On the Risk of Leaving the Euro

Manuel Macera, Albert Marcet, Juan P. Nicolini

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- Proposals to leave the Euro for South-European countries.
- Presumably, there are gains by devaluing own currency as a result of large recessions or long stagnations.
- In this paper we focus on a potential cost.
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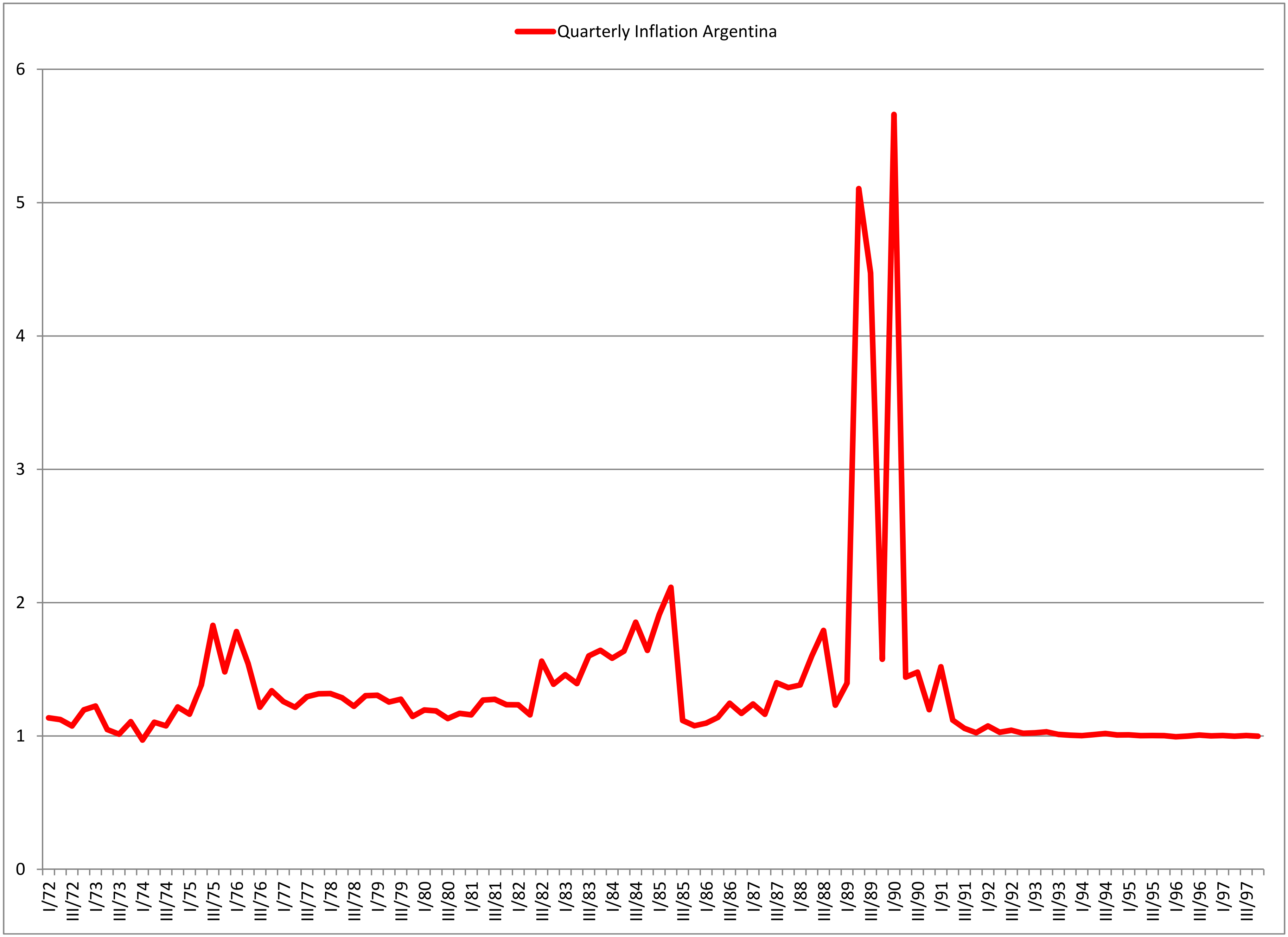
- Related to Marcet and Nicolini (2003) AER

- In the framework of ”Internal Rationality”, as in Adam, Marcet, Nicolini (2016) JofF, Adam Marcet (2011) JET.


