Capital Flows: Real Determinants and Some Policy Implications

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Disclaimer

- The views expressed represent are those of the author and do not necessarily represent those of the IMF or IMF policy.
- This presentation relies on ideas developed jointly with Tim Lane, Leslie Lipschitz and Steve Russell.

Outline

- Focus on real determinants of capital flows, illustrated by:
  - A frictionless neoclassical model
  - A model with adjustment costs
  - A model of financial crises
- Takeaways
  - Strong pull forces could give rise to large K flows that are bound to grow as destination countries improve infrastructure, policies and institutions.
  - In practice, monetary factors affect real rates and could raise the level of inflows.
  - Reduce information asymmetries that lead to maturity and currency mismatches and financial crises.
  - Insurance through reserve accumulation. Role for remunerated reserve requirements.

Real factors driving Capital flows

- The argument: high productivity of investment in EMEs attracts capital inflows.

- Strong real (pull) factors:
  - Low relative PPP income per capita (y)
  - Labor (L) abundance, capital (K) scarcity
  - Growing endowments of human capital, infrastructure, technology and institutions, summarized in A term of production functions

- In frictionless world, large, one way capital flows would underpin rapid real convergence: “catch up growth”.

Implications of Capital Scarcity: A simple frictionless model

$$y_i = Ak_i^{\alpha}$$

$$r_i = A\alpha k_i^{-(1-\alpha)}$$

$$\frac{r_i}{r_G} = \left[\frac{A_i}{A_G}\right]^{\frac{1}{\alpha}} \left[\frac{y_G}{y_i}\right]^{\frac{1-\alpha}{\alpha}}$$

Size of Potential Capital Flow is huge!

$$\frac{\bar{k}_i - k_i}{y_i} = \frac{k_G}{y_G}\left[\frac{y_i}{y_G}\right]^{-1}\left[\left[\frac{A_G}{A_i}\right]^{\frac{1}{1-\alpha}} - \left[\frac{y_i / y_G}{A_i / A_G}\right]^{\frac{1}{\alpha}}\right]$$

Potential Capital Flows to EM Countries 1/ 2/

y_i/y_{ger}	Capital Inflow on the assumption that A_i/A_{ger} equals 1	0.9	0.8	0.7
0.1	1739	1484	1242	1015
0.2	863	734	609	489
0.3	565	474	385	294
0.4	407	333	257	174
0.5	305	238	164	77
0.6	227	162	85	-13
0.7	163	95	11	-103
0.8	106	33	-62	-197
0.9	52	-28	-137	-298
1.0	0	-90	-215	-406

1/ Cobb-Douglas production function $y_i=A_i k_i^{\alpha}$, with $\alpha=1/3$.

2/ In percent of pre-inflow GDP, calculated for different levels of A_i.

The Lucas paradox: frictions

- In reality, frictions slow down the pace of capital inflows and even lead to outflows (Lucas paradox)
- The A term is key: undersupplied complementary factors (public infrastructure, lack of connectivity) and underdeveloped institutions (rule of law, friendly business environment) that reduce the productivity of private capital in some destinations.
- Currency and maturity mismatches, information frictions and agency costs could lead to capital flows that are volatile and unpredictable, and to sudden reversals (described in model below).

Capital flows in a model with adjustment costs

- Real Business Cycle Model
- Financial Integration vs autarkic growth
- Adjustment Costs to Investment (Kehoe-de Cordoba)
- Capital inflows, current account deficits lower, gradual.
- Adjustment of capital intensity takes time.
- Improvements in absorptive capacity (reduction in adjustment costs) raises inflows, leads to faster growth

Households

- Representative Household with preferences
- $$U = \sum_{t=0}^{\infty} \beta^t \frac{c_t^{\rho} - 1}{\rho}$$
- $0<\beta<1$ is the subjective time discount factor
- $\sigma=1/(1-\rho)$ is the intertemporal elasticity of substitution
- Household owns a unit of labor each period and
- Initial assets of $a_0 = q_{-1}k_0 + l_0$
- k_0 is the initial stock of domestic capital
- l_0 *is the initial level of net foreign assets*
- q_t *is the market price of an installed unit of capital*
- $a_{t+1} = q_t k_t + l_t$ *are household assets at beginning of t+1*
- *Household budget constraint*
- $$c_t + a_{t+1} \leq w_t + (1 + r_t^*)a_t$$

