

# Exchange Rate Exposure and Firm Dynamics

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## Motivation

- Foreign currency (FC) borrowing in the corporate sector has been associated with financial fragility and currency crises in Emerging markets.
- This paper
  - studies the micro-level trade-offs implied in firms' currency debt decisions.
  - builds on from firms' decisions to aggregate implications of this financing.

## Stylized Facts in Emerging Markets

1. Large share of corporate foreign currency loans:
  - In Hungary, FC share was 50% between 2005-2015.
2. FC loans associate with deviations from the uncovered interest rate parity:
  - UIP deviation  $\approx$  4pp and 70% correlation b. UIP dev. and FC share.
3. Cross-sectional heterogeneity in firms' FC borrowing choices:
  - at the extensive margin: only 33% of firms borrowed in FC.
  - at the intensive margin: heterogeneity in the share of FC loans.
4. High exposure to currency risk:
  - 2/3 of firms are not naturally hedged (nor export or import).
  - Firms do not use FX derivatives (95%).
  - Firms are domestically-owned (90%).

## Contribution I

### 1) Build a firm-dynamics model and propose mechanism leading to FC borrowing:

- UIP deviations make FC loans cheaper, but increase firms' default risk.
- Firms trade exposure to *currency risk for higher growth*.

## Contribution II

- 1) Build a firm-dynamics model and propose mechanism leading to FC borrowing.
- 2) **Test this mechanism using firm-level census data on Hungarian firms:**
  - Why Hungary?
    - Policy reform to study the characteristics of firms using FC loans.
    - Firm-level census data on all economic activities over 1996-2010.

## Contribution III

- 1) Build a firm-dynamics model and propose mechanism leading to FC borrowing.
- 2) Test this mechanism using firm-level census data on Hungarian firms.
- 3) **Conduct counterfactual exercises to:**
  - quantify the impact of FC borrowing and assess how countries' policies affect its aggregate implications.

## Outline

1. Model
2. Data and Firm-Level Analysis
3. Aggregate Implications and Policies

## Model: Mechanism in a Two-Period Setting

- Two shocks: exchange rate  $s$  and idiosyncratic productivity  $z$ .
- In  $t = 1$ : firms can issue local and foreign bonds,  $b$  and  $b^*$  at prices  $q$  and  $q^*$ .
- In  $t = 2$ : firms choose to repay and produce or default and exit.
- Total value of the firm

$$\max_{k, b, b^*} [-k + qb + q^*b^*s] + \beta E_{z', s'} V(s', z', k, b, b^*).$$

$$\text{where } V(s', z', k, b, b^*) = \max\{0, z'k^\alpha - b - s'b^*\}.$$

- Bond prices:  $q = \frac{1 - P(V(s', z', k, b, b^*) < 0)}{1+r}$  and  $q^* = \frac{1 - P(V(s', z', k, b, b^*) < 0)}{1+r^*}$ .
- UIP condition:  $\underbrace{\theta}_{\text{UIP Dev.}} E(s') (1 + r^*) = s(1 + r), \quad (\text{let } \theta > 1).$



## Foreign Currency Borrowing in a Two-Period Setting

→ **UIP condition:**

$$\underbrace{\theta}_{\text{UIP Dev.}} E(s') (1 + r^*) = s(1 + r)$$

→ **Firms' bond prices:**

$$q = \frac{1 - P(V(s', z', k, b, b^*) < 0)}{1 + r} \quad \text{and} \quad q^* = \frac{1 - P(V(s', z', k, b, b^*) < 0)}{1 + r^*}$$

→ **Mechanism: 2 main forces driving currency debt composition**

- (1) *Aggregate* UIP deviations ( $\theta > 1$ ) make FC bonds relatively cheaper.
- (2) FC debt exposes firms to ER shocks and raises *idiosyncratic* default prob ( $P$ ).

→ **Borrow in FC when marginal benefit=marginal cost:**

- (1) Marginal benefit: function of  $\theta$ .
- (2) Marginal cost: function of increase in default probability  $P$  ( $\downarrow q$  and  $\downarrow q^*$ ).

