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Capital Flows and Income Inequality

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CAPITAL FLOWS AND INCOME INEQUALITY

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ABSTRACT. We document empirical evidence that surges in capital inflows (outflows) raise (reduce) income inequality. We study the mechanism through which changes in capital flows and capital account policies can influence income distributions in a small open economy model. Our model features heterogeneous agents and financial frictions, with banks intermediating between household savings and entrepreneur investment. Inflow surges disproportionately raise entrepreneur income, exacerbating inequality, while increases in outflows boost the share of household income, alleviating inequality. Under capital-skill complementarity, capital account liberalization that induces net capital inflows raises both the skill wage premium and overall income inequality. These predictions are in line with our empirical evidence.

I. Introduction

Surges in capital inflows driven by changes in global economic conditions can have adverse impacts (Ghosh et al., 2014, 2016). In the short run, capital inflows can benefit the destination economy by reducing the cost of financing domestic consumption and investment. Over time, however, capital flow reversals can cause painful sudden stops (Calvo, 1998), elevating the risks of domestic banking crises (Mendoza, 2010; Caballero, 2016). Policymakers have acknowledged the potential adverse effects of excessive capital flows. For example, while the IMF advocated capital account openness, it has become more amenable in recent years to the use of capital account restrictions as a "... part of the policy toolkit to manage inflows" (Ostry et al., 2010).

Capital flows may also influence the distribution of income. For example, de Haan and Sturm (2016) argue that the benefits of inflow surges disproportionately accrue to agents who are more adept at capitalizing on them, exacerbating the skewness of the distribution of income. In contrast, when capital flow reversals occur, the burdens are likely to fall disproportionately on the poor. Similarly, Furceri and Loungani (2018) and Furceri et al. (2019) document evidence that episodes of capital account liberalization are associated with increased inequality.

In this paper, we examine the relations between capital flow surges and income distributions, both empirically and theoretically.

We first document empirical evidence that capital flows have significant impacts on income inequality. We use an unbalanced panel of 128 countries, including both advanced economies (AE) and emerging market economies (EME), during the period from 2000 to 2020 to estimate the impact of changes in both gross capital flows (inflows and outflows) and net capital inflows on income inequality, measured by year-over-year changes in the Gini coefficient.

To address potential endogeneity issues, we instrument our capital flow measures using changes in two-year U.S. Treasury yields interacted with a measure of financial remoteness constructed by Rose and Spiegel (2009) based on the great-circle distance from New York City, the financial center of the United States. Under the assumption that the non-U.S. economies in our sample are small relative to the global financial market, an easing of U.S. financial conditions should encourage capital flows to other economies. To identify the relative impact of this shock across foreign countries, we follow the literature in assuming that gravity effects imply that proximity to the United States amplifies a nation's sensitivity to changes in U.S. financial conditions.

Our evidence suggests that this instrumental variable is valid and null hypothesis of weak instruments is strongly rejected.

We estimate that, on average, a one standard deviation increase in capital inflows is associated with a 0.75 percentage point increase in the year-over-year changes in a country's Gini coefficient, while a one standard deviation increase in outflows is associated with a 0.79 percentage point decrease. We also find that a one standard deviation increase in *net* inflows is associated with a 0.39 percentage point increase in the growth rate of a country's Gini coefficient. These numbers are statistically and economically significant, and are robust to a wide variety of perturbations in specification, sample, and estimation method.

To understand the mechanisms that drive the empirical link between capital flows and income distributions, we next construct a small open economy model with heterogeneous agents and financial frictions.

The model features two types of infinitely-lived agents: households and entrepreneurs, with a large number of each type. Competitive firms use capital, skilled labor and unskilled labor to produce a homogeneous consumption good. The production technology features capital-skill complementarity in the spirit of Krusell et al. (2000). Entrepreneurs supply skilled labor to firms. They have access to an investment technology that transforms consumption goods to productive capital. They finance spending from labor income, capital returns, and borrowings from domestic banks and foreign investors. Foreign borrowing rates include a risk premium that depends on the size of the external debt (Neumeyer and Perri, 2005; Uribe and Yue, 2006). Households supply unskilled labor to firms. They do not have access to the investment technology. They can save in domestic banks or buy foreign assets. Competitive and risk-neutral domestic banks take deposits from the households and extend loans to the entrepreneurs. Financial intermediation costs generate a spread between deposit and lending interest rates, as in Cúrdia and Woodford (2016). The government imposes taxes on both capital inflows and outflows, and rebates the tax revenues to domestic households and entrepreneurs.

In this model environment, changes in capital flows impact on income distributions through changes in capital returns and capital-skill complementarity. We use our model to study the implications of capital flow shocks and capital account policies for the distribution of income between households and entrepreneurs.

The model predicts that a shock that leads to a surge in capital inflows benefits entrepreneurs more than households, and therefore increases income inequality,

whereas a shock that leads to an increase in capital outflows would reduce income inequality. Capital flow shocks in our model impact not only on capital income distributions through their effect on relative returns on entrepreneurs' capital investment vs. households' savings, but also on labor income distributions through capital-skill complementarity.

In our model, a shock that induces capital outflows (e.g., a reduction in the capital outflow tax rate) would raise the households' capital income by boosting the domestic deposit rate. Facing higher funding costs, banks increase the lending rate, depressing investment and output. The contraction in output reduces the marginal product of capital, lowering the entrepreneurs' capital income. Although the decline in investment reduces future capital stocks, mitigating the decline in capital rents, the decline in output under our calibration dominates, leading to persistent declines in capital rents. The fall in capital stocks also reduces the skill wage premium through capital-skill complementarity, lowering the entrepreneurs' share in labor income as well. Thus, the shock that induces capital outflows also reduces income inequality measured by the Gini coefficient.

In contrast, a shock that induces capital inflows (e.g., a reduction in the inflow tax rate) increases income inequality. With increased capital inflows, entrepreneurs rely less on domestic banks for financing investment spending, leading to a decline in the domestic lending rate and reducing the financing costs of investment. This in turn boosts investment and production, raising the levels of labor income for both households and entrepreneurs. Increased investment leads to increases in future capital stocks, raising the skill wage premium through capital-skill complementarity. Thus, the entrepreneurs' share in labor income rises. Meanwhile, the entrepreneurs' share in capital income also rises because the expansion in production raises capital rental income. Overall, the shock that induces a surge in capital inflows also skews the income distribution in favor of entrepreneurs, raising income inequality measured by the Gini. A shock that induces *net* capital inflows (e.g., a decline in the foreign interest rate) would raise income inequality through the same channels.

To evaluate the quantitative importance of the model's mechanism, we simulate the model and run the same regressions using simulated data as we do using actual data. We obtain estimates of the relation between changes in the Gini and capital flows that are very similar—both qualitatively and quantitatively—to those using actual data. This finding suggests that the model's mechanism is empirically plausible and quantitatively important.

Our paper contributes to the literature on the implications of capital account policies. Capital account restrictions have been shown to distort financial markets (Edwards, 1999; Jeanne et al., 2012), international trade (Wei and Zhang, 2007; Costinot et al., 2014), and the ability of the central bank to stabilize the macroeconomy (Chang et al., 2015; Liu and Spiegel, 2015).[1] Our work is also related to the literature on capital account liberalization in the presence of financial frictions (Aoki et al., 2009; Wang et al., 2016; Liu et al., 2019).

Our primary focus is the distributional implications of capital account policies. In an earlier study, Bumann and Lensink (2016) examine restrictions on *net* capital flows. They show that liberalization can raise capital inflows, with the distributional impacts dependent on the level of financial sector development. In contrast, our analysis considers the implications of liberalization of *gross* capital flows, with changes in capital inflows and outflows having quite different implications for income distributions.

II. Capital flows and income distributions: Empirical evidence

This section provides cross-country evidence that surges in capital inflows (outflows) increase (decrease) income inequality.

II.1. **Data and methodology.** We examine the impact of changes in capital flows on income distributions using an unbalanced panel of 128 advanced and emerging market economies, with annual data from 2000 to 2020.[2]

We measure gross capital outflows by the sum of net acquisitions of financial assets in the financial account in US dollars obtained from the IMF Balance of Payments Statistics (BOPS). Gross capital inflows are measured by the sum of the net incurrences of liabilities in the financial account, also obtained from the BOPS. We measure income inequality using the Gini coefficients provided by the Standardized World Income Inequality Database. We describe the data and their sources in Appendix A.

Figure 1 displays the scatter plot of average annual growth in the Gini coefficient against net capital inflows between 2001 and 2020 for a cross-section of 79 advanced and emerging economies that are not offshore financial centers (OFC), each with a

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[1]See Wei (2018), Erten et al. (2019), and Rebucci and Ma (2019) for recent surveys of the literature on capital controls.

[2]With our baseline conditioning variables included, the number of countries in our sample falls to 119 and our sample runs from 2000-2019. Our baseline model includes GDP and population series as conditioning variables. These series are obtained from the Penn-World Tables 10.0, constraining the size of our sample. However, we demonstrate below that our results are robust to dropping these conditioning variables and examining the full 128 country sample.
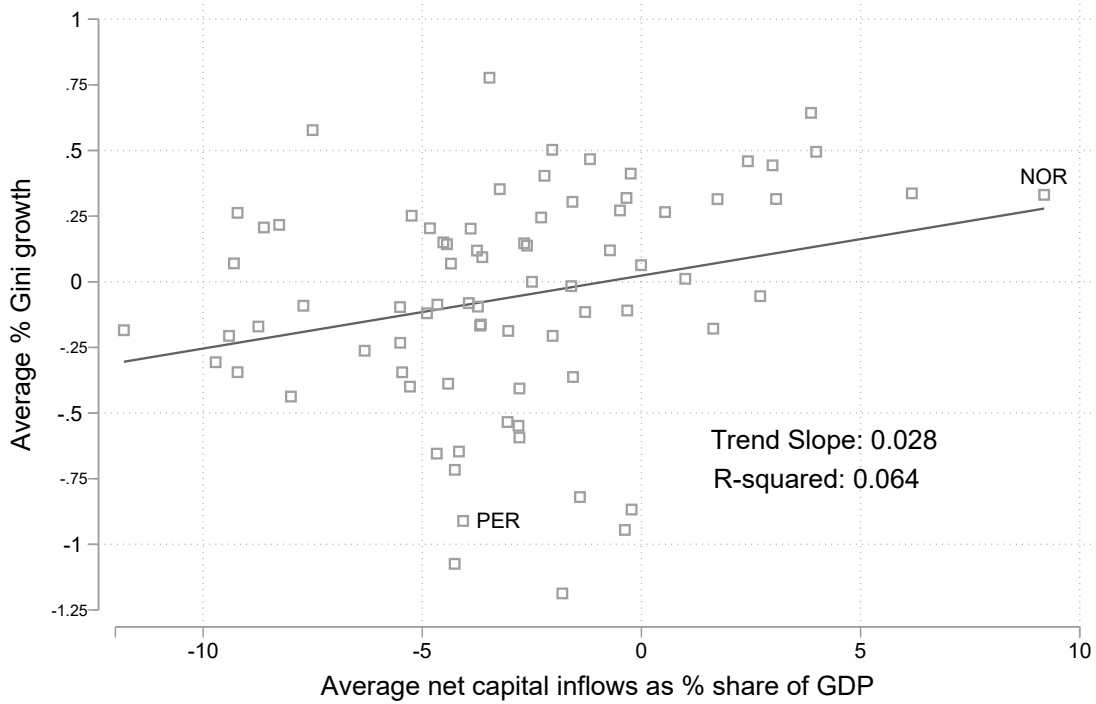
FIGURE 1. Average annual percentage growth rate in the Gini coeffi-
cient and average net capital inflows (as a share of GDP) in 79 advanced
and emerging economies, each with a population size above two million,
over the years from 2001 to 2020. The regression line reports univariate
regression. See the text for variable definitions and data sources.

