

Crises and Recoveries: A Disaggregated Approach

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Financial Crises in the 1990s (Argentina, Mexico, East Asian countries) have had significant real effects

- Large fall in output and investment
- Current Account reversal
- Real Exchange Rate depreciation
- Slow Recovery: output below trend for several years after the crisis

The Question

What are the channels through which a crisis is propagated?

What accounts for the slow recovery after the crisis?

Standard open economy RBC models cannot provide an answer.

- Capital account smooths consumption between good and bad states.
- A sudden stop is ruled out by definition.

Growth accounting exercises show that output drops in crises are due to falls in observed TFP, not due to a drop in input use.

- Models with exogenous decline in TFP: Bergoeing, Kehoe, Kehoe, and Soto (2002), Meza & Quintin (2006),
 - Output falls but current account worsens
 - Exogenous fall in TFP is not very satisfactory.

One sector models disregard important features of crisis economies

- Output in the traded goods sector falls less and recovers faster than the non traded goods sector
- Labor is reallocated from the non traded goods to the traded goods sector

Sectoral disaggregation can give us insights into the mechanisms through which crises are propagated.

Two Sector Models:

- Kehoe and Ruhl (2006): Sudden stop makes domestic traded goods more valuable
 - Shifting labor from the non traded sector to the traded sector is costly
 - Real exchange rate depreciation but no change in output
 - Also, the model predicts an increase in real wages and investment

OBJECTIVE

Construct a quantitative general equilibrium two sector model with an endogenous mechanism that

- propagates a financial crisis into real variables
- looks like a negative TFP shock

Calibrate it to the Mexican economy

OBJECTIVE

Quantitative Exercise: Taking as given a sudden stop as in Dec. 1994 ...

... To what extent can the propagation mechanisms of the model account for the evolution of main real variables after the crisis?

In addition, can our model explain the divergent trajectories of the traded and non-traded sector?

We do not attempt to explain the sudden stop as part of the business cycle phenomena

We do model the reaction to an exogenous sudden stop of an economy which look like the Mexican economy prior to the crisis

- Financial liberalization
- Capital accumulation (outside balanced growth path)
- Large investment and debt

OUTLINE

1. Financial Frictions and Propagation Mechanisms
2. Some Supporting Evidence
3. A Model with Working Capital Constraints
 - Calibration
 - Sudden stop experiment
4. A Model with Heterogeneous Firms and Investment Constraints

MAIN MECHANISMS EXPLORED

Source: unexpected cut in foreign lending (sudden stop)

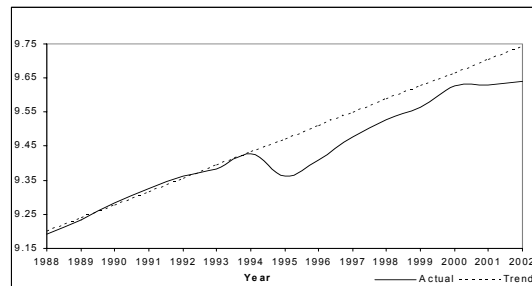
- As in Kehoe and Ruhl (2005), the sudden stop in our model makes traded goods more valuable
 - ... shifting resources towards traded sector
 - ... and depreciating the real exchange rate
- The domestic interest rate increases
 - ... making borrowing more expensive
 - ... this is where financial frictions start playing a crucial role

- *Working capital constraint*: Intermediate goods must be bought with (short term) loans
 - ... user cost of intermediate goods increases
 - ... acting as a distorting tax on production of intermediate goods
 - ... and shows up as a negative TFP shock which affects current output