Firms

- Perfect competition, own domestic capital, which depreciates at rate δ
- Installation of new capital is costly
- Let z be net real investment

,

$$k_{t+1} \leq \varphi(z_t / k_t)k_t + (1-\delta)k_t$$

$$\varphi' > 0, \ \varphi'' \leq 0$$

$$\varphi(\delta) = \delta \ and \ \varphi'(\delta) = 1.$$

Adjustment Costs

- Following de Cordoba-Kehoe,

$$\varphi(z/k) = \frac{1}{\eta}\left(\delta^{1-\eta}(z/k)^{\eta} - (1-\eta)\delta\right)$$

$$0 < \eta \leq 1$$

- Advantage of this is that adjustment costs are independent of the firms's scale

Firm's Problem

- Select sequences of labor hires and investment to maximize profits

$$\sum_{t=0}^{\infty}\left(\frac{1}{1+r^{*}}\right)^{t}\left[Ak_{t}^{\alpha}N_{t}^{1-\alpha}-w_{t}N_{t}-z_{t}\right]$$

- Subject to

$$k_{t+1}\leq\varphi(z_{t}/k_{t})k_{t}+(1-\delta)k_{t}$$

Firm's Problem

- Firm's investment falls short of ideal (or desired) stock of capital that would solve

$$r_{t+1}^{*} + \delta = \alpha A k_{t+1}^{\alpha-1}$$

- Adjustment costs slow down investment. Implicitly, investment is given from

$$\varphi'(z_t / k_t) = \frac{1}{q_t}$$

- I>0 only if the shadow price of installed capital (q) exceeds the market price of new capital goods
-
- For the CK functional form, investment is

$$z_t = \delta k_t q_t^{\frac{1}{1-\eta}}$$

Optimal K accumulation

- Along the optimal path of K accumulation,

$$q_t = \frac{1}{1+r^*}\left[A\alpha k_{t+1}^{\alpha-1} + (1-\delta)q_{t+1} + q_{t+1}\varphi_{t+1} - \frac{z_{t+1}}{k_{t+1}}\right]$$

- Shadow price of K is the discounted sum of
  - MPK next period
  - The shadow price of undepreciated K
  - The contribution of a unit of K to lower adjustment costs next period

General Equilibrium

- A set of sequences $\{q,k,z,c,l\}$ satisfying feasibility and the conditions for household and firm optimization

$$c_t + z_t + l_{t+1} \leq Ak_t^{\alpha} + (1 + r_t)l_t$$

$$a_{t+1} = q_t k_{t+1} + l_{t+1}$$

$$1 + r_{t+1}^{*} = \frac{u'(c_t)}{\beta u'(c_{t+1})}$$

$$z_t = \delta k_t q_t^{\frac{1}{1-\eta}}$$

$$q_t = \frac{1}{1 + r^{*}}\left[A\alpha k_{t+1}^{\alpha-1} + (1 - \delta)q_{t+1} + q_{t+1}\varphi_{t+1} - \frac{z_{t+1}}{k_{t+1}}\right]$$

Steady State

- A steady state is an equilibrium with

$$k_t = k_{t+1} = k^*$$

$$z_t = z^* = \delta k^*$$

$$q_t = q_{t+1} = 1$$

$$r^* + \delta = \alpha \mathrm{A}(k^*)^{\alpha\text{-}1}$$

$$y^* = \mathrm{A}(k^*)^{\alpha}$$

Calibration

- Assume $1 + r^* = \beta$
- Consumption is annuity value of Wealth

$$c^* = \frac{r^*}{1 + r^*} W$$

- Consumer wealth is the PV of initial assets and future income

$$W \equiv (1 + r^*) a_0 + \sum_{t=0}^{\infty} (1 + r^*)^{-t} (1 - \alpha) k_t^{1-\alpha}$$

Discussion

- Capital inflow now gradual. At the beginning of transition, Tobin's q, the shadow value of K, is high.
- Unlike the frictionless model, rate of K accumulation is finite.
- Over time, q gradually declines to unity, investment rates fall, and economy approaches the steady state.
- Both C and I drive capital inflows, and domestic absorption A=C+I is high..
- C and I booms are both observed and Y-A=CAD<0.
- While adjustment costs slow down I demand, lack of liquidity constraints drive consumers to borrow in order to smooth C.