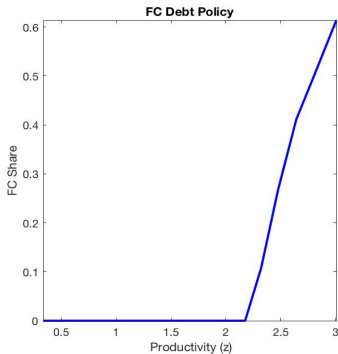
## Model's Implications

### -*Lemma 1. Selection:*

Only highly productive firms borrow in foreign currency. These firms have higher investment rates.

### -*Lemma 2. UIP Deviations:*

Higher UIP deviations increase foreign currency borrowing and investment.



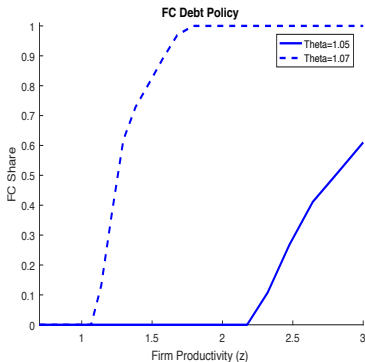
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### -*Lemma 2. UIP Deviations:*

Higher UIP deviations increase foreign currency borrowing and investment.



## Full Dynamic Model

→ **The full dynamic model has additional ingredients**

- Exchange rate and UIP deviations are endogenously determined by the pricing kernels of local and foreign investors.
- The local currency pays a premium as it depreciates in bad states of the world.
- Foreign currency borrowing is riskier:
  - aggregate productivity lowers during depreciations.
  - adjustment costs of capital make the converge to the optimal size slow.
- Distribution of firms is endogenous.

## Data, Calibration and Model's Validation

### → **Two datasets:**

- APEH: census data on all firms in the economy (1996-2010).
- Credit Register: census data on all loans (2005-2010).

### → **Calibration and Validation**

1. Calibrate to Hungary to the period after the deregulation of FC loans (2001).
2. We validate the model's implications in two different ways:
  - the model matches key moments of the distribution of FC borrowing.
  - simulate data and test the model's *qualitative* and *quantitative* firm-level responses.

▶ Simulation

▶ Calibration

▶ NT Moments

## Firm-Level Analysis: Lemma 1. Selection

→ Exploit deregulation of FC loans to identify firms selecting into FC borrowing.

1. Productive firms had a higher probability of borrowing in FC and FC share.
2. Firms borrowing in FC associate with 7% higher investment rates (and sales).

	FC Loan Dummy		Log Share of FC Loans		Log Investment Rate	
	Model	Data	Model	Data	Model	Data
	(1)	(2)	(3)	(4)	(5)	(6)
Log productivity	0.045*** (0.001)	0.012*** (0.002)	0.016*** (0.001)	0.003** (0.001)		
R*FC dummy					0.131** (0.004)	0.071*** (0.027)
Sector FE		Yes		Yes		Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes
$R^2$	0.009	0.053	0.006	0.035	0.218	0.512
N	152,706	33,327	152,706	33,327	1,527,060	393,149

Notes: \*, \*\*, \*\*\* significant at the 10, 5, and 1 percent level. Standard errors in parentheses.

Source: APEH and Credit Register.

## Firm-Level Analysis: Lemma 2. UIP Deviations

- **Exploit UIP dev. to identify responses to changes in interest rate differentials.**
1. UIP dev. increase probability of borrowing in FC, particularly of high MPK firms.
  2. Similar results for the share of foreign currency loans, investment and sales.

	Model			Data		
	(1)	(2)	(3)	(4)	(5)	(6)
	<b>FC Dummy</b>					
Log Dev. UIP	0.082** (0.002)			0.150*** (0.017)		
Log (Dev. UIP x Productivity)		0.098*** (0.029)			0.047*** (0.008)	
Log (Dev. UIP x $MPK^H$ )			0.222*** (0.003)			0.196*** (0.031)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes			
Sector* Year FE					Yes	Yes
$R^2$	0.419	0.501	0.21	0.742	0.688	0.743
N	1,039,875	1,039,875	1,039,875	892,584	892,584	892,584

Notes: \*, \*\*, \*\*\* significant at the 10, 5, and 1 percent level. Standard errors in parentheses. Period 2005-2010.