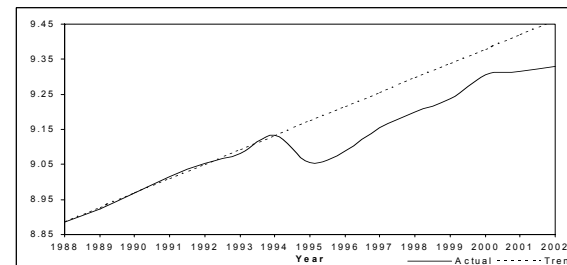
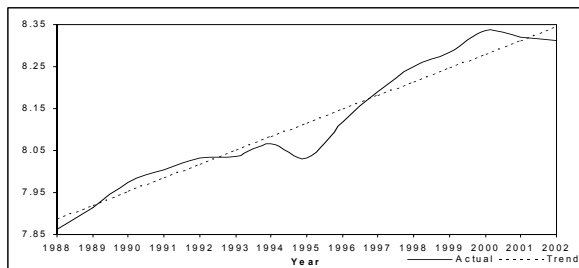
- *Investment constraint*: investment must be financed out of current profits and loans subject to a borrowing limit
 - ... firm's net worth decreases, tightening the constraint
 - ... investment falls (financial accelerator)
 - ... making the drop in output persistent
- Non-traded firms must borrow in traded goods
 - ... the real exchange depreciation affects their balance sheets
 - ... investment falls more and output stagnates longer in the non-traded sector