population size of at least 2 million. The correlation between these two averages is
positive and statistically significant at a 5% confidence level.[3]

The figure also highlights Norway and Peru as two countries with contrasting ex-
periences in capital flows and income inequality. During this time period, Norway
experienced large net capital inflows on average and also a substantial increase in
Gini growth. Peru had the opposite experience, with net capital outflows on average
and a decline in Gini growth. These patterns are suggestive of a positive relation
between income inequality and capital inflows.

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[3]We include the 79 economies with at least 10 years of data for income inequality and capital
flows between 2001 and 2020. We drop small countries with population under 2 million and OFCs:
Hong Kong, Russia, Morocco, Mauritius, Israel, Lebanon, Cyprus, Singapore, Panama, Uruguay,
Philippines, Malaysia, Thailand, Malta, Costa Rica, and Barbados. We also drop Mongolia because
it has an exceptional experience of capital outflows close to 20% of GDP on average during this
period.

Since capital flows are potentially endogenous to domestic economic conditions, we use instrumental-variables (IV) estimation to isolate exogenous movements in capital flows and their implications for income inequality. We consider the countries in our sample to be relatively small, and thus changes in world interest rates represent exogenous shocks. We measure the world interest rate by movements in the two-year U.S. Treasury yields, obtained from FRED of the Federal Reserve Bank of St. Louis. Unlike the short-term interest rates such as the three-month Treasury bills rate, the two-year U.S. Treasury yields did not reach the zero lower bound (ZLB) in our sample.[4]

To distinguish the impact of movements in two-year U.S. Treasury yields across countries, we interact the interest rate movements with a measure of financial remoteness, and use this interaction variable (denoted by $INTREMOTE$) as an instrument for capital flows. We follow Rose and Spiegel (2009) and measure financial remoteness by the logarithm of the great-circle distance of a country from New York City, the financial center of the United States.[5] A large literature documents that costs of financial intermediation increase with geographic distance, with distance impacting both investment returns and lending behaviors. Indeed, Portes and Rey (2005) demonstrate that physical distance is a superior predictor of patterns in financial flows relative to the share of trade flows explained by the well-known "gravity model". As a result, some studies have found that financial remoteness is associated with enhanced business cycle volatility [Rose and Spiegel (2009)] and reduced global monetary policy "discipline" [Spiegel (2009)].

Because our baseline regression includes both inflows and outflows as independent variables, we include regional dummies as additional instrumental variables identifying countries from from Asia ($ASIA$), Africa ($AFRICA$), or the Western Hemisphere ($WESTHEM$). By including these regional dummies as instruments, we implicitly assume that the regional location of a country affects annual changes in its income

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[4]Swanson and Williams (2014) argue that, during the financial crisis of 2008-2009 when the short-term policy rate reached the ZLB, the Federal Reserve's unconventional policies such as quantitative easing and forward guidance are still effectively transmitted through longer-term (such as the two-year) Treasury yields. In a robustness check, we also use the 1-year or 10-year yields as an alternative for constructing our instrument for capital flows. We have obtained similar results. See Table A.2 in Appendix B.

[5]Rose and Spiegel (2009) identify remoteness as the minimum distance of a country to either New York, London, or Tokyo. However, since our interacted variable is the two-year U.S. Treasury yields, remoteness from the United States seems more appropriate for our purposes.

distribution only through its impact on capital flows. We report weak-instrument diagnostics below.[6]

Our use of regional fixed effects as instruments precludes the inclusion of country fixed effects in the second stage specification, so we also introduce a battery of conditioning variables to control for other characteristics that may influence changes in income distribution. We include the Chinn and Ito (2008) measure of capital account openness ($CAPOPEN$), the World Bank governance indicator for "control of corruption" ($LOWCORR$), the median age of the population (AGE), production-based GDP per capita ($GDPPCAP$), and the population size (POP) from the Penn World Tables 9.1. Since the two-year Treasury yields are likely to influence global financial conditions, we also control for time fixed effects.

We consider two empirical specifications to study the relation between changes in income inequality and gross and net capital flows. Our baseline second-stage specification for gross inflows and outflows satisfies

$$GGINI_{i,t} = c + \beta_1 INFLOWS_{i,t} + \beta_2 OUTFLOWS_{i,t} + \beta X_{i,t} + \theta_t + \epsilon_{i,t}, \quad (1)$$

where $GGINI_{i,t}$ denotes the change in country i's Gini coefficient from year $t-1$ to year t, $INFLOWS_{i,t}$ and $OUTFLOWS_{i,t}$ denote gross capital inflows and outflows, respectively, as a share of GDP for country i in year t , $X_{i,t}$ denotes the set of conditioning variable discussed above, θ_t represents time fixed effects, and $\epsilon_{i,t}$ represents the regression residual, with standard errors clustered by year.

Similarly, our baseline second-stage specification for net capital inflows satisfies

$$GGINI_{i,t} = c + \gamma_1 NINFLOWS_{i,t} + \gamma X_{i,t} + \theta_t + \epsilon_{i,t}, \quad (2)$$

where $NINFLOWS_{i,t}$ represents net inflows into country i in year t as a share of GDP, calculated as the difference between $INFLOWS_{i,t}$ and $OUTFLOWS_{i,t}$. We use the same set of conditioning variables $X_{i,t}$ as those in the specification (1).

Table 1 displays the summary statistics for the sample used in our baseline regressions. Our sample shows substantial variability in both changes in the GINI coefficient and the measures of capital flows. We therefore consider the sensitivity of our results to winsorizing the data in our robustness checks, discussed below.

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[6]See Pflueger and Wang (2015) for discussions of weak instrument tests in linear IV regressions and Finlay et al. (2014) for Stata implementations of weak-instrument robust tests. We have also calculated robust F statistics for the first-stage weak instrument test. Although such F statistics may have questionable accuracy in regressions with more than one endogenous regressor, they reject the null of weak instruments in our first-stage regressions.

TABLE 1. Summary Statistics

Variables	N	Mean	Std. Dev.	Min	Max
$GGINI$	1626	-0.001	0.007	-0.030	0.039
$INFLOWS$	1626	0.055	0.163	-0.443	1.989
$OUTFLOWS$	1626	0.090	0.180	-0.991	2.015
$NINFLOWS$	1626	-0.035	0.092	-0.832	0.965

Note: Summary statistics of the data sample for the baseline regressions. $GGINI$ denotes the annual change in the GINI coefficient, $INFLOWS$ denotes gross capital inflows, $OUTFLOWS$ denotes gross capital outflows, and $NINFLOWS$ denotes net capital inflows (i.e., the difference between $INFLOWS$ and $OUTFLOWS$). See the text for detailed descriptions of these variables.

Source: IMF International Balance of Payments Statistics and the Standardized World Income Inequality Database.

While changes in the GINI coefficient in our sample are only slightly negative on average, $GGINI$ displays substantial variability, with a standard deviation about 7 times as large as the mean and varies from -3 to 4 percent. Capital inflows as a share of GDP are positive on average (about 5.5 percent) per year. However, there are clearly large surges in both capital inflows and outflows in our data, with flows in some years in our sample exceeding the value of a country's GDP.[7] Such large surges in capital flows can be particularly true for "risk off" episodes in our sample, including the global financial crisis. We therefore consider the implications of omitting the crisis years from our sample in one of our robustness exercises below.

II.2. **Baseline results.** Table 2 shows the regression results under our baseline empirical specifications. Our base specification results demonstrate that an increase in gross capital inflows is associated with an increase in income inequality, while an increase in gross outflows is associated with a decrease in income inequality [see Column (1)]. Our estimated coefficient on gross inflows is statistically significant at a 5% confidence level, while that for gross outflows is significant at a 1% confidence level.

Based on the summary statistics in Table 1, the point estimates in Column (1) of Table 2 indicate that a one standard deviation annual increase in inflows is associated on average with a 0.75 percentage point increase in the growth of a country's Gini

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[7]Note that while our measures of gross inflows and outflows are positive on average, we also observe large negative movements in these flows. Essentially, our measurement treats changes in asset holdings as outflows and changes in liability holdings as inflows. As such, for example, a large principal payment on debt issuance would be considered a negative movement in inflows, and could result in a negative value for overall annual inflows.