▶ Robustness

## Outline

1. Model
2. Data and Firm-Level Analysis
3. Aggregate Implications and Policies:
  - 3.1. Impact of FC Borrowing
  - 3.2. Exchange Rate Market Interventions
  - 3.3. Other Policies and Countries' Characteristics



## Aggregate Implications: Impact of Foreign Currency Borrowing

→ **FC borrowing:** promotes investment, reduces default and lowers MPK dispersion.

	Benchmark	Economy without FC Borrowing
	(1)	(2)
<i>Firm-level results</i>		
FC Debt Share	8.8	-
Investment rate	13.7	11.7
E(K)	43.2	42.3
Default rate	2.6	3.1
<i>Aggregate results</i> (normalized to benchmark)		
Capital Growth	100.0	91.6
MPK Dispersion	100.0	319.8

Notes: Rows 1-4 are in %. Period: 2001-2015.

## Aggregate Implications: Exchange Rate Market Interventions

- **Full Pegs:** increase intensive and extensive margins of FC borrowing.
- No currency risk and a low rate allow least productive firms to borrow in FC.
  - Higher capital growth and lower MPK dispersion, but unsustainable pegs can lead to massive bankrupts.

	Benchmark	Full Peg
	(1)	(2)
Share of firms borrowing	36.3	89.4
<i><u>Firms borrowing in FC</u></i>		
Share of FC firms	48.6	100.0
FC share	47.3	100.0
Leverage	34.4	49.4
Productivity threshold	1.43	1.26
Default rate (normalized to benchmark)	100.0	81.0
<i><u>Aggregate results</u></i> (normalized to benchmark)		
Capital Growth	100.0	126.5
MPK Dispersion	100.0	89.9

Notes: Rows 1-4 are in %. Period: 2001-2015.

## Aggregate Implications: Exchange Rate Market Interventions

- **Managed Floats:** decrease intensive margin, but increase extensive margin.
- the absence of large appreciations lowers the benefit of lower debt repayment.
  - the absence of large depreciations lowers currency risk.

	Benchmark	Full Peg	Managed Float
	(1)	(2)	(3)
Share of firms borrowing	36.3	89.4	36.4
<i>Firms borrowing in FC</i>			
Share of FC firms	48.6	100.0	36.1
FC share	47.3	100.0	42.0
Leverage	34.4	49.4	37.3
Productivity threshold	1.43	1.26	1.32
Default rate (normalized to benchmark)	100.0	81.0	132.3
<i>Aggregate results</i> (normalized to benchmark)			
Capital Growth	100.0	126.5	96.7
MPK Dispersion	100.0	89.9	100.6

Notes: Rows 1-4 are in %. Period: 2001-2015.

## Aggregate Implications: Countries' Characteristics

### → Additional exercises

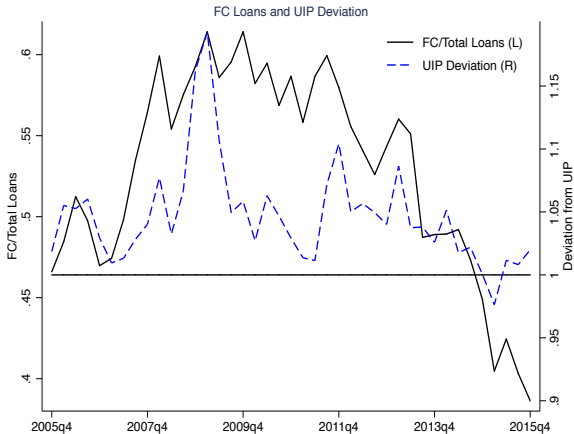
1. **Limit to depreciations:** (systemic bailouts) can create systemic risk by increasing extensive and intensive margins of FC borrowing.
2. **Stages of development:** capital-scarce economies grow faster, but to the expense of higher default.
3. **Financial development:** well-functioning banking sector is necessary before deregulating FC borrowing.
4. **Currency crises:** impact of depreciations is non-monotonic and depends on their size and bonanzas prior to the shock.