- Some supporting evidence - GDP

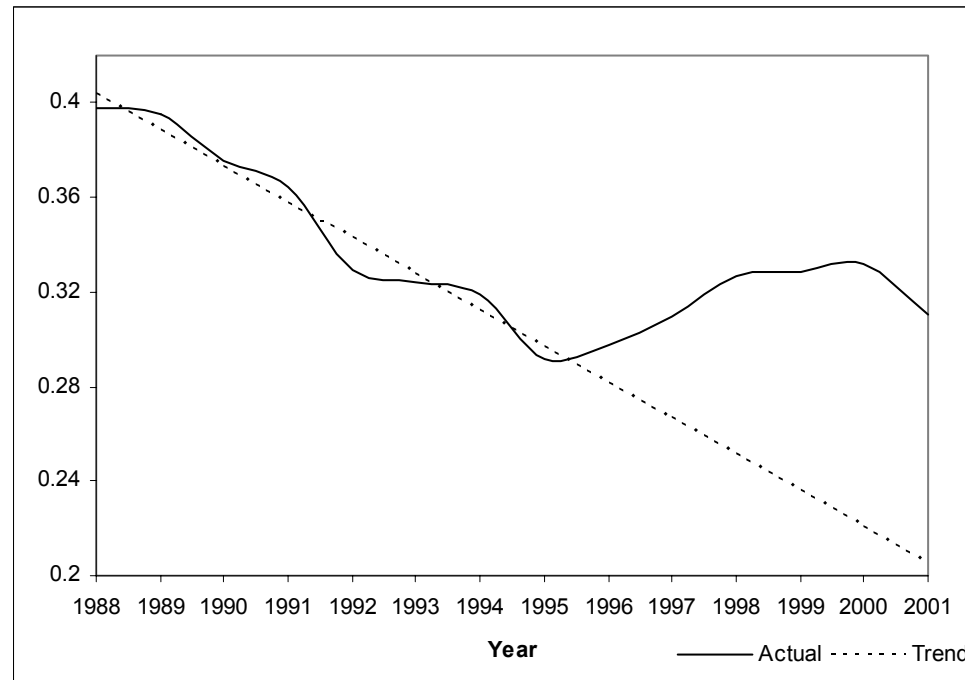
Aggregate GDP



GDP in the traded goods sector GDP in the non traded goods sector

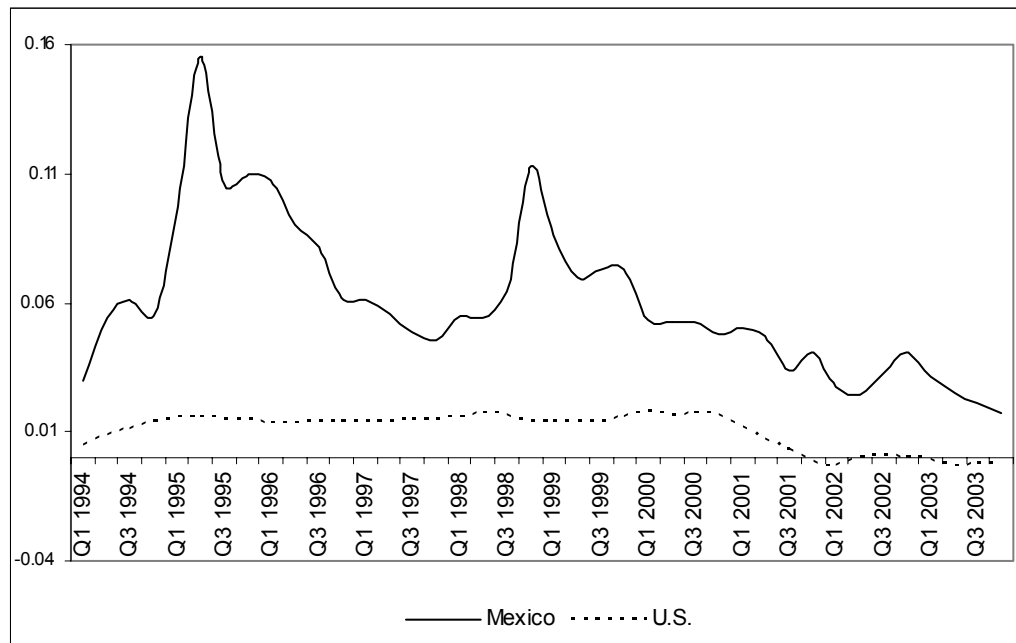


- Labor Reallocation across Sectors

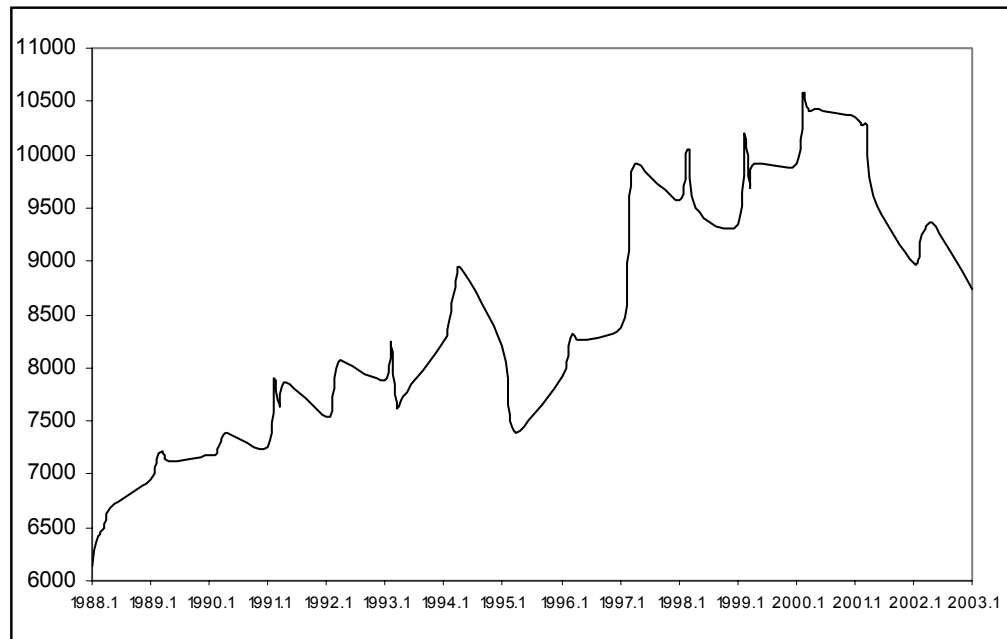


Ratio of hours worked in the T sector relative to the N sector

- Increase in Interest Rates

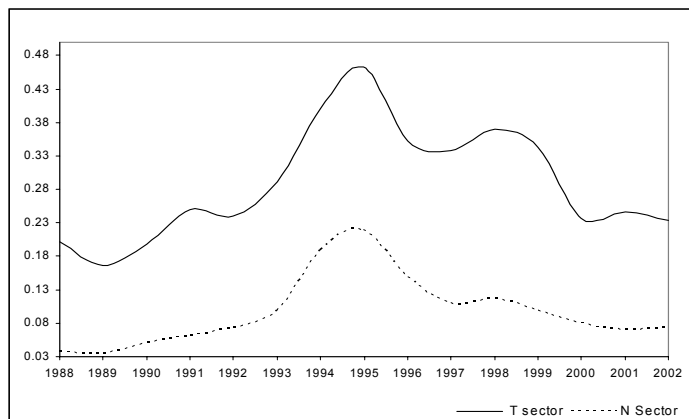


- Fall in Intermediate Demand

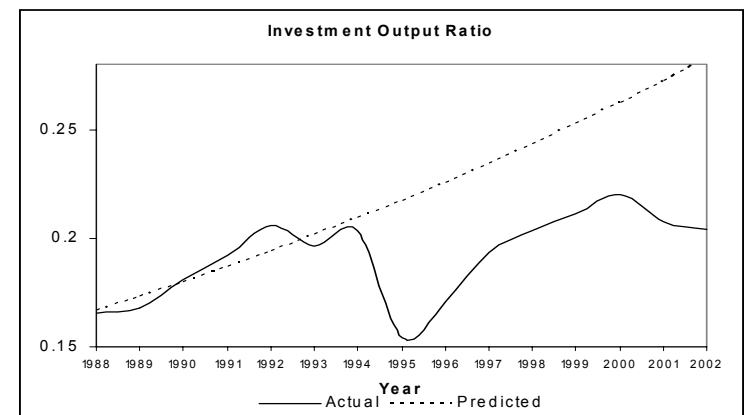


Energy Consumption by Business Sector

- Fall in Credit and Investment



Ratio of Dollar Denominated Debt to GDP



Investment Output Ratio

- Balance Sheet Effects on Investment

		Low Exports	High Exports
Low Debt	89-94	17.6	7.14
	95-00	16.2	5.54
High Debt	89-94	217	226
	95-00	108	201

Firm Level Investment by Debt and Exports

Source: *Pratap and Urrutia (2004), Mexican stock market data*

A MODEL WITH WORKING CAPITAL CONSTRAINTS

- Four production sectors
 - Traded good: domestic consumption, net exports
 - Non-Traded good: domestic consumption
 - Intermediate good
 - Investment good
- Representative consumer
- Competitive financial intermediaries

Traded good Sector

- Representative Firm
- Production Function