Takeaways

- Strong real (pull) forces are driving K flows to the EMEs.
- Both investment and consumption smoothing.
- Inflows large even with plausible frictions (adjustment costs, absorptive capacity constraints.
- EMEs highly sensitive to global interest rates, liquidity conditions, other external influences: Size of inflow rises when world interest rates decline.
- Adding nontraded goods and assets to this model would lead to RER appreciation.
- That's an equilibrium phenomenon, not to be concerned about, would take place regardless of the choice of exchange rate regime.

EM financial crises: a model

- EM countries often borrow short to finance long-term projects. This introduces rollover risk.
- In join work with Steve Russell, we analyze optimal EM country responses in a neoclassical growth model in which investment takes two periods to mature and is financed by one period loans.
- Domestic banks in the EM borrow abroad. In the intermediate period, adverse information arrives about the productivity of investment (or the terms of trade),
- If the shocks are large, foreign loans are not rolled over, domestic firms go bankrupt and liquidate capital.
- Workers face a double shock: wages decline (and jobs disappear) because of the shock to TFP and because of the liquidation of capital.

Time Line

- **Planning period:** Foreign borrowing, investment initiated. Capital must be in place for two periods. Workers cannot insure ex ante against risk of income loss.

- **Interim period:** Future productivity of investment revealed (high or low). Firms have option to liquidate capital at a loss (a fire sale), pay off loans early.

- **Final period:** Workers hired (labor supply is one), investment returns realized, production, wages and consumption take place.

Crisis response

- In this model, financing of long-term projects with short-term credit arises endogenously.
- There is overinvestment: workers are not insured against real shocks and their consequences (firm bankruptcies and fire sales).
- This calls for a policy response in a crisis. We follow a public finance approach: taxing inflows and using the war chest of reserves in a crisis to extend loans to firms is a second best policy that cushion the effects of the crisis on workers.
- Loans are extended to firms during a crisis conditionally, dollar on dollar, on reducing fire sales.

Firms' problem

- Representative firm operates a Cobb-Douglas technology, faces TFP (or TOT) shocks.

$$Y_1 = z_1 A K^{\alpha} L_1^{1-\alpha} \qquad Y_2 = A z_2 [(1-\psi)K]^{\alpha} L_2^{1-\alpha} \qquad z_1 > z_2$$

$\text{TFP}_1 = Az_1$ with prob 1-Π $\qquad$ $\text{TFP}_2 = Az_2$ with prob Π

- Firms borrow from domestic banks. These banks obtain their funds from risk-neutral foreign lenders:

$$(1) \qquad (1-\Pi) R_1 + \Pi R_2 \geq \bar{R}$$

- Firms choose K, L_1, L_2 to max expected profit

$$(1-\Pi)\left\{ z_1 A K^{\alpha} L_1^{1-\alpha} + (1-\delta)K - w_1 L_1 - R_1 K \right\} + \Pi \left\{ z_2 A K^{\alpha} L_2^{1-\alpha} + (1-\delta)K - w_2 L_2 - R_2 K \right\}$$

s.t. to the rate of return constraint (1) and a limited liability constraint: in the bad state lenders get liquidation value of firm's capital stock.