Quarterly Inflation Argentina
6
5
4
3
2
1
0
I/72
III/72
I/73
III/73
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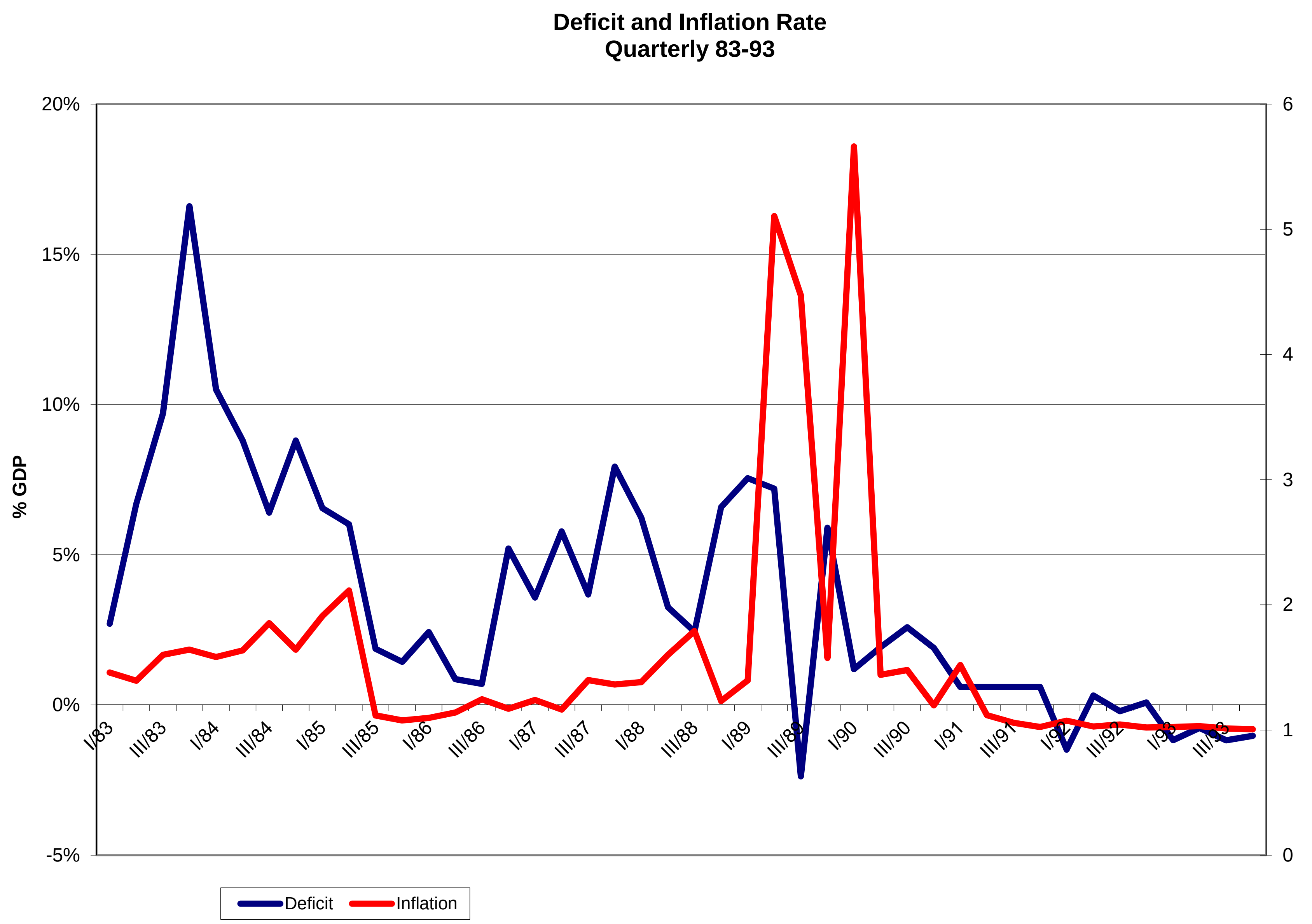