$$Y = A_T \left[\left(k^{\alpha_T} l^{1-\alpha_T} \right)^{\varepsilon_T} m^{1-\varepsilon_T} \right]^v$$

- Capital accumulated through investment x_t :

$$(1 + \gamma) k_{t+1} = (1 - \delta) k_t + x_t$$

γ : trend growth rate

- Working capital constraint: Intermediate goods must be bought in advance with loans

- Static profit function

$$\Pi_t^T(k) = \max_{\{Y, l, m\}} \{Y - w_t l - (1 + \hat{r}_{t+1}) p_t^m m\}$$

$$\text{s.to} \quad Y = A_T \left[(k^{\alpha_T} l^{1-\alpha_T})^{\varepsilon_T} m^{1-\varepsilon_T} \right]^v$$

\hat{r}_{t+1} : domestic interest rate ($\hat{r}_{t+1} = r^* + \mu$)

- μ : (small) intermediation cost

- Firms can finance investment by issuing equity (negative dividends)
- Dynamic problem

$$V_t^T(k) = \max_{\{x, k'\}} \left\{ \Pi_t^T(k) - p_t^x x - \psi \left(\frac{x}{k} \right)^2 + \left(\frac{1}{1 + r_{t+1}} \right) V_{t+1}^T(k') \right\}$$

$$s.to. \quad (1 + \gamma) k' = (1 - \delta) k + x$$

ψ (small) adjustment cost of capital

Similarly for Non-Traded Sector:

- Static profit function

$$\Pi_t^N(k) = \max_{\{Y, l, m\}} \{p_t^n Y - w_t l - (1 + \hat{r}_{t+1}) p_t^m m\}$$

$$\text{s.to} \quad Y = A_N \left[(k^{\alpha_N} l^{1-\alpha_N})^{\varepsilon_N} m^{1-\varepsilon_N} \right]^v$$