Equilibrium without fire sales

- Demand for K and L are given by

$$(1-\alpha)z_1 A k_1^{\alpha} = w_1$$

$$(1-\alpha)z_2 A k_2^{\alpha} = w_2$$

$$\alpha A\left[(1-\Pi)z_1 k_1^{\alpha-1} + \Pi z_2 k_2^{\alpha-1}\right] + \left(1-\delta\right) = E[R]$$

- If fire sales are not possible, then $k_1=k_2=k^*$. And with flexible wages there is full employment, $L_1=L_2=1$.

$$k^* = \left(\frac{\alpha A E[z]}{\bar{R}-\left(1-\delta\right)}\right)^{\frac{1}{1-\alpha}} \qquad w_1^* = (1-\alpha)z_1 A\left(k^*\right)^{\alpha} \qquad w_2^* = (1-\alpha)z_2 A\left(k^*\right)^{\alpha}$$

Equilibrium with fire sales

- Firms respond to bad news ($z = z_2$) by declaring bankruptcy, liquidating capital, and paying off loans early.
- A unit of capital sold in a fire sale is worth x units of output.
- In equilibrium, banks accepting early loan payoffs must be indifferent between the payoff x they receive in the middle period and a default payoff d in the final period.

$$x\left(1+\bar{r}\right)=d \qquad R=1-\delta+\alpha z_1 A\bar{k}^{\alpha-1} \quad R_2^* \equiv d=\alpha z_2 A\left(k^*\right)^{\alpha-1}+\left(1-\delta\right)$$

- Investment and real wages are higher when fire sales are allowed. But workers' expected utility would be higher if there were no fire sales:

$$\bar{k}>k^* \qquad (1-\bar{\psi})\bar{k}<k^* \qquad \mathrm{EU}_{\mathrm{LNP}}>\mathrm{EU}_{\mathrm{LP}}$$

Equilibrium with fire sales

- An equilibrium with fire sales ($0 < \psi < 1$) exists if the price of capital in a fire sale is "not too low" and the adverse shock is "sufficiently bad" and doesn't occur "too often

$$x\left(1+\bar{r}\right) > 1-\delta \quad \text{and} \quad \frac{z_2}{z_1}\frac{\bar{R}-\left[\left(1-\Pi\right)\left(1-\delta\right)+\Pi x\left(1+\bar{r}\right)\right]}{\left(1-\Pi\right)\left[x\left(1+\bar{r}\right)-\left(1-\delta\right)\right]} < 1,$$

- In this equilibrium, there is more investment and higher wage variability than if fire sales were not possible.

$$\bar{k} = \left\{\frac{\alpha A\left(1-\Pi\right)z_1}{\bar{R}-\left[\left(1-\Pi\right)\left(1-\delta\right)+\Pi x\left(1+\bar{r}\right)\right]}\right\}^{\frac{1}{1-\alpha}}$$

$$1-\bar{\psi} = \left\{\frac{z_2}{z_1}\frac{\bar{R}-\left[\left(1-\Pi\right)\left(1-\delta\right)+\Pi x\left(1+\bar{r}\right)\right]}{\left(1-\Pi\right)\left[x\left(1+\bar{r}\right)-\left(1-\delta\right)\right]}\right\}^{\frac{1}{1-\alpha}}$$

A second best policy

- Raise a war chest of foreign exchange reserves by imposing (remunerated) reserve requirements on inflows.
- In a crisis, fight liquidation by making emergency loans to domestic firms, at subsidized rates and on condition that they reduce capital liquidation dollar for dollar.
- Higher reserve requirements allow more emergency loans in a crisis, reducing inflows are reduced and liquidation.
- The policy that maximizes workers' expected utility is to eliminate all capital liquidation. (For conventional ranges of elasticity of output with respect to capital and workers' risk aversion.)