Deficit and Inflation Rate
Quarterly 83-93
% GDP
20%
15%
10%
5%
0%
-5%
6
5
4
3
2
1
0
I/83
III/83
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III/93
Deficit
Inflation

Internal Rationality:

- Agents behave fully optimally given a perception about price behavior (in our case will be inflation). Agents don't know pricing function

- Given their model about inflation the agents' "learning mechanism" follows

- Agents' model of inflation has to be "good".

An exercise on policy analysis under IR.

- Combination of sovereign debt crisis and independent monetary policy can lead to very high inflation.

- Government budget constraint

$$(M_t - M_{t-1}) + (B_t - B_{t-1}(1 + R_t)) = d_t P_t$$

  d_t exogenous deficit

- If a sovereign debt crisis implies $B_t \leq B_{t-1}$, then budget deficits imply money creation and inflation.

- Also, of interest as an application of Learning and Internal Rational Equilibrium to policy analysis

- We study two features that can severely amplify the effect of deficits on the equilibrium inflation rate
  - Deficits that are highly persistent.
  - Learning, due to high uncertainty regarding new regime.
- High nominal instability associated to poor economic performance

Plan

1. Model

2. Version under RE

3. Version with learning

4. Calibration and simulation

The Model

- Money Demand

$$\frac{M_t}{P_t} = \phi(1 - \gamma \frac{P_{t+1}^e}{P_t})$$

- The government budget constraint

$$M_t = M_{t-1} + d_t P_t$$

- Exogenous seignorage $\{d_t\}$, which evolves according to

$$d_t = (1-\rho)\delta + \rho d_{t-1} + (1-\rho)\epsilon_t$$

where ϵ_t is iid.

Rational Expectations

- Combining the money demand equation and the government budget constraint delivers
$$\pi_{t-1} = \frac{\phi - \phi\gamma\pi^e_{t-1}}{\phi - \phi\gamma\pi^e_t - d_t}$$
where
$$\pi^e_t = \frac{P^e_{t+1}}{P_t}$$

- Consider the case of a deterministic and constant $d_t = d$.

- RE implies $\pi^e_t = \pi_t$ for all t. Plugging this condition and rearranging delivers:

$$\pi_t = \frac{\phi + \phi\gamma - d}{\phi\gamma} - \frac{1}{\gamma\pi_{t-1}}$$

- This equation governs the dynamics of inflation under rational expectations.

- One stationary equilibrium in "good side" of the Laffer curve is locally unique.

- Continuum of equilibria converging to equilibrium in "bad side".

- With stochastic and persistent shocks, the logic is similar.

- d_t is the only state variable.

- The solution for inflation is not a linear function of d_t.

- A log linearization of the solution implies

$$\widehat{\pi}_t = \rho \widehat{\pi}_{t-1} + \eta_t$$

so inflation, with RE, inherits the persistency of the deficit - up to a log-linear approximation.

- In forecasting inflation, and as long as the economy lives close to the steady state, one could use past inflation instead of using the true state variable.

The Model with Learning

- The main two equations are given by

$$\pi_{t-1} = \frac{\phi - \phi\gamma\pi^e_{t-1}}{\phi - \phi\gamma\pi^e_t - d_t}$$

and

$$d_t = \rho d_{t-1} + (1-\rho)\delta + (1-\rho)\epsilon_t$$

- Agents' model of inflation follows the process

$$\begin{aligned} \pi_t &= \rho_\pi \pi_{t-1} + (1-\rho_\pi) b_t + u_t \\ b_t &= b_{t-1} + \eta_t \end{aligned}$$

- This captures two ideas:
  - as in RE, all relevant information regarding the current state variable (the deficit) is embedded in past inflation (which is true with RE close to the low steady state equilibrium).
  - the agent does not observe average inflation, proportional to b_t
  - agents "know" a fixed ρ_π
  - to begin with, agents "know" $\sigma_\eta^2, \sigma_u^2$.
- we allow for

$$\rho_\pi \neq \rho$$

due to the effect that learning can have on the behavior of equilibrium inflation.