- Bellman equation

$$V_t^N(k) = \max_{\{x, k'\}} \left\{ \Pi_t^N(k) - p_t^x x - \psi \left(\frac{x}{k} \right)^2 + \left(\frac{1}{1 + r^*} \right) V_{t+1}^N(k') \right\}$$

$$\text{s.to.} \quad (1 + \gamma) k' = (1 - \delta) k + x$$

Intermediate good Sector

$$\begin{aligned} & \max_{\{M_t, M_t^T, M_t^N\}} \left\{ p_t^m M_t - M_t^T - p_t^n M_t^N \right\} \\ & \text{s.to} \quad M_t = A_m \left(M_t^T \right)^\phi \left(M_t^N \right)^{1-\phi} \end{aligned}$$

Investment good Sector

$$\begin{aligned} & \max_{\{X_t, X_t^T, X_t^N\}} \left\{ p_t^x X_t - X_t^T - p_t^n X_t^N \right\} \\ & \text{s.to} \quad X_t = A_x \left(X_t^T \right)^\eta \left(X_t^N \right)^{1-\eta} \end{aligned}$$

Representative consumer

$$\max_{\{C_t^T, C_t^N, s_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left[\lambda \log(C_t^T) + (1 - \lambda) \log(C_t^N) \right]$$

$$\text{s.to} \quad C_t^T + p_t^n C_t^N + (1 + \gamma) S_{t+1} = w_t + (1 + r^*) S_t + \pi_t$$

S_{t+1} : savings

π_t : dividends

Calibration: Production function parameters calibrated to input output tables for Mexico, updated in 1993

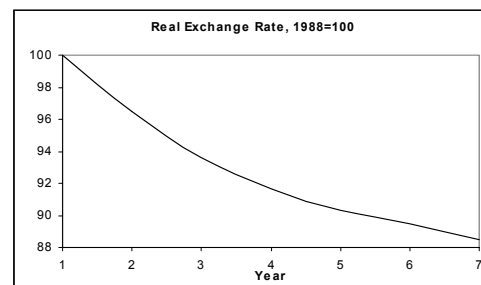
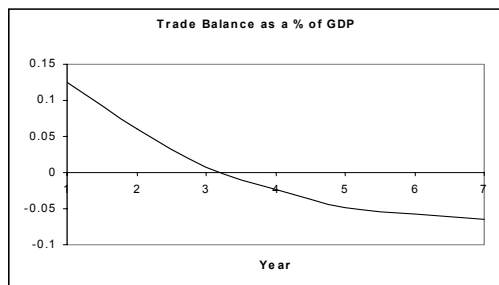
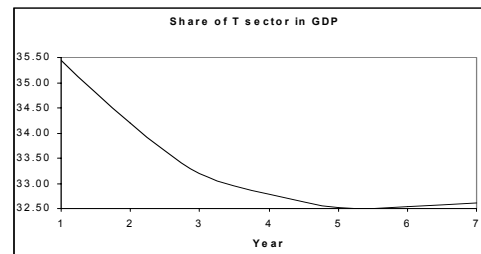
Statistic	Target	Parameter	Value
Ratio of T to N consumption	0.45	λ	0.31
Ratio of T to N investment goods	0.98	η	0.48
Returns to Scale Parameter		ν	0.9
Ratio of intermediate goods to V.A. in T	1.10	ε_T	0.42
Ratio of wage bill to V.A. in T	0.52	α_T	0.34
Ratio of intermediate goods to V.A. in N	0.44	ε_N	0.66
Ratio of wage bill to V.A. in N	0.64	α_T	0.25
Ratio of T inputs to total intermediates in T Sector	0.74		
Ratio of T inputs to total intermediates in N sector	0.32		
Weighted average of ratios		ϕ	0.55

Parameters calibrated using the steady state (balanced growth path) of the model

Statistic	Target	Parameter	Value
World interest rate	0.05	r^*	0.05
Depreciation rate	0.10	δ	0.10
Intermediation cost		μ	0.01
Trend (long run) growth rate	0.03	γ	0.03
Stationary Investment rate in T sector	0.26	A_T	1.4
Stationary Investment rate in N sector	0.14	A_N	0.7
Stationary Fraction of Labor in T sector	0.25	A_m	3.0
		A_x	2.0

3. Cost of adjustment (ψ) and initial savings (s_0) calibrated to the first six periods of the transitional path of the economy after a financial liberalization (Mexico, 1998-94)

Starting from steady state with high intermediation cost, at date 0 intermediation costs decline over the transition.