TABLE 2. Baseline Regression Results

Dependent variable: GGINI	(1)	(2)	(3)	(4)	(5)	(6)
INFLOWS	0.046**		0.124***		0.115***	
	(0.018)		(0.028)		(0.025)	
OUTFLOWS	-0.044***		-0.088***		-0.093***	
	(0.012)		(0.018)		(0.029)	
NINFLOWS		0.042***		0.071***		0.098***
		(0.009)		(0.015)		(0.032)
AGE	0.000***	0.000***				
	(0.000)	(0.000)				
CAPOPEN	-0.000	-0.000				
	(0.001)	(0.001)				
INFCONT			0.006***	0.004***		
			(0.001)	(0.001)		
OUTCONT			-0.004***	-0.004***		
			(0.001)	(0.001)		
LOWCORR	0.000	0.001**	-0.001	0.001***		
	(0.000)	(0.000)	(0.001)	(0.000)		
GDPPCAP	-0.000***	-0.000***	-0.000**	-0.000***		
	(0.000)	(0.000)	(0.000)	(0.000)		
POP	0.000***	0.000***	0.000***	0.000***		
	(0.000)	(0.000)	(0.000)	(0.000)		
Constant	-0.003**	-0.003**	-0.002	0.001	0.002**	0.003***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Observations	1626	1626	1102	1102	1787	1787
CLR	14.06	14.05	15.85	15.69	15.91	15.38
	[0.005]	[0.005]	[0.003]	[0.003]	[0.003]	[0.003]
AR	15.11	15.11	16.01	16.01	16.45	16.45
	[0.005]	[0.005]	[0.003]	[0.003]	[0.003]	[0.003]
Wald	28.37	22.08	24.11	21.51	31.82	9.47
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]

Note: Dependent variable: Year-over-year changes in the Gini coefficient. Two-stage least squares estimation with $INTREMOTE$ and regional dummies as instruments for $INFLOWS$, $OUTFLOWS$, $NINFLOWS$. Year fixed effects are included in all specifications. See the text for variable definitions. For models (1), (2), we use the base sample with the conditioning variables, including the Chinn and Ito (2008) measure of capital account openness ($CAPOPEN$). For models (3), and (4), we replace the Chinn and Ito (2008) index by the Fernández et al. (2016) indices for restrictions on capital inflows ($INFCONT$) and capital outflows ($OUTCONT$). Models (5) and (6) drop the conditioning variables, and thus expand the sample size. Standard errors clustered by year are shown in parentheses. P-values are reported for CLR, AR, and Wald tests of weak instruments. Statistical significance levels are indicated by the asterisks: *** p<0.01, ** p<0.05, and * p<0.10.

coefficient in that year, while a one standard deviation increase in outflows is associated with a 0.79 percentage point decrease.[8] The CLR, AR and Wald statistics all strongly reject the null of weak instruments, with a p-value of less than 1%.

Column (2) in Table 2 reports the regression results in the specification for net capital inflows. The estimation results show that an increase in net inflows is associated with increased income inequality, again with statistical significance at a 1% confidence level. Our point estimate indicates that a one standard deviation increase in net inflows is associated with a 0.39 percentage point increase in the growth of country's Gini coefficient in that year. As in the case for the gross flow regression in Column (1), the CLR, AR, and Wald statistics continue to reject the null of weak instruments.

Columns (3) and (4) in Table 2 substitute the Fernández et al. (2016) indices which separately represent controls on inflows and outflows for the Chinn-Ito index of overall capital account openness. This alternative measure reduces our coverage and the size of our sample, but the qualitative results remain the same. As in our base regression, we obtain statistically significant positive and negative coefficients for the impact on growth in income inequality from capital inflows and outflows respectively. Our coefficient point estimates are also larger in absolute value, about twice as large for outflows and close to three times the size for inflows. We also obtain a larger point estimate for net capital flows. The results for all the common conditioning variables are also comparable, leaving us to conclude that our results are largely robust to either form of conditioning for capital account restrictions. As before, the CLR, AR and Wald diagnostics all strongly reject the null of weak instruments with a p-value of less than 1%.

To demonstrate that our baseline estimation results are not driven by the second-stage conditioning variables, we drop the conditioning variables from our second-stage regressions and run our full 128 country sample in columns (5) and (6). These results are also qualitatively similar, as increases in gross (or net) capital inflows continue to raise inequality, while increases in gross outflows continue to reduce it. These effects are statistically significant at the 1% level, and the magnitudes are roughly double those obtained in the baseline specifications.

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[8]To get these numbers, we multiply the standard deviation of the capital inflows (0.163) or outflows (0.180) by the point estimates of the coefficient on these two variables in the baseline regression (0.046 and -0.044, respectively), and scale the results by 100 to obtain the percentage point changes in the growth rate of the Gini coefficient.

II.3. **Robustness.** We have conducted a battery of further robustness checks. Those results are presented in Appendix B.

We first consider a variety of alternative specifications. These include dropping the conditional variables, as we do in columns (5) and (6) of Table 2, but restricting our sample to those in our base specification. We then consider a number of alternative specifications with additional conditioning variables added one at a time, including average years of schooling, the World Governance Indicators (WGI) for voice and accountability, political stability, government effectiveness, regulatory quality, and rule of law; bank lending rates, our remoteness measure, the share of self-employment in the population, and individual country dummies. We also consider alternative measures of our $INTREMOTE$ variable with 1 and 10-year US treasury rates substituted for our base 2-year measure. We consider both substituting these alternative measures for our base measure and adding them to the base measure one at a time.

Our results are robust to almost all of these alternative specifications as the estimated coefficients on the variables of interest continue to enter with their predicted signs and similar levels of statistical significance. One exception is the case for capital outflows in the model with the average years of schooling variable added.[9] We also find that with the WGI Rule of law indicator or the remoteness variable added the $INFLOWS$ variable continues to enter with the same sign, but insignificantly, while the $OUTFLOWS$ and $NINFLOWS$ variables continue to enter significantly with their expected signs at standard confidence levels.

We also examine the robustness of our results to a variety of changes in sample. We drop the extreme observations with very large or very small capital inflows and outflows one at a time, with the outliers defined as observations more than three standard deviations from the sample mean. We also drop observations with exceptionally unequal or exceptionally equal income distributions, and those with exceptionally remote or proximate countries, again one at a time with the outliers defined as the realizations more than three standard deviations from the sample mean. We also drop observations coinciding with the 2008 and 2009 global financial crisis. For all of these perturbations, we re-estimate our base specification and cluster the standard errors by year. Our estimation results are robust to all of these perturbations. The

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[9]The issue with the years of schooling variable appears to be its impact on our sample. When we include the education variable, the sample is reduced from 1,626 to 1,390 observations. To confirm this, we reestimated our baseline specification without the education variable for this smaller sample. All three variables of interest lose their statistical significance. These results are available on request from the authors.

estimated coefficients on the variables of interest all enter with the predicted signs and with strong statistical significance.

Finally, we examine the robustness of our results to changes in estimation methods. First, to demonstrate that our baseline estimation results are not driven by outliers in the data, we winsorize the sample at the 1% level. Next, we re-estimate our baseline specification with White's heteroskedasticity-robust standard errors, and then with regular standard errors. All of the specifications continue to enter with statistical significance and with point estimates similar to what we obtain under the base specification.

Overall, the empirical results provide robust evidence that capital inflows, both gross and net, are associated with short-run increases in income inequality, whereas capital outflows are associated with short-run declines in inequality.

III. The model

To understand the empirical link between capital flows and income inequality, we construct a small open economy model with two types of infinitely-lived agents, entrepreneurs and households, with a continuum of each type. We normalize the population size to one and assume that the share of households is $\theta \in (0, 1)$. There is a homogeneous consumption good produced by competitive firms using capital and labor supplied by the two types of agents. Entrepreneurs supply skilled labor to firms and accumulate capital. They finance the acquisition of capital through labor income and borrowings from domestic banks and foreign investors. Households supply unskilled labor to firms, although they do not have access to capital investment technology. Households can save in domestic banks or buy foreign assets.[10] We allow for endogenous variations in the discount factors of each type of agents to ensure the model to be stationary.

Domestic banks operate in a perfectly competitive market, taking as given the market interest rates on deposits and loans. Banks face financial intermediation costs, which give rise to a credit spread, driving a wedge between the deposit and lending interest rates. The government implements capital account restrictions by taxing earnings on both capital inflows and outflows.

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[10]This is a simplifying assumption to keep our model tractable. In reality, especially in emerging market economies, savers and unskilled labor are not perfectly correlated. Some entrepreneurs are also savers.

III.1. **Households.** The representative household has the utility function

$$U_{ht} = E \sum_{s=0}^{\infty} \beta_{h,t+s} \ln(c_{h,t+s}), \tag{3}$$

where E is an expectation operator, c_{ht} denotes consumption in period t, and β_{ht} denotes a time-varying subjective discount factor. To ensure stationarity of the small open economy model, we follow the approach of Schmitt-Grohe and Uribe (2003) by assuming that the discount factor is endogenous and depends on average household consumption $\bar{c}_{h,t}$. Specifically, the discount factor is given by

$$\beta_{h,t+1} = \beta_{ht} \gamma (1 + \bar{c}_{ht})^{-\chi}, \tag{4}$$

where $\gamma > 0$ is a scale parameter and $\chi > 0$ measures the elasticity of the discount factor with respect to average household consumption.[11]

In each period t, the household chooses consumption (c_{ht}), domestic bank deposits (d_t), and foreign assets (b_{ft}^d) to maximize the utility function (3), subject to Eq. (4) and the sequence of budget constraints

$$c_{ht} + d_t + b_{ft}^d = w_{ht} h_{ht} + R_{t-1} d_{t-1} + (1 - \tau_{dt}) R_{t-1}^* b_{f,t-1}^d + t_{ht}. \tag{5}$$

where h_{ht} denotes the household's endowment of low-skill labor, which is inelastically supplied to firms at the competitive wage rate w_{ht} for low-skill workers; R_t denotes the domestic deposit interest rate; R_t^* denotes the world risk-free interest rate; τ_{dt} denotes the tax rate on earnings from foreign assets (i.e., a capital outflow tax); and t_{ht} denotes lump-sum transfers from the government and dividend income from domestic banks.

The household's optimizing decisions imply the Euler equations

$$1 = E_t \gamma (1 + \bar{c}_{h,t})^{-\chi} R_t \frac{c_{ht}}{c_{h,t+1}}, \tag{6}$$

$$1 = E_t \gamma (1 + \bar{c}_{h,t})^{-\chi} (1 - \tau_d) R_t^* \frac{c_{ht}}{c_{h,t+1}}, , \tag{7}$$

which in turn imply the no-arbitrage condition

$$R_t = (1 - \tau_{dt}) R_t^*. \tag{8}$$

A positive tax rate τ_{dt} represents capital outflow controls and it drives a wedge between the domestic deposit rate and the world interest rate.

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[11]This type of preference, originally introduced by Uzawa (1968), has been widely used in the small open economy literature. Examples include Mendoza (1991),Uribe (1997),Schmitt-Grohe (1998), Schmitt-Grohe and Uribe (2003), and Ju et al. (2021).