## Conclusion

- FC borrowing is back and timely re-evaluate risks and rewards at the micro and macro levels.
- Rich firm-level data + quantitative model to evaluate micro trade-offs and macro policies.
  - Build on from firms' decisions to country aggregates and policies.
  - Use detailed data and a policy reform to identify firms using FC loans.
  - Assess how countries' policies affect the allocation and impact of FC loans.
    - Exchange rate market interventions can create systemic risk, by allowing least productive firms to borrow in FC.
    - The implications of FC loans also depend on the stage of economic development and functioning of the financial sector.

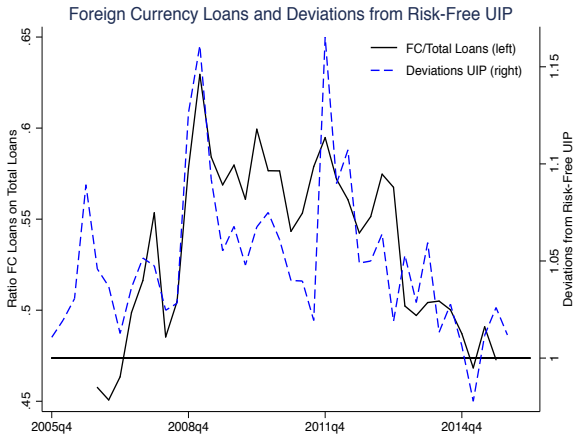
# Extra Slides

## Hungary: FC Loans and UIP Deviations



→ Considering valuation effects (ER=2005q4).

## Hungary: FC Loans and UIP Deviations

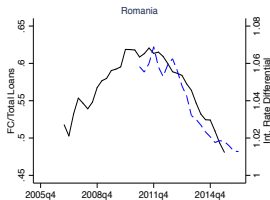
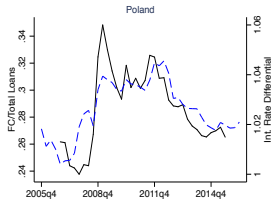
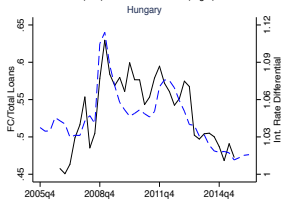


→ Without taking into account CDS.



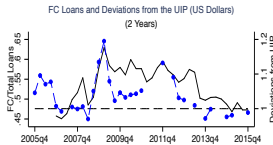
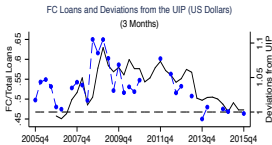
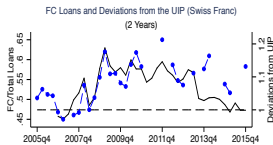
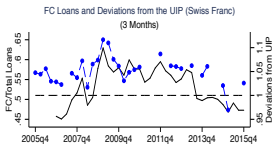
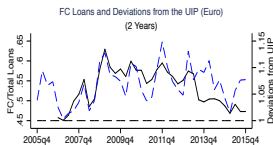
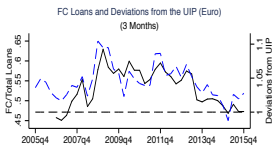
# FC Loans and Interest Rate Differential in Developing Countries

— FC/Total Loans (Left) - - IR Differential (Right)



$$\rightarrow \text{IRDiff}_t = \frac{(1+r_t)}{(1+r_t^*)} > 1$$

# Foreign Currency Loans and Deviations from the UIP (3M & 2Y)



— FC/Total Loans (left)    ···· Deviations UIP (right)

## Simulation Strategy

**To simulate the years following the deregulation of FC loans in Hungary:**

1. Solve the model without FC borrowing and find a stationary distribution.
2. Solve the model with foreign currency borrowing.
3. We simulate 160.000 firms from distribution in (1) using:
  - policies of the model with foreign currency and
  - realized foreign interest rate shock between 2001-2015.