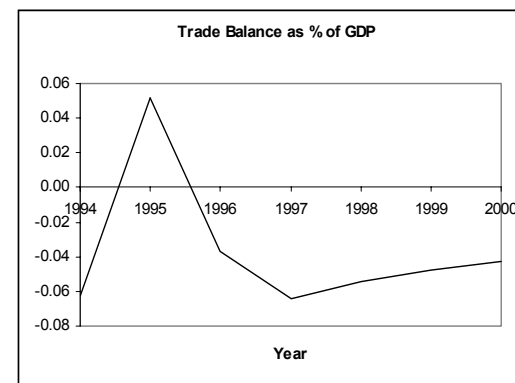
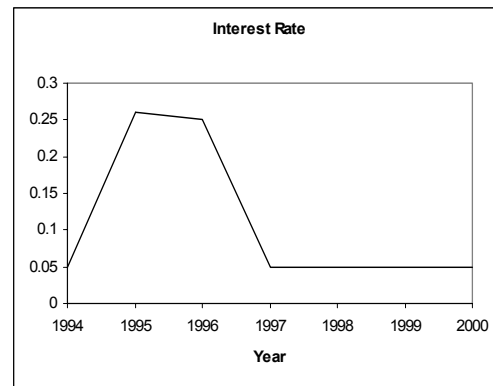
SUDDEN STOP EXPERIMENT

Starting from initial conditions given by the 8th period of the transition after financial liberalization (Mexico, 1994)

... the economy faces an unexpected sudden stop

... for two periods, the economy cannot borrow from abroad

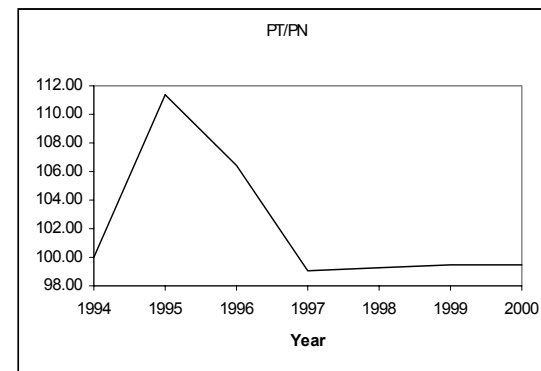
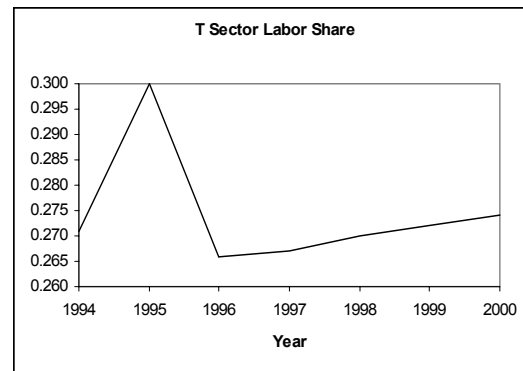
... the domestic interest rate adjusts to clear the credit market



Traded goods become more valuable, so labor reallocates towards T Sector

Reallocation is costly (adjustment cost for capital, intermediates effects)

... the relative price of T/N goods the real exchange rate increases by 12%



(in Mexico 1995, the relative price of T/N goods increased by 8%, but the RER depreciated by 50%)