III.2. **Entrepreneurs.** The representative entrepreneur has the utility function

$$U_{et} = \mathrm{E} \sum_{s=0}^{\infty} \beta_{e,t+s} \ln(c_{e,t+s}), \tag{9}$$

where c_{et} denotes the entrepreneur's consumption in period t and β_{et} denotes the entrepreneur's time-varying discount factor. Similar to that for the household, we assume that the entrepreneur's discount factor is a function of average entrepreneur consumption $\bar{c}_{et}$ and it is given by

$$\beta_{e,t+1} = \beta_{et}\gamma(1 + \bar{c}_{et})^{-\chi}. \tag{10}$$

The entrepreneur has access to an investment technology that transforms final consumption goods into productive capital. The capital stock (k_t) held by the entrepreneur evolves according to the law of motion

$$k_t = (1 - \delta)k_{t-1} + \left[1 - \frac{\Omega_k}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t. \tag{11}$$

where i_t denotes the flow of investment, $\delta \in [0, 1]$ denotes the capital depreciation rate, and the term in the squared brackets shows the quadratic investment adjustment cost function, the size of which is governed by the parameter Ω_k.

The entrepreneur is endowed with h_{et} units of skilled labor, which is inelastically supplied to firms at the competitive wage rate w_{et}. The entrepreneur rents the available capital stock at the beginning of period t (k_{t-1}) to firms at the competitive rental rate r_t^k. The entrepreneur uses the labor income, capital rental income, along with loans b_{et} and transfer payments t_{et} to finance consumption, investment, and repayments of loans at the loan interest rate R_{lt}. Thus, the entrepreneur faces the sequence of budget constraints

$$c_{et} + i_t + R_{l,t-1}b_{e,t-1} = w_{et}h_{et} + r_t^k k_{t-1} + b_{et} + t_{et}. \tag{12}$$

The entrepreneur chooses consumption c_{et}, borrowing b_{et}, and investment i_t to maximize the utility function (9) subject to Eq. (10), (11), and (12). The entrepreneur's

optimizing decisions imply the following Euler equations

$$1 = \mathrm{E}_t \gamma (1 + \bar{c}_{e,t})^{-\chi} R_{lt} \frac{c_{e,t}}{c_{e,t+1}}, \tag{13}$$

$$q_t^k = \mathrm{E}_t \gamma (1 + \bar{c}_{e,t})^{-\chi} [q_{t+1}^k (1 - \delta) + r_{t+1}^k] \frac{c_{e,t}}{c_{e,t+1}}, \tag{14}$$

$$1 = q_t^k [1 - \frac{\Omega_k}{2} (\frac{i_t}{i_{t-1}} - 1)^2 - \Omega_k (\frac{i_t}{i_{t-1}} - 1) \frac{i_t}{i_{t-1}}] + \tag{15}$$

$$\mathrm{E}_t \gamma (1 + \bar{c}_{e,t})^{-\chi} \frac{c_{e,t}}{c_{e,t+1}} q_{t+1}^k \Omega_k (\frac{i_{t+1}}{i_t} - 1)(\frac{i_{t+1}}{i_t})^2 ..$$

where q_t^k denotes the Tobin'q, defined as the ratio the marginal value of capital (i.e., the Lagrangian multiplier for Eq. (11)) to the marginal utility of income (i.e., the Lagrangian multiplier for the budget constraint (12)).

The aggregate capital stock K_t and investment I_t are then given by

$$K_t \equiv (1 - \theta)k_t, \quad I_t \equiv (1 - \theta)i_t. \tag{16}$$

III.3. **Firms.** There is a continuum of identical and competitive firms with measure one. The representative firm produces a homogeneous good Y_t using capital K_{t-1}, low-skill labor H_{ht} and high-skill labor H_{et}. Following Krusell et al. (2000), we introduce capital-kill complementarity using a nested CES production function

$$Y_t = \left[(\alpha_u)^{\frac{1}{\sigma}} (H_{ht})^{\frac{\sigma-1}{\sigma}} + (1 - \alpha_u)^{\frac{1}{\sigma}} (V_t)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{17}$$

where

$$V_t = \left[(\alpha_k)^{\frac{1}{\rho}} (K_{t-1})^{\frac{\rho-1}{\rho}} + (1 - \alpha_k)^{\frac{1}{\rho}} (H_{et})^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}. \tag{18}$$

Here, the parameters $\alpha_u \in (0,1)$ and $\alpha_k \in (0,1)$ govern the relative importance of low-skill labor and capital inputs in production. The parameter $\rho > 0$ denotes the elasticity of substitution between capital and high-skill labor and the parameter $\sigma > 0$ denotes the elasticity of substitution between the capital-skill composite (V_t) and low-skill labor.

Cost-minimizing implies the conditional factor demand functions

$$w_{ht} H_{ht}^{\frac{1}{\sigma}} = (\alpha_u Y_t)^{\frac{1}{\sigma}}, \tag{19}$$

$$w_{et} H_{et}^{\frac{1}{\rho}} = ((1 - \alpha_u)Y_t)^{\frac{1}{\sigma}} (1 - \alpha_k)^{\frac{1}{\rho}} V_t^{\frac{\sigma-\rho}{\sigma\rho}}, \tag{20}$$

and

$$r_t^k K_{t-1}^{\frac{1}{\rho}} = ((1 - \alpha_u)Y_t)^{\frac{1}{\sigma}} (\alpha_k)^{\frac{1}{\rho}} V_t^{\frac{\sigma-\rho}{\sigma\rho}}. \tag{21}$$

The skill premium, measured by the ratio of the skilled wage and unskilled wage, is given by

$$
\begin{aligned}
\frac{w_{et}}{w_{ht}} &= (\frac{1-\alpha_u}{\alpha_u})^{\frac{1}{\sigma}} \frac{H_{ht}^{\frac{1}{\sigma}}}{H_{et}^{\frac{1}{\rho}}} (1-\alpha_k)^{\frac{1}{\rho}} V_t^{\frac{\sigma-\rho}{\sigma\rho}} \\
&= (\frac{1-\alpha_u}{\alpha_u})^{\frac{1}{\sigma}} \frac{H_{ht}^{\frac{1}{\sigma}}}{H_{et}^{\frac{1}{\rho}}} (1-\alpha_k)^{\frac{1}{\rho}} \left[(\alpha_k)^{\frac{1}{\rho}} (K_{t-1})^{\frac{\rho-1}{\rho}} + (1-\alpha_k)^{\frac{1}{\rho}} (H_{et})^{\frac{\rho-1}{\rho}} \right]^{\frac{\sigma-\rho}{\sigma(\rho-1)}} \quad (22)
\end{aligned}
$$

If $\sigma > \rho$, the production function features capital-skill complementarity. In this case, an increase in the capital stock raises the marginal product of high-skill labor more than the marginal product of low-skill labor. For any given labor supply, an increase in the capital stock raises the skill premium, as in Krusell et al. (2000).[12]

III.4. **Banks.** There is a continuum of competitive banks with measure one. The representative bank takes deposits D_t from households at the deposit interest rate R_t and lends to entrepreneurs at the lending interest rate R_{lt}, where $D_t \equiv \theta d_t$ denotes the aggregate deposits held by the households.

Following Cúrdia and Woodford (2016), we assume that financial intermediation is costly. In the process of originating B_t units of loans, the bank needs to spend real resources $\Xi\left(\frac{B_t}{Y_t}\right) Y_t$ (in units of final output). The function $\Xi(\frac{B_t}{Y_t})$ takes the form

$$
\Xi\left(\frac{B_t}{Y_t}\right) = \xi\left(\frac{B_t}{Y_t}\right)^\eta, \quad (23)
$$

where the elasticity parameter $\eta > 1$, implying that the intermediation cost function $\Xi(\cdot)$ is strictly increasing and strictly convex. The convexity of $\Xi(\cdot)$ reflects diseconomies of scale in the enforcement of loan contracts.

Taking the interest rates and aggregate output as given, the representative bank chooses deposits D_t and loans B_t to maximize profits

$$
\Pi_t^b \equiv D_t - B_t - \Xi\left(\frac{B_t}{Y_t}\right) Y_t, \quad (24)
$$

subject to the flow-of-funds constraint

$$
R_{lt}B_t = R_t D_t. \quad (25)
$$

---

[12] For simplicity, we follow Krusell et al. (2000) and abstract from the general equilibrium effect from endogenous skill accumulation. See He and Liu (2008) for a general equilibrium model with capital-skill complementarity and endogenous skill accumulation decisions.

At the end of the period, the bank distributes all excess funds received from depositors that are not lent out or used to cover the intermediation costs to its shareholders (i.e., the households) in the form of dividend payments.

The optimizing credit supply decision implies that

$$R_{lt} = R_t \left[1 + \Xi' \left(\frac{B_t}{Y_t} \right) \right]. \tag{26}$$

Thus, financial intermediation costs drive a wedge between the loan rate and the deposit rate, with the wedge (or credit spread) given by the term $\Xi' \left(\frac{B_t}{Y_t} \right)$.[13] The convexity of the $\Xi(\cdot)$ function implies that credit spread increases with the loan-to-output ratio $\frac{B_t}{Y_t}$.

III.5. **Foreign investors.** Foreign investors lend to domestic entrepreneurs at the market loan rate R_{lt}, subject to a capital inflow tax of $\tau_{l,t}$.[14] The after-tax return for foreign investors is thus $(1 - \tau_{lt})R_{lt}$. External debt also requires a risk premium (Liu et al., 2019).

Under these assumptions, no arbitrage implies that

$$(1 - \tau_{l,t})R_{lt} = R_t^* \Phi \left(\frac{B_{ft}^l}{Y_t} \right). \tag{27}$$

where B_{ft}^l denotes the amount of foreign investment and $\Phi \left(\frac{B_{ft}^l}{Y_t} \right)$ denotes the risk premium, which depends on the amount of external debt relative to aggregate output. We assume that the risk premium function is given by

$$\Phi \left(\frac{B_{ft}^l}{Y_t} \right) = \exp \left[\Phi_b \left(\frac{B_{ft}^l}{Y_t} - \kappa_f \right) \right], \tag{28}$$

where $\kappa_f \geq 0$ denotes the desired ratio of external debt to aggregate output and the parameter $\Phi_b > 0$ measures the sensitivity of the risk premium to changes in external debts.

The dependence of the risk premium on the relative size of external debts implies an externality, as individual firms take interest rates (inclusive of the risk premium) as given. The presence of the risk premium, along with capital inflow taxes, drives a wedge between domestic loan interest rate and the world interest rate.

---

[13]This time-varying interest rate wedge captures the severity of credit frictions faced by domestic banks. As we show in the quantitative analysis, the time-varying interest rate wedge plays an important role in the transmission of capital inflow shocks to real activity and income distributions.