- More generally, one could allow for a process for inflation that depends separately on inflation and the deficit.

- Such a perceived model is fully compatible with agents' optimal behavior.

- Even if agents see d_t they can hold separate expectations about inflation.

- The issue that we can discuss is if this is a "reasonable" assumption about agents' beliefs

- Easier to discuss this in the framework of an agents' model than an agents' imposed learning mechanism

- We also assume that, when forming expectations at $t-1$ regarding P_t, agents do not use π_{t-1}.

- The one and two period ahead forecasts are

$$\begin{aligned}\pi_t^e &= \rho_\pi \pi_{t-1} + (1-\rho_\pi)\beta_t \\ \pi_{t+1}^e &= \rho_\pi^2 \pi_{t-1} + \left(1-\rho_\pi^2\right)\beta_t\end{aligned}$$

where $\beta_t = E_t^{\mathcal{P}}(b_t)$

- By the end of the period, after π_{t-1} is realized, this posterior is optimally updated as follows:

$$\beta_t = \beta_{t-1} + \frac{1}{\alpha_t}\left(\frac{\pi_{t-1} - \rho_\pi \pi_{t-2}}{1-\rho_\pi} - \beta_{t-1}\right)$$

where $\frac{1}{\alpha_t}$ is the gain, and indicates the relative importance of the previous forecast error.

Given an initial prior mean β_0.

- We will consider various cases for α_t
  - $\sigma_\eta^2 = 0$ and finite prior precision, then OLS $\alpha_t = \alpha_{t-1} + 1$
  - $\sigma_\eta^2 > 0$ and finite prior precision, then $\alpha_t \to \bar{\alpha}$, an increasing function of σ_u^2/σ_η^2.
  - Combined

$$
\begin{aligned}
\alpha_t &= \alpha_{t-1} + 1 && \text{if } \left| \frac{\pi_{t-1} - \rho_\pi \pi_{t-2}}{1 - \rho_\pi} - \beta_{t-1} \right| < \nu \\
&= \bar{\alpha} && \text{otherwise}
\end{aligned}
$$

"motivated" by an agent that learns about $\sigma_\eta^2, \sigma_u^2$.

- If the prior is initially centered at the RE solution and the precision is arbitrarily high $1/\alpha_t = 0$, we obtain the RE solution as a special case.

- Using this in the solution for inflation, we obtain

$$\pi_{t-1} = \frac{\phi - \phi\gamma(\rho_\pi \pi_{t-2} + (1-\rho_\pi)\,\beta_{t-1})}{\phi - \phi\gamma(\rho_\pi^2 \pi_{t-2} + \left(1-\rho_\pi^2\right)\beta_{t-1}) - d_t}$$

- Expectations in period t are formed using the information at the beginning of the period, namely the prior β_{t-1} and the realized inflation π_{t-2}.

- To understand dynamics, notice that if past inflation is close to perceived inflation $\pi_{t-2} \simeq \beta_{t-1}$, then

$$\pi_{t-1} \simeq \frac{\phi - \phi\gamma\beta_{t-1}}{\phi - \phi\gamma\beta_{t-1} - d_t}$$

governs the map from perceived inflation to observed inflation.

Anoter possibility after exit: fixed exchange rate

- The government generates incom occasionally by changing its stock of foreign currency R_t.

- The budget constraint of the government is therefore given by

$$\frac{M_t - M_{t-1}}{P_t} = d_t + (R_t - R_{t-1})\frac{e_t}{P_t}$$

- *A Floating Regime:* All the government expenditure is financed by means of money creation, as before

$$M_t = d_t P_t + M_{t-1}$$

- *A fixed ERR regime:* The government buys or sells foreign currency at a given exchange rate. Assuming zero foreign inflation and given e_{t-1} and a desired level of inflation β^*, the desired exchange rate is

$$e_t \equiv \beta^* e_{t-1}$$

- This policy achieves $\beta^* = \frac{P_t}{P_{t-1}}$, then $R_t - R_{t-1}$ adjusts