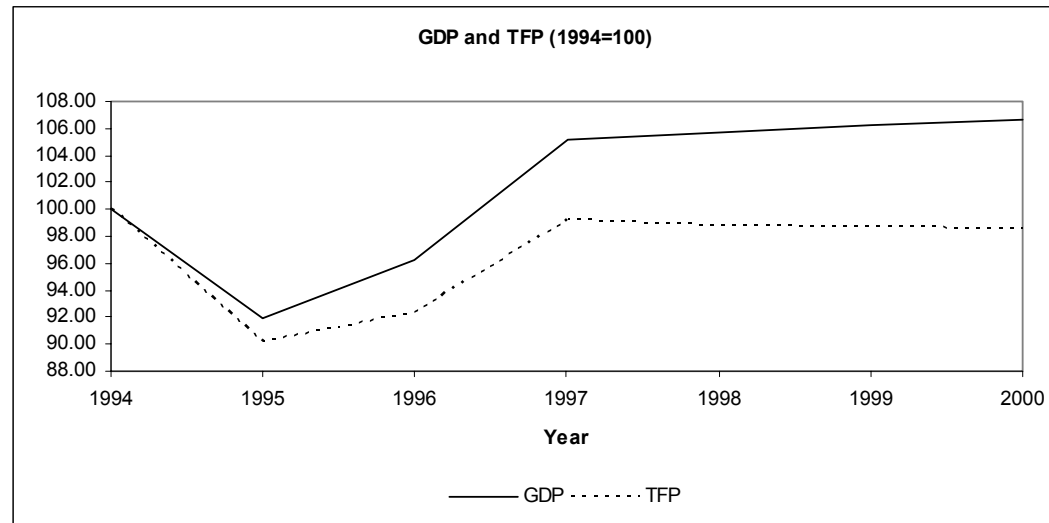


Figure 0.1:

The model generates large effects in output and TFP

... accounts for about 80% of the observed drop in detrended GDP

The TFP drop reflects a misallocation of inputs due to the working capital constraint

Strength of WK Constraint	Detrended GDP fall (%)	Detrended TFP fall (%)	P^T/P^N increase (%)
100% (benchmark)	8.04	9.77	11.3
75%	5.53	7.36	10.7
50%	4.61	6.46	9.9
25%	3.84	5.71	9.1

Main discrepancies with data:

- Sectoral output changes are not consistent with data
 - Output in the traded goods sector rises by 3%, output in the non traded goods sector falls by 11%
 - Labor flows “over react” .
- Output effects are not persistent

When interest rates come back to normal, output also returns to trend
- Investment falls more in Traded good sector since T sector uses intermediates more intensively

Need a mechanism to reduce over reaction of labor flows.

... cost of adjustment of labor (to be completed)

Need a mechanism that increases the persistence of the sudden stop effects

... and amplifies them for the non-traded sector

A MODEL WITH CREDIT CONSTRAINTS FOR INVESTMENT

Same structure, except for the T and N sectors

- In each sector, there is a continuum of ex-ante identical firms
- Firms face idiosyncratic productivity shocks
- Same working capital constraint as before
- Each firm decides how much to invest, subject to financial frictions

No aggregate uncertainty - No entry/exit modelled

Financial frictions for investment

- Investment cannot be financed through equity (non-negative dividends)
- Investment must be financed out of profits plus one period loans
- Loans are in units of the traded good
- Ad-hoc borrowing constraint: firms can borrow for investment up to a fraction κ of their net worth (in units of the T good)

Bellman equation in T sector

$$V_t^T(\theta_i, k, b) = \max_{\{x, k', b'\}} \left\{ \Pi_t^T(\theta_i, k) - (1 + \hat{r}_t) b - p_t^x x - \psi \left(\frac{x}{k} \right)^2 + (1 + \gamma) b' \right. \\ \left. + \frac{1}{1 + r^*} \sum_{\theta_j \in \{\theta_L, \theta_M, \theta_H\}} \rho(\theta_i, \theta_j) V_{t+1}^T(\theta_j, k', b') \right\}$$

$$\text{s. to } \Pi_t^T(\theta_i, k) - (1 + \hat{r}_t) b - p_t^x x - \psi \left(\frac{x}{k} \right)^2 + (1 + \gamma) b' \geq 0$$

$$0 \leq (1 + \gamma) b' \leq \kappa \left(\Pi_t^T(\theta_i, k) + (1 - \delta) p_t^x k - (1 + \hat{r}_t) b \right)$$