[14]Since the domestic deposit interest rate lies below the market loan rate (see Eq. (26)), foreign investors have no incentive to deposit funds in domestic banks.

III.6. **Market clearing and equilibrium.** In equilibrium, final goods market clearing implies that the trade surplus (i.e., net exports) is given by

$$NX_t = Y_t - \theta c_{ht} - (1 - \theta)c_{et} - I_t - \Xi(\frac{B_t}{Y_t})Y_t. \tag{29}$$

The loan market clearing condition is given by

$$B_t + B_{ft}^l = (1 - \theta)b_{et}. \tag{30}$$

We assume that individual labor supplies of both the households and entrepreneurs are inelastic and normalized to one ($h_{ht} \equiv 1, h_{et} \equiv 1$). Then, labor market clearing implies that

$$H_{ht} = \theta h_{ht} = \theta, \quad H_{et} = (1 - \theta)h_{et} = 1 - \theta. \tag{31}$$

In each period, the government collects capital control taxes and transfers these taxes to the households and the entrepreneurs. Banks distribute profits to the households and the entrepreneurs, who are their share holders. Both the capital flow taxes and bank profits are equally distributed to the households and the entrepreneurs as lump sum transfers. Specifically, the per-capita transfers are given by

$$t_{ht} = t_{et} = \tau_{d,t-1}R_{t-1}^* B_{f,t-1}^d + \tau_{l,t-1}R_{l,t-1}B_{f,t-1}^l + \Pi_t^b. \tag{32}$$

Summing up all sectors' budget constraints, we obtain the balance of payments condition

$$NX_t + (R_{t-1}^* - 1)B_{f,t-1}^d - (R_{l,t-1} - 1)B_{f,t-1}^l = (B_{ft}^d - B_{ft}^l) - (B_{f,t-1}^d - B_{f,t-1}^l). \tag{33}$$

where $B_{f,t}^d \equiv \theta b_{f,t}^d$ denotes the aggregate holdings of foreign assets by the households. The left-hand side of the equation is the current account balance, including net exports and net capital income received by the small open economy. The right-hand side is the financial account balance, measured by net capital outflows.

III.7. **Income distributions.** Each household's capital income includes interest earnings from domestic deposits and foreign asset holdings, given by

$$w_{ht}^c = (R_{t-1} - 1)d_{t-1} + [(1 - \tau_{d,t-1})R_{t-1}^* - 1]b_{f,t-1}^d. \tag{34}$$

Each entrepreneur's capital income consists of returns on capital net of interest payments on debt, given by

$$w_{et}^c = r_t^k k_{t-1} - (R_{l,t-1} - 1)b_{e,t-1}. \tag{35}$$

The per-capita labor incomes for the household and the entrepreneur are given by

$$w_{ht}^l = w_{ht}, \quad w_{et}^l = w_{et}, \tag{36}$$

We use the Gini coefficient to measure the economy's overall income inequality. Since there are two types of agents, the Gini coefficient is defined by

$$
\begin{aligned}
Gini_t &= \frac{\theta(1-\theta)|(w_{et}^c + w_{et}^l) - (w_{ht}^c + w_{ht}^l)|}{\theta(w_{ht}^c + w_{ht}^l) + (1-\theta)(w_{et}^c + w_{et}^l)} \\
&= \left| \theta - \frac{\theta(w_{ht}^c + w_{ht}^l)}{\theta(w_{ht}^c + w_{ht}^l) + (1-\theta)(w_{et}^c + w_{et}^l)} \right|.
\end{aligned}
\tag{37}
$$

If the per-capita income of the entrepreneur $(w_{et}^c + w_{et}^l)$ exceeds that of the household $(w_{ht}^c + w_{ht}^l)$, then the Gini coefficient defined here would be measured by the difference between the population share of the entrepreneurs $(1 - \theta)$ and the income share of the entrepreneurs. A decline in the entrepreneur's share in total income would lower the Gini coefficient and thus reduce income inequality.

III.8. **Shocks.** There are three types of shocks in the model, including the world interest rate shock, the capital inflow tax shock, and the capital outflow tax shock. We assume that the world risk-free interest rate R_t^* follows the stationary stochastic process

$$
\ln R_t^* = (1 - \rho_r) \ln R^* + \rho_r \ln R_{t-1}^* + \epsilon_{rt},
\tag{38}
$$

where R^* denotes the steady-state value of the world risk-free interest rate, $\rho_r \in (-1, 1)$ is a persistence parameter, and the term ϵ_{rt} is an i.i.d. innovation drawn from a log-normal distribution $N(0, \sigma_r)$.

Since capital account policies are usually long-term policies in reality, we assume that the capital inflow taxes τ_{lt} and outflow taxes τ_{dt} both follow a random walk process such that

$$
\tau_{lt} = \tau_{l,t-1} + \epsilon_{lt}, \quad \tau_{dt} = \tau_{d,t-1} + \epsilon_{dt}
\tag{39}
$$

where ϵ_{lt} and ϵ_{dt} are i.i.d. innovations drawn from a log-normal distribution with a mean of zero and a standard deviation of σ_l and σ_d, respectively.

IV. CALIBRATION

We calibrate most of the model parameters to match moments in the World Bank data over the period from 2000 to 2020 for the set of countries in the sample for our empirical analysis. The calibrated values of the parameters are summarized in Table 3.

A period in our model corresponds to 1 year. We set the discount factor parameters $\gamma = 1.12$ and $\chi = 0.10$ to match the average private consumption-to-output ratio of 67% and the average annual domestic credit spread of 7% in the World Bank data for our country sample. We set $\theta = 0.55$ such that the population share of the

entrepreneur is $1 - \theta = 0.45$, consistent with the average share of self employment in our country sample.

We calibrate the capital-skill complementarity parameters σ and ρ based on the empirical study of Duffy et al. (2004), who use a panel of 73 countries (including both advanced and emerging economies) over the period 1965-1990, a country sample that overlaps substantially with ours. For skilled labor defined as those workers who attained or completed colleges, the estimated capital-skill complementarity obtained by Duffy et al. (2004) implies an elasticity of substitution between capital and skilled labor of $\rho = 1.26$ and an elasticity of substitution between the capital-skill composite and unskilled labor of $\sigma = 2.20$.[15]

We calibrate the relative weight of capital input in production to $\alpha_k = 0.75$, implying a labor income share of 0.4, consistent with the average labor income share estimated by Karabarbounis and Neiman (2014). Our calibrated parameter $\alpha_u = 0.86$ implies a skill premium of about 1.5, which lies within the range of the cross-country skill premium estimated by Papageorgiou and Chmelarova (2005).[16]

For the parameters associated with financial frictions, we set $\xi = 0.07$, implying a steady-state domestic credit to output ratio of $\frac{B}{Y} = 0.5$, in line with the average credit-to-output ratio in our country sample.[17] We set $\eta = 1.31$ such that a 1 percent increase in the volume of domestic bank credit raises the domestic credit spread by 0.02 percentage points, consistent with the estimates by López-Espinosa et al. (2011) using bank-level data in 15 developed and emerging economies.[18]

For the parameters in the capital accumulation equation, we calibrate the investment adjustment cost parameter to $\Omega_k = 1$, which lies in the range of empirical estimates (Liu et al., 2011). We calibrate the capital depreciation rate to $\delta = 0.1$, such that the stock of capital depreciates at a rate of 10 percent per year.

---

[15]We have examined the robustness of our results to alternative definitions of skilled labor based on different levels of education studied by Duffy et al. (2004). We find that our model predictions are robust.

[16]Papageorgiou and Chmelarova (2005) estimated the country-specific skill premium for 46 developed and developing countries. These cross-country estimates range from 1.1 in Italy to 3.2 in Jamaica with a median value of 1.5.

[17]The domestic credit-to-output ratio varies widely across countries. The World Bank data shows that the domestic credit to private sector as a share of GDP per annum ranges from 25% in Mexico, to 50% in Brazil and 60% in Belgium, and to over 120% in Canada and South Africa.

[18]This elasticity of credit spread to bank credit in our model is given by $\frac{d \ln(R_l/R)}{d \ln(B)} = \frac{\xi \eta (\eta-1) B^{\eta-1}}{1 + \xi \eta B^{\eta-1}} = \frac{(\eta-1)(R_l/R-1)}{R_l/R}$.

For the parameters in the external debt risk premium function, we set the sensitivity parameter to $\Phi_b = 0.06$, consistent with the estimates obtained by Dell'Erba et al. (2013) using data on sovereign spreads and external debt in advanced and emerging market countries. We set the desired external debt-to-output ratio to $\kappa_f = 0.4$, in line with the 2002 "sustainability framework" of the IMF, which notes that 40% is the suggested ratio of external debt to annual output that should not be breached on a long-term basis.[19]

Under our calibration, households' income is lower than entrepreneurs' income in the steady state. Thus, a shock that reduces the households' income share would increase income inequality, raising the Gini coefficient.

For the parameters in the exogenous shocks, we set the steady-state values of capital control taxes to $\tau_d = 3.54\%$ and $\tau_l = 2.53\%$, implying that $\frac{B_f^d}{Y} = 0.65$ and $\frac{B_f^l}{Y} = 0.5$ in the steady state. These two steady state values are consistent, respectively, with the average ratios of foreign assets and external debts to aggregate output in our country sample. We set the standard deviations of the capital control tax shocks to $\sigma_d = 0.005$ and $\sigma_l = 0.004$ to match, respectively, the volatilities of capital outflows and inflows as shares of aggregate output (i.e., the variables $OUTFLOWS$ and $INFLOWS$ in our empirical analysis). We set the average world risk-free rate to $R^* = 1.05$. We use the annual data on U.S. one-year *ex ante* real Treasury rates estimated by the Federal Reserve Bank of Cleveland for the period from 2000 to 2020 to calibrate the world interest rate shock parameters and obtain $\rho_r = 0.6$ and $\sigma_r = 0.015$.

---

[19]International Monetary Fund, 2002, "Assessing Sustainability," SM/02/06.