Optimal policy in detail

- A fraction g of every dollar borrowed is deposited in a central bank account, raising $L^{cb} = (1+\bar{r})\, g\, K$
- Returns to domestic banks and their foreign lenders

$$R_1 = (1-\lambda)\hat{R}_1 + \lambda \bar{R} \qquad R_2 = (1-\lambda)d + \lambda \bar{R}^{cb}$$

- In a crisis, emergency loans L^{cb} at rate $-1 \le r^{cb} \le \bar{r}$
- Policy aims to lower capital liquidation to $\psi^{cb} = (1-\mu)\bar{\psi}$
- *F*unds to finance early loan repayments $F = x\psi^{cb}K + L^{cb}$
- Firms repay an amount L early, L=F/h, where $d = h(1+\bar{r})$

Inflows under the optimal policy

- The fraction of capital liquidated in a crisis and the capital-labor ratios are given by:

$$k = \left\{ \alpha A \frac{(1-\Pi) z_1 + \left(1-\psi_2^{cb}\right)^{\alpha} \Pi z_2}{\bar{R}\text{-}\left[(1\text{-}\Pi)(1\text{-}\delta) + \Pi x(1+\bar{r})\right] + \Pi\left(1-\psi_2^{cb}\right)\left[\Pi x(1+\bar{r})\right]} \right\}^{\frac{1}{1-\alpha}}$$

$$\psi^{cb} = \bar{\psi} - \frac{(1+\bar{r})g}{x} \qquad k_2 = (1-\psi^{cb})k$$

- Central bank loans must be subsidized if firms are to accept them voluntarily:

$$r^{cb} = \frac{1-\delta+z_2\,\alpha A k_2^{\alpha-1}}{x} - 1 < \bar{r}.$$

Example

- $\{\square, z_2/z_1, a, A, x, d, r^*\} = \{0.1, 1/3, 1/3, 1, 0.9, 0.19, 0.05\}$.
- Worker preferences: log or stronger risk aversion in CRRA class of utility functions.
- Policymakers maximize worker expected utility.
- Welfare comparisons using the standard approach from the RBC literature (consumption compensation)

Equilibrium

Table 2. Holdings of International Reserves and Worker Welfare
(in percent)

g	*λ*	*ψ2*	***R/Y***	***U(γ=1)***	***Ew***	***CVw***	***U(γ=2)***	***U(γ=4)***
0	0.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.0	31.9	1.1	0.1	0.0	-0.3	0.0	0.5
5	4.8	27.2	5.4	0.7	0.0	-1.2	0.2	2.2
10	9.1	21.4	10.7	1.3	0.0	-2.4	0.3	4.2
15	13.0	15.5	16.0	1.8	0.0	-3.6	0.5	6.1
20	16.7	9.7	21.3	2.3	-0.1	-4.6	0.6	7.8
25	20.0	3.9	26.6	2.7	-0.1	-5.7	0.7	9.4
28.3	22.1	0.0	30.1	3.0	-0.1	-6.3	0.8	10.5

SSource: Authors' estimates.

Takeaways

- In this model, financing long-term projects with short-term loans raises investment but at the cost of higher macro volatility.
- Large real shocks cause financial crises—fire sales of capital tied up in uncompleted projects lead to reversals of inflows.
- Because workers are not insured against many aggregate shocks, fire sales amplify welfare losses: higher wage variability; in Keynesian models, higher unemployment.
- The loss in worker welfare is large and depends on attitudes toward risk. With a coefficient of RRA γ=2, increased wage variability resulting from fire sales is 3 percent of wages and consumption.

Takeaways

- Policies: National welfare can be increased by imposing remunerated reserve requirements on inflows, acquiring buffer stocks of international reserves, and providing conditional financial support to distressed firms in a crisis.
- For plausible degrees of worker risk aversion, the second best policy is to suppress all fire sales of capital.
- In the model calibration, reserves need to be about 28 percent of debt-generating inflows, or 30 percent of GDP.
- Improving social insurance arrangements for workers (wage and employment insurance) has large effects on worker welfare and is superior to reserve requirements.

Takeaways

- Main results hold in a model with traded and non-traded goods and assets.
- Build financial cushions:
  - Strong fiscal positions, low and flexible public debts
  - Maintain adequate reserves.
- Reform financial system, remain vigilant in financial supervision, regulation.
  - Avoid large currency and maturity mismatches.
- Flex ex rate more likely to contain vulnerabilities: it acts as a shock absorber, discourages unhedged exposures.
- Maintain information flows
  - Open communication channels
  - Transparency with markets, public
  - Build capacity to respond to unexpected events.