$$(1 + \gamma) k' = (1 - \delta) k + x$$

Bellman equation in N sector

$$V_t^N(\theta_i, k, b) = \max_{\{x, k', b'\}} \left\{ \Pi_t^N(\theta_i, k) - (1 + \hat{r}_t) b - p_t^x x - \psi \left(\frac{x}{k} \right)^2 + (1 + \gamma) b' \right. \\ \left. + \frac{1}{1 + r^*} \sum_{\theta_j \in \{\theta_L, \theta_M, \theta_H\}} \rho(\theta_i, \theta_j) V_{t+1}^N(\theta_j, k', b') \right\}$$

$$\text{s.to. } \Pi_t^N(\theta_i, k) - (1 + \hat{r}_t) b - p_t^x x - \psi \left(\frac{x}{k} \right)^2 + (1 + \gamma) b' \geq 0$$

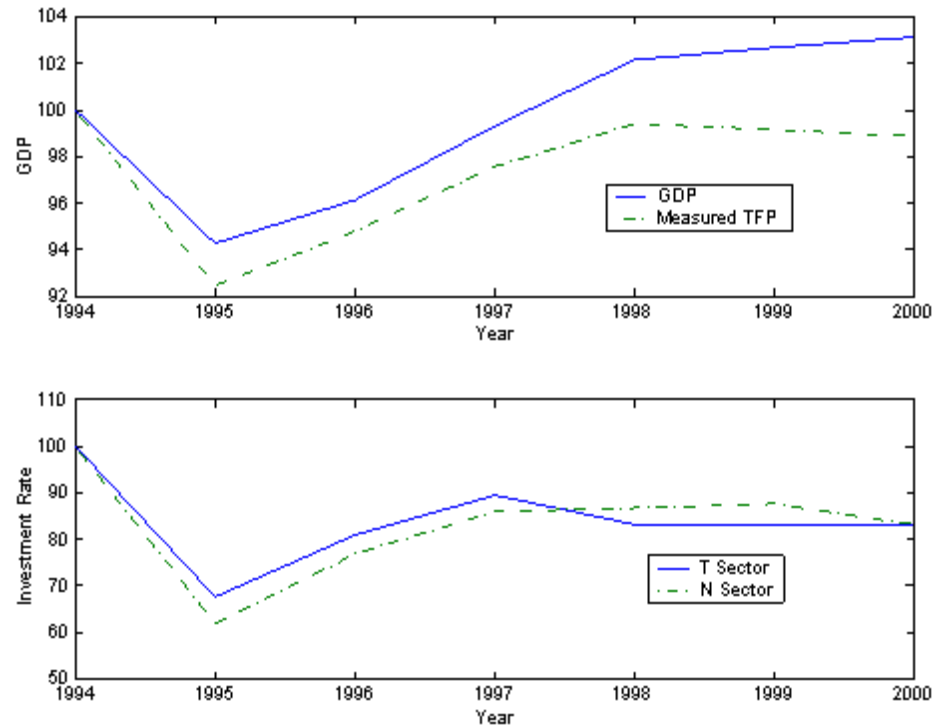
$$0 \leq (1 + \gamma) b' \leq \kappa \left[\Pi_t^N(\theta_i, k) + (1 - \delta) p_t^x k - (1 + \hat{r}_t) b \right]$$

$$(1 + \gamma) k' = (1 - \delta) k + x$$

Experiment:

- Transition from “closed” to “open” economy
- Recalibrate the adjustment cost of capital (ψ) and initial savings (s_0) to match the growth rate of GDP and current account deficit previous to the crisis
- Calibrate κ to obtain a debt to output ratio for both sectors consistent with Mexico in 1994
- Unexpected sudden stop in the eighth year of the transition

Main result:



We obtain more persistent effects on output, and a larger fall in investment in Non-traded sector

Intuition:

- TFP fall reduces net worth of firms, tightening borrowing constraints
- This reduces investment and capital accumulation
- Fall in price of non-traded goods exacerbates this effect for N sector

CONCLUSIONS

- Simple financial frictions can account for an important part of the real effects of a sudden stop
- Model seems consistent with the Mexican experience
 - with one exception
 - Output in the traded goods sector does not fall as a result of the sudden stop
- More work needed in order to understand the micro-foundations behind working capital and investment constraints