TABLE 3. Calibration

Parameter	Description	Parameter Value	Target Variable	Target Value	Source
γ	Scale of discount factor	1.12	Consumption/output ratio	0.67	World Bank data
χ	Elasticity par of discount factor	0.1	Domestic credit spread	0.07	World Bank data
θ	Population share of households	0.55	Share of self-employed workers	0.45	World Bank data
α_k	Capital weight	0.75	Ave. labor income share	0.4	Karabarbounis and Neiman (2014)
α_u	low-skill labor weight	0.86	Skill wage premium	1.5	Papageorgiou and Chmelarova (2005)
σ	Substitution elasticity between capital and low-skill labor	2.20			Duffy et al. (2004)
ρ	Substitution elasticity between capital and high-skill labor	1.26			Duffy et al. (2004)
ξ	Scale of intermediation cost	0.07	Domestic bank credit to output ratio	0.5	World Bank data
η	Elasticity of intermediation cost	1.31	Sensitivity of interest rate margin to bank assets	0.02	López-Espinosa et al. (2011)
Ω_k	Investment adjustment cost	1			Liu et al. (2011)
δ	Capital depreciation rate	0.1			Dell'Erba et al. (2013)
Φ_b	Elasticity of external debt risk premium	0.06			IMF(2002)
κ_f	Desired external debt/output ratio	0.4			
τ_d	Tax rate on foreign asset	3.54%	Foreign asset to output ratio B_f^d/Y	0.65	World Bank data
τ_l	Tax rate on foreign debt	2.53%	External debt to output ratio B_f^l/Y	0.5	World Bank data
σ_d	Standard deviation of outflow tax shock	0.005	Std of outflow/GDP ratio	0.18	IMF BOPS data
σ_l	Standard deviation of inflow tax shock	0.004	Std of inflow/GDP ratio	0.16	IMF BOPS data
r^*	World interest rate	1.05			
ρ_r	Persistence of world interest rate	0.6			Real yields of one-year U.S. Treasuries
σ_r	Volatility of world interest rate	0.015			Real yields of one-year U.S. Treasuries

Note: The final column ("Source") shows the source of the target value or the parameter value if the target value is left blank. The source is labeled as "World Bank data" if we obtain the target value by calculating the historical average of the target variable using World Bank data from 2001 to 2020 for the country sample covered in our empirical analysis.

V. Quantitative exercises

We now examine the model's transmission mechanism based on impulse response functions from the calibrated model. We also assess the quantitative importance of our model's mechanism for explaining the observed link between capital flows and income inequality.

V.1. **Impulse responses to a world interest rate shock.** To help understand the economic mechanism in our model, we solve the model based on the calibrated parameters and plot the impulse responses of a few key variables to an exogenous shock to the world interest rate. We focus on world interest rate shocks because these shocks are more important for generating fluctuations in income inequality than the two types of capital flow shocks. Under our calibration, the world interest rate shock accounts for over 90% of the variance of the growth rate of the Gini coefficient ($GGINI_t$).

Figure 2 displays the impulse responses to a transitory increase in the world interest rate. The shock raises the return on foreign deposits, leading to increases in capital outflows and in the households' holdings of foreign assets. Since the shock raises the funding costs for foreign investors, it leads to a decline in capital inflows, reducing the entrepreneurs' holdings of foreign debt. Net capital inflows (i.e., changes in net foreign asset holdings) rise unambiguously.

With less capital inflows, entrepreneurs have to rely more on domestic bank loans for funding. Facing increased loan demand, banks pass through a part of the increase in their funding costs (i.e., increases in the deposit rate) to entrepreneurs by raising the domestic lending interest rate. The credit spread falls, however, because capital outflows reduce the available loanable funds for domestic banks. The increase in the lending rate depresses domestic investment and production. As a consequence, both the household and the entrepreneur experience a fall in the their labor income. In the impact period, the decline in investment does not affect the households' share in labor income because, with predetermined capital stocks, the shock has no impact on the skill wage premium. Over time, however, as the stock of capital falls, the skill premium declines, raising the households' share in labor income.

The rise in the world interest rate also raises the households' share in capital income. The shock pushes up the domestic deposit rate through the no-arbitrage condition, raising households' capital income. The shock also reduces the entrepreneurs' capital income, because the contraction in production reduces the marginal product of capital (MPK). The decline in the MPK is partially cushioned by the reduction in the capital
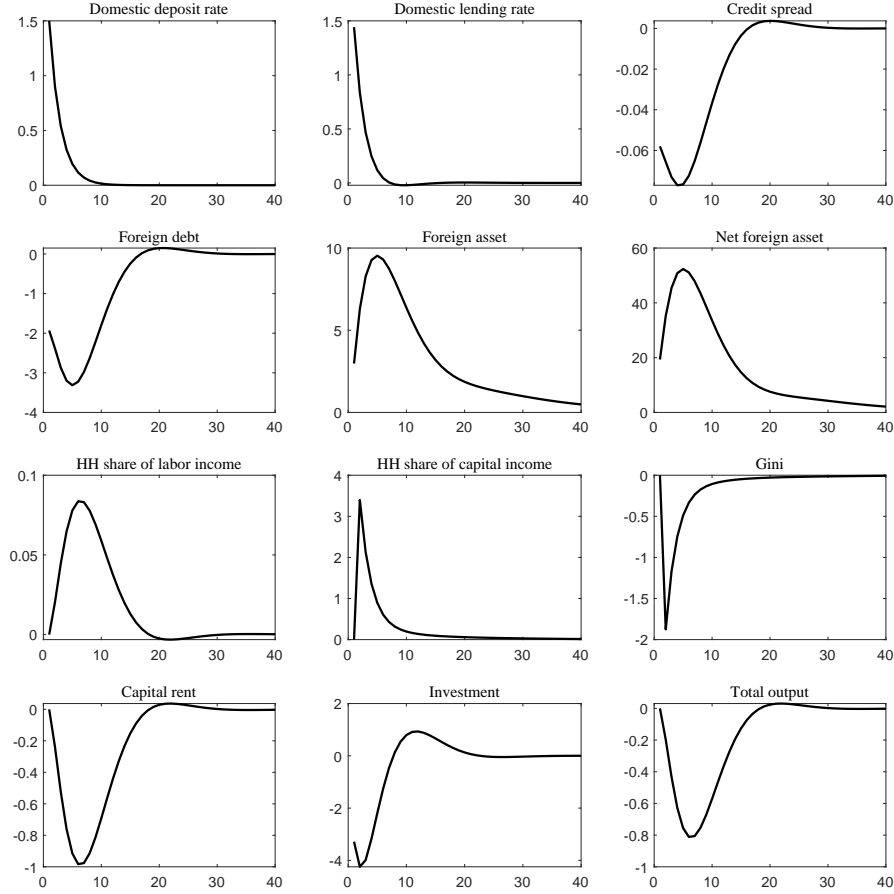
FIGURE 2. Impulse responses to a one-standard-deviation increase in world interest rate $(\epsilon_{rt} = 0.015)$. The units of the vertical axes are percent deviations from the steady state levels for all variables, except that the units for household (HH) share of labor income, HH share of capital income, and Gini are percentage-point deviations from the steady state.

stock. However, under our calibration, the negative effect of the reduction in output dominates the positive impact of the reduced capital stock on the MPK. Thus, the entrepreneurs' capital income share declines persistently.

Under our calibration, households' income is lower than entrepreneurs' income in the steady state. Thus, following a world interest rate shock, the increase in the

households' share in both labor income and capital income reduces the Gini coefficient relative to its steady state.

V.2. **Effects of changes in capital account policies.** In our model, changes in capital account policies can also impact on income inequality through their effects on capital flows. To study these impacts, we examine the impulse responses following a shock to capital flow taxes. Under the random walk process of capital flow taxes in Eq. (39), a one-time shock with a decline in ϵ_{lt} (ϵ_{dt}) would lead to a permanent reduction in the capital inflow (outflow) tax rate (τ_{lt}).

Figure 3 shows the impulse responses to a one standard deviation decline in ϵ_{lt}. The inflow tax cut induces more capital inflows and raises the stock of foreign debt. Facing increased competition from foreign investors, domestic banks reduce the credit spread and the domestic lending rate. The deposit rate is not affected because it is determined by the world interest rate and the outflow taxes, which are independent of the inflow taxes. The increases in capital inflows, along with the declines in the domestic lending rate, stimulate investment and production, raising the labor income for both households and entrepreneurs. The rise in households' income raises savings, leading to capital outflows and transitory increases in foreign asset holdings.

The shock has no effect on income distributions in the impact period, because capital incomes of the two types of agents are predetermined and the skill wage premium is a function of predetermined capital stock and is thus also predetermined. In subsequent periods, however, the increase in investment raises the stock of capital. All else being equal, an increase in capital stock would reduce the MPK. However, under our calibration, the expansion in aggregate output more than offsets the increase in capital, leading to persistent increases in capital rental income for entrepreneurs. Thus, the entrepreneurs' share in capital income rises. Furthermore, the increase in capital stock also boosts the skill wage premium through capital-skill complementarity, raising the entrepreneurs' share in labor income. Consequently, the reduction in the inflow tax rate skews the income distribution in favor of entrepreneurs, worsening the overall income equality and raises the Gini coefficient.

A capital outflow shock (i.e., a one-time reduction in ϵ_{dt}) works through a similar transmission channel. Figure 4 shows the impulse responses to a one standard deviation decline in ϵ_{dt}, which reduces the capital outflow tax rate (τ_{dt}) permanently. The shock induces capital outflows, raising the holdings of foreign assets permanently. It also pushes up the domestic deposit rate, increasing the households' capital income. Facing higher funding costs, banks raise the lending rate, depressing investment and

FIGURE 3. Impulse responses to a one-standard-deviation cut in the capital inflow tax ($\tau_{l,t}$). The units of the vertical axes are percent deviations from the steady state levels for all variables, except that the units for household (HH) share of labor income, HH share of capital income and Gini are percentage-point deviations from the steady state..