◀ Return

# Calibration

	Parameter Values	
	Value	Target
<i>Parameters of the Affine Model</i>		
Foreign interest rate	$\kappa = 0.007$	German Bund, 1 year rate
	$\varphi = 0.58$	
	$\sigma_\omega = 0.196$	
Domestic Interest rate	$\bar{\delta} = 0.043$	Hungarian Government Bond, 1 year rate
	$\gamma = 1.065$	
Pricing of risk	$\lambda = 1.4$ $\lambda^* = 2.7$	UIP Deviation and Depreciation Rate
<i>Firm-level Parameters</i>		
Firms' productivity	$\rho_z = 0.63$	Hungarian firms
	$\sigma_z = 0.57$	
Return to scale	$\alpha = 0.6$	Hungarian firms
Depreciation rate	$\delta = 10\%$	
Exchange rate pass-through	$\eta = 0$	
Demand shock	$\zeta = -0.43$	
<i>Jointly calibrated parameters</i>		
Fixed operational costs	$c_f = 4.33$	Default rate
Investment adjustment cost	$c_0 = 0.05$	Investment rate of borrowing firms
Fixed cost of credit	$c = 0.1$	Share of firms borrowing
Constant discount factor	$\beta = 0.998$	Leverage

## Non-Targeted Moments

Moment	Group	Model	Data
		(1)	(2)
1. Firm share (%)	LC debt only	21	21
	LC & FC debt	8	6
	FC debt only	1	3
2. Relative productivity*	LC debt only	0.97	0.99
	LC & FC debt	1.07	1.02
	FC debt only	1.08	1.05
3. Relative capital*	LC debt only	0.95	0.97
	LC & FC debt	1.10	1.06
	FC debt only	1.05	0.99
4. Investment rate (%)	LC debt only	10	9
	LC & FC debt	15	18
	FC debt only	17	19
5. FC Share (%)	LC debt only	0	0
	LC & FC debt	41	50
	FC debt only	100	100
6. Leverage (%)	LC debt only	21	17
	LC & FC debt	33	25
	FC debt only	21	18
7. LC Leverage (%)	LC debt only	21	17
	LC & FC debt	20	14
	FC debt only	0	0
8. FC Leverage (%)	LC debt only	0	0
	LC & FC debt	13	9
	FC debt only	21	18

## Robustness Tests

- ✓ UIP deviations: 1) without adjusting for sovereign default premium and 2) realized exchange rates.
- ✓ FC share: 1) controlling for valuation effects (ER=2005) and 2) current ER.
- ✓ Pass-through: differential pass-through across 4-digit industries.
- ✓ Sample: including exporters and MNC firms.
- ✓ MPK: computing firms' MPK measure.
- ✓ Productivity: 1) RTFP estimated with Olley and Pakes (1996) and 2) Labor productivity.
- ✓ Additional controls: access to credit prior to the reform and firms' age.
- ✓ Currencies: results hold across currencies.
- ✓ Mechanism: firms borrowing in foreign currency pay lower interest rates.

## Characteristics of Firms Holding Foreign Currency Loans in 2005

	Non FC Debt	FC Debt
	(1)	(2)
Share of FC Debt	0	64
Share of Non-Exporters	91	73
Interest Rate	13.4	12.3
Employment	17	45
Log RTFP	6.5	6.7
Corr(FC Share, Log RTFP)	-	0.02
Corr(FC Share, Log Capital)	-	-0.05
Number of firms	147,166	13,493

Notes: Rows 1-3 are in %. The difference in means and correlation are statistically significant at one percentage point. Source: APEH, Credit Register data BEEPs (World Bank and EBRD).

## Data

Sector	Number of firms		
	All	Borrowing in FC	
	(1)	(2)	
A	Agriculture, forestry and fishing	7,511	748
B	Mining and quarrying	351	30
C	Manufacturing	22,656	3,083
D	Electricity, gas steam and air conditioning supply	357	50
E	Water supply, sewerage, waste management and remediation activities	1,099	119
F	Construction	19,334	1,738
G	Wholesale and retail trade, repair of motor vehicles and motorcycles	48,198	4,485
H	Transportation and storage	6,291	631
I	Accommodation and food service activities	9,305	611
J	Information and communication	8,153	351
M	Professional, scientific and technical activities	18,522	814
N	Administrative and support service activities	10,014	525
R	Arts, entertainment and recreation	3,933	97
S	Other service activities	4,935	211
<b>Total</b>		<b>160,659</b>	<b>13,493</b>

Notes: Nace Rev.2 Industry Classification. Source: APEH.