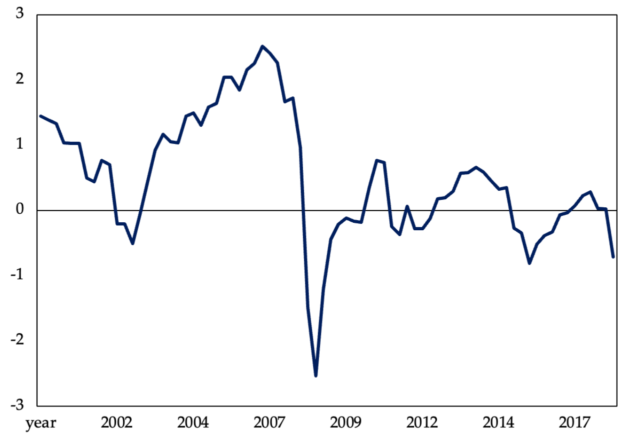
Notes: This figure shows the response of the Portfolio Equity flows (PE) to the CFM dummy variable reported by the IMF taxonomy on capital flows and based on an estimation for equation (1). The flows are included as reported in the Balance of Payments statistics, that is, as residents' income. Therefore, outflows have a negative sign, and an increase in outflows due to higher domestic investment abroad is associated with a negative effect in the right panels.

Figure C.2: LP-IRFs: Effect of Global Financial Cycle on Capital Flows with and without CFMs (All flows)



Notes: This figure shows the response of total capital flows to the Global Financial Cycle variable with and without CFM measures (dashed line, includes the interaction coefficient). The effect and interaction are based on the estimation of the equation (1). The flows are included as reported in the Balance of Payments statistics, that is, as residents' income. Therefore, outflows have a negative sign, and an increase in outflows due to higher domestic investment abroad is associated with a negative effect in the right panels.

Figure C.3: Global Financial Cycle variable used in panel estimates



Notes: The Global Financial Cycle factor showed here is standardized as reported Miranda-Agrippino and Rey (2020). We aggregate their monthly measure into quarterly frequency with a simple average.

Table C.1: Data description and sources for LP panel model

Name	Description	Sources
Dependent variables		
Capital flows		
Net (in)flows, Gross inflows and Gross outflows	Flows are smoothed following Cavallo, Izquierdo and León (2017) and Forbes and Warnock (2012). Quarterly flows are aggregated for 4 quarters and then year-over-year differences are computed. We consider the series as a ratio to GDP.	IMF IFS (BoP, BPM6)
Explanatory variables		
CFM dummy	1 if any kind of CFM is used during the period. Otherwise, 0.	IMF 2019 Taxonomy of CFMs
Global Financial Cycle	Standardized global assets prices factor (extended sample reported in authors' website)	Miranda-Agrippino and Rey (2020)
Control variables		
VIX	The Chicago Board Options Exchange S&P 500 Volatility Index	GFDFinaeon
US Growth Rates	Nominal GDP (non-seasonally adjusted, in USD)	IMF IFS
Country-specific control variables		
Output Growth Rates	Nominal GDP (non-seasonally adjusted, in USD)	IMF-IFS, Monnet and Puy (2019), Central Banks, and Statistical agencies.
Inflation	Consumer Price Index (2010 = 100)	IMF IFS
Exchange Rates	Nominal exchange rate (Price of 1 USD in terms of local currency, Average period)	IMF IFS
Domestic MP Rates	Domestic interest rates (3-month government bond rates) (as proxies)	Bloomberg
Others		
GFC dummy	Before/after the Global Financial Crisis (2008Q1)	FRED (NBER recession indicator)