output. The increase in the lending rate also attracts capital inflows, leading to transitory increases in foreign debt and partly cushioning the contraction in output and investment. Since capital outflows reduce the available loanable funds for domestic banks, the credit spread falls, also mitigating the contractionary effects of the increase in the domestic lending rate.
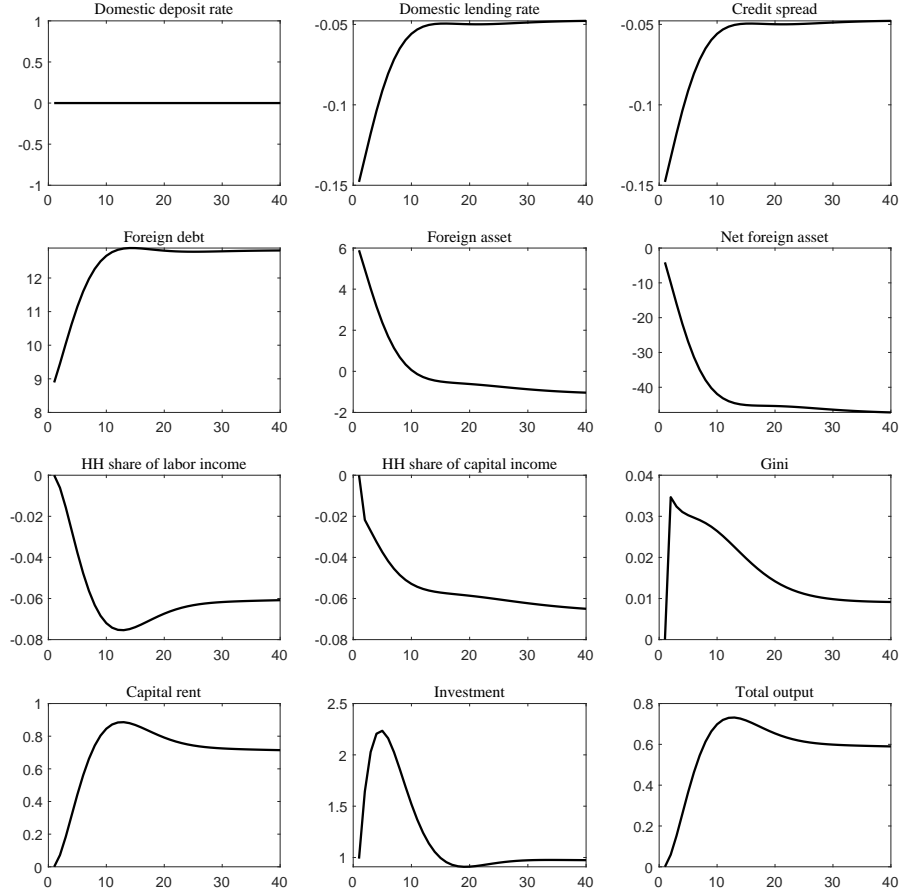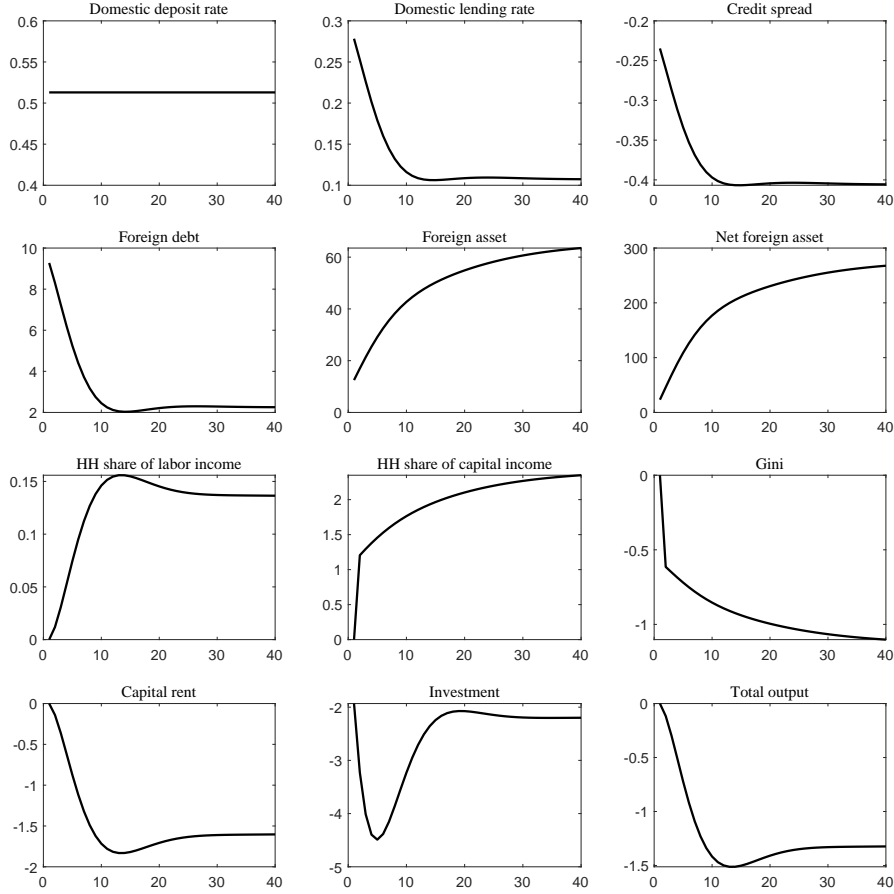
FIGURE 4. Impulse responses to a one-standard-deviation cut in the capital outflow tax $(\tau_{d,t})$. The units of the vertical axes are percent deviations from the steady state levels for all variables, except that the units for household (HH) share of labor income, HH share of capital income and Gini are percentage-point deviations from the steady state..

Similar to the case with an inflow shock, the outflow shock does not affect income distributions in the impact period because the households' shares in capital and labor income are both predetermined. Over time, however, the fall in aggregate output dominates the fall in capital stock, lowering the MPK and reducing the entrepreneurs' capital rental income. In addition, the increase in the domestic deposit rate directly increases the households' capital income. Thus, the households' share in

capital income increases. The decline in the capital stock over time also reduces the skill premium through capital-skill complementarity, boosting the households' share in labor income. Overall, the outflow shock that reduces the capital outflow tax rate permanently raises the income of households relative to entrepreneurs, reducing income inequality measured by the Gini coefficient.

Comparing Figures 3 and 4 suggests that a cut in capital outflow taxes has a greater impact (in absolute value) on income inequality than an equal-sized cut in inflow taxes. This is because changes in inflow taxes do not affect the domestic deposit rate, whereas changes in outflow taxes directly impact on the deposit rate.

Through the endogenous responses of the deposit rate, the two types of capital flow shocks of an equal size can lead to different sizes of the impulse responses of capital flows. In particular, an outflow shock has a greater impact on both capital inflows and outflows than does an equal-sized inflow shock, because the domestic deposit rate responds to a change in outflow taxes, but not to changes in inflow taxes. For instance, Figure 3 shows that a one standard deviation inflow shock (i.e., a permanent reduction of τ_{lt} by 0.4 percent) induces more capital inflows, raising the foreign debt holdings by 9 percent on impact and by about 13 percent in the long run. Figure 4 shows that a one standard deviation outflow shock (i.e., a permanent reduction of τ_{dt} by 0.5 percent) encourages capital outflows, raising foreign asset holdings by about 17 percent on impact and by about 60 percent in the long run. Evidently, after adjusting for the shock sizes, an outflow shock has a much greater impact on outflows than does a comparable inflow shock on inflows.

V.3. **Model-based regressions.** The empirical relations between income inequality and capital flows may reflect both the direct effects of the capital flow shocks on the Gini coefficient and the indirect effects through the endogenous responses of capital flows to those shocks. Thus, a priori, the impulse responses do not inform us about whether we should expect a greater elasticity of inequality with respect to capital outflows than inflows. To assess the empirical plausibility of the model's predictions, we now run regressions using simulated data from the calibrated model, similar to the regressions using actual data, and we compare the model-based regression results with those in the data.

For the model-based regressions, we consider the regression specifications

$$GGINI_t = c + \beta_1 INFLOWS_t + \beta_2 OUTFLOWS_{i,t} + \epsilon_t, \qquad (40)$$

and

$$GGINI_t = c + \gamma_1 NINFLOWS_t + u_t, \tag{41}$$

where the terms ϵ_t and u_t denote the regression residuals. These regressions are analogous to Eq. (1) and (2) used for our empirical analysis.

The measures of income inequality and capital flows are calculated using simulated data, with the same definitions as those used in our empirical analysis. Specifically, we define

$$GGINI_t = \frac{Gini_t}{Gini_{t-1}} - 1, \tag{42}$$

$$INFLOWS_t = \frac{B_{ft}^l - (1 - \tau_{l,t-1})R_{l,t-1}B_{f,t-1}^l}{Y_t}, \tag{43}$$

$$OUTFLOWS_t = \frac{B_{ft}^d - (1 - \tau_{d,t-1})R_{t-1}^* B_{f,t-1}^d}{Y_t}, \tag{44}$$

$$NINFLOWS_t = INFLOWS_t - OUTFLOWS_t. \tag{45}$$

Since we have a single country in the model instead of a panel of countries, these model-based regressions could be interpreted as a reduced-form way of capturing the effects of changes in capital flows on changes in income inequality through the lens of the model.

In generating the simulated data, we turn on all three types of shocks, including the world interest rate shock, the capital inflow shock, and the capital outflow shock. We simulate the model for 2,760 periods and discard the first 200 periods to avoid dependence on initial conditions. This leave us with 2,560 observations for our regressions, which could be interpreted as a simulation for 128 economies with 20 periods (years), as in the sample used for our empirical analysis. The key parameters of interests are the coefficients on capital inflows (β_1), capital outflows (β_2), and net inflows (γ_1).

Table 4 shows the estimated parameters from the regressions using the model-based simulated data (Columns (1) and (2)). For comparison, Columns (3) and (4) of the table display the estimates for the corresponding set of parameters using the actual data (reported in the first two columns in Table 2).[20]

The estimated relations between capital flows and income inequality using the model-based simulated data are similar to those using the actual data, both qualitatively and quantitatively. In the regression with both gross inflows and gross outflows

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[20]In the regressions using actual data, we applied instrumental variable estimation and included a set of control variables in the regressions. In the regressions using simulated data from our model, we simply estimate an OLS.

(Column (1)), the estimated coefficients β_1 and β_2 using the simulated data are of the same sign as and with a similar magnitude to those estimated using the actual data. Specifically, the estimated coefficient on gross inflows is positive and statistically significant at the 1 percent level, although it is somewhat smaller than that in the data (0.032 vs. 0.046). The estimated coefficient on gross outflows is negative and also significant at the 1 percent level, with a magnitude close to that in the data (-0.040 vs. -0.044). In the regression with net inflows (Column (2)), the estimated coefficient γ_1 is significantly positive and also close to that in the data (0.037 vs. 0.042).

Overall, the model-predicted relations between capital flows and income inequality are in line with our estimates using the panel of advanced and emerging economies. In both the model and the data, an increase in capital inflows (gross or net) raises income inequality and an increase in capital outflows reduces inequality.

TABLE 4. Capital flows and income inequality: Model-based regressions vs. actual data

	(1)	(2)	(3)	(4)
Constant	-0.006*	-0.004^{***}	-0.003^{**}	-0.003^{**}
	(0.003)	(0.002)	(0.001)	(0.001)
Inflows	0.032***		0.046**	
	(0.009)		(0.018)	
Outflows	-0.040^{***}		-0.044^{***}	
	(0.007)		(0.012)	
Net inflows		0.037***		0.042***
		(0.006)		(0.009)

Note: Columns (1) and (2) report the estimates using simulated data from the calibrated model. Columns (3) and (4) show the estimates using actual data reported in the first two columns in Table 2. Standard errors are shown in parentheses. Statistical significance levels are indicated by asterisks: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

VI. Conclusion

We present robust empirical evidence that short-run movements in capital flows have significant impacts on income distribution. In particular, using an instrumental variables approach and a panel of advanced and emerging economies, we show that

income inequality (measured by the Gini coefficient) rises with capital inflows and falls with outflows. These effects are statistically significant and economically important.

We then build a small open economy model with heterogeneous agents and financial frictions to illustrate the mechanism that might drive the empirical connections between capital flows and income inequality. Our model predicts that a shock that leads to short-run surges in capital inflows (for example, a decline in the world interest rate) would boost domestic production and investment, increasing entrepreneur capital income. Through capital-skill complementarity, inflow surges also increase the entrepreneur labor income share. Overall, an increase in capital inflows skews the income distribution in favor of the entrepreneurs and against the households, raising income inequality. Through a similar channel, the model also predicts that a shock that leads to an short-run increase in capital outflows would reduce income inequality, consistent with our empirical evidence. The model-predicted relations between capital flows and income inequality are in line with the empirical evidence, both qualitatively and quantitatively.

Appendix A. Data

In our empirical analysis, we use an unbalanced panel of 128 countries, including both advanced and emerging economies, for the years from 2000 to 2020, 2000-2019 with covariates included. Below, we describe our data sample and measurements.

(1) $GGINI_{i,t}$: year-over-year changes in the Gini coefficient in country i and year t, where the Gini coefficients are taken from the Standardized World Income Inequality Database.

(2) $OUTFLOWS_{i,t}$: the ratio of gross capital outflows to GDP in country i and year t. Gross capital outflows are measured by the sum of the net acquisitions of financial assets in the country's financial account (in U.S. dollars) obtained from the IMF BOPS. In particular, it is the sum of net acquisitions of (1) outflows of direct investment ($BFDA\_BP6\_USD$), (2) financial derivatives (other than reserves) and employee stock options ($BFFA\_BP6\_USD$), (3) financial assets from other investment ($BFOA\_BP6\_USD$), and (4) financial assets from portfolio investment ($BFPA\_BP6\_USD$).

(3) $INFLOWS_{i,t}$: the ratio of gross capital inflows to GDP in country i and year t. Gross capital inflows are measured by the sum of the net incurrence of liabilities in the country's financial account (in U.S. dollars) obtained from the IMF BOPS. In particular, it is the sum of the net incurrence of liabilities including (1) inflows of direct investment ($BFDL\_BP6\_USD$), (2) financial derivatives (other than reserves) and employee stock options ($BFFL\_BP6\_USD$), (3) debt instruments of financial corporations ($BFOLFR\_BP6\_USD$), and (4) portfolio investment ($BFPL\_BP6\_USD$).

(4) $NINFLOWS_{i,t}$: net capital inflows as a share of GDP, which equals the difference between $INFLOWS_{i,t}$ and $OUTFLOWS_{i,t}$ defined above.

(5) $INTREMOTE$: interactions between two-year U.S. Treasury yields (taken from FRED II of the St. Louis Fed) and a measure of financial remoteness. We measure financial remoteness of a country by the logarithm of the great-circle distance of a country from New York City, which is the financial center of the United States, using the approach of Rose and Spiegel (2009).

(6) $CAPOPEN$: the Chinn and Ito (2008) index of a country's capital account openness.

(7) $LOWCORR$: an indicator for a country's "control for corruption", taken from the World Bank.

(8) *AGE*, *GDPPCAP*, **and** *POP*: the median age of a country's population (*AGE*), production-based real GDP per capita (*GDPPCAP*), population size (*POP*), all taken from the Penn World Tables 9.1.

(9) *INFCONT* **and** *OUTFCONT*: the Fernández et al. (2016) indices of a country's controls on capital inflows (*INFCONT*) and outflows (*OUTFCONT*).

Appendix B. Robustness checks for empirical results

Our baseline results are robust to a battery of alternative empirical specifications, samples, and estimation methods. Tables A.1 and A.2 summarize the estimated coefficients on capital inflows, outflows, and net inflows under 10 alternative specifications. Table A.3 summarizes the estimation results in a variety of subsamples and under alternative methods of estimation and standard error calculations.

TABLE A.1. Alternative Specifications

Model	(1) INFLOWS	(2) OUTFLOWS	(3) NINFLOWS
(1) No cond. vars. w/ orig. Sample	0.059***	-0.040**	0.055***
	(0.020)	(0.020)	(0.020)
(2) Add education	-0.015	0.019	-0.022**
	(0.019)	(0.012)	(0.010)
(3) Add voice and accountability	0.039**	-0.038***	0.038***
	(0.017)	(0.012)	(0.008)
(4) Add political stability	0.048***	-0.046***	0.044***
	(0.018)	(0.012)	(0.009)
(5) Add Gov. effectiveness	0.044***	-0.042***	0.041***
	(0.017)	(0.011)	(0.009)
(6) Add reg. quality	0.047***	-0.044***	0.042***
	(0.018)	(0.012)	(0.009)
(7) Add rule of law	0.011	-0.017*	0.022***
	(0.013)	(0.010)	(0.007)
(8) Add lending	0.073***	-0.052***	0.031***
	(0.020)	(0.013)	(0.010)

Note: Dependent variable: Year-over-year changes in the income Gini coefficient. See the text for regression specifications and variable definitions. Columns (1) and (2) report estimated coefficients on capital inflows and outflows respectively. Column (3) reports estimated coefficient on net inflows. Row (1) removes conditioning variables with base sample. Row (2) adds average years of schooling as a control. Rows (3) through (7) add five different World Governance Indicators as controls. Row (8) adds bank lending rates as controls. Standard errors are clustered by years and are reported in parentheses. Statistical significance levels are indicated by the asterisks: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$. Full regression results are available on request.

TABLE A.2. Alternative Specifications (cont.)

Model	(1) INFLOWS	(2) OUTFLOWS	(3) NINFLOWS
(1) Add remoteness	0.021	-0.037**	0.050***
	(0.018)	(0.016)	(0.013)
(2) Add self employment	0.049**	-0.042***	0.036***
	(0.020)	(0.013)	(0.009)
(3) Add country dummies	0.010***	-0.011***	0.010***
	(0.002)	(0.002)	(0.002)
(4) Sub. 10YR US Treasury	0.046***	-0.044***	0.043***
	(0.017)	(0.013)	(0.010)
(5) Sub. 1YR US Treasury	0.047***	-0.044***	0.036***
	(0.017)	(0.012)	(0.011)
(6) Add 10YR US Treasury	0.046**	-0.044***	0.042***
	(0.018)	(0.012)	(0.009)
(7) Add 1YR US Treasury	0.039**	-0.037***	0.036***
	(0.017)	(0.013)	(0.011)

Note: Dependent variable: Year-over-year changes in the income Gini coefficient. See the text for regression specifications and variable definitions. Columns (1) and (2) report estimated coefficients on capital inflows and outflows respectively. Column (3) reports estimated coefficient on net inflows. Row (1) adds financial remoteness measure as a control variable. Row (2) adds share of self-employment as a control. Row (3) adds country dummies as controls. Rows (4) and (5) substitute 10 and 1 year U.S. Treasury rates respectively for the 2-year Treasury yields used in the baseline in the interaction variable $INTREMOTE$. Rows (6) and (7) add interactions of financial remoteness with 10-year and 1-year Treasury rates, respectively, to the baseline specification as control variables. Standard errors are clustered by years and are reported in parentheses. Statistical significance levels are indicated by the asterisks: *** $p<0.01$, ** $p<0.05$, and * $p<0.10$. Full regression results are available on request.

TABLE A.3. Alternative samples and estimation methods

Model	(1) INFLOWS	(2) OUTFLOWS	(3) NINFLOWS
(1) Drop Large Inflows	0.036*	-0.044***	0.043***
	(0.021)	(0.010)	(0.010)
(2) Drop Small Inflows	0.046**	-0.044***	0.042***
	(0.018)	(0.012)	(0.009)
(3) Drop Large Outflows	0.040*	-0.046***	0.045***
	(0.020)	(0.009)	(0.010)
(4) Drop Small Outflows	0.033*	-0.033**	0.033***
	(0.019)	(0.014)	(0.010)
(5) Drop High GINI	0.044**	-0.041***	0.039***
	(0.018)	(0.012)	(0.009)
(6) Drop Low GINI	0.051***	-0.049***	0.046***
	(0.019)	(0.013)	(0.010)
(7) Drop Most Remote	0.046**	-0.044***	0.042***
	(0.018)	(0.012)	(0.009)
(8) Drop Least Remote	0.046**	-0.044***	0.042***
	(0.018)	(0.012)	(0.009)
(9) Drop Crisis Years	0.039**	-0.040***	0.040***
	(0.015)	(0.012)	(0.010)
(10) Winsorize 1%	0.038**	-0.039***	0.045***
	(0.017)	(0.011)	(0.011)
(11) Robust SEs	0.046***	-0.044***	0.042***
	(0.015)	(0.012)	(0.011)
(12) Standard SEs	0.046**	-0.044***	0.042***
	(0.018)	(0.015)	(0.009)

Note: Dependent variable: Year-over-year changes in the Gini coefficient. See the text for the regression specifications and variable definitions. Columns (1) and (2) report the estimated coefficients on capital inflows and outflows, respectively. Column (3) reports estimated coefficient on net inflows. Rows (1) and (2) drop observations with large and small inflows (> 3 standard deviations from sample mean) respectively. Rows (3) and (4) drop observations with large and small outflows respectively. Rows (5) and (6) drop observations with high and low Gini coefficient values respectively. Rows (7) and (8) drop observations with most and least remote countries respectively. Row (9) drops observations from 2008 and 2009. Row (10) reports estimates with winsorized sample. Rows (11) and (12) report estimation results with robust and the standard (non-robust) standard errors respectively. Standard errors are clustered by years (with the exceptions of Rows (11) and (12)) and are reported in parentheses. Statistical significance levels are indicated by the asterisks: *** $p<0.01$, ** $p<0.05$, and * $p<0.10$. Full regression results are available upon request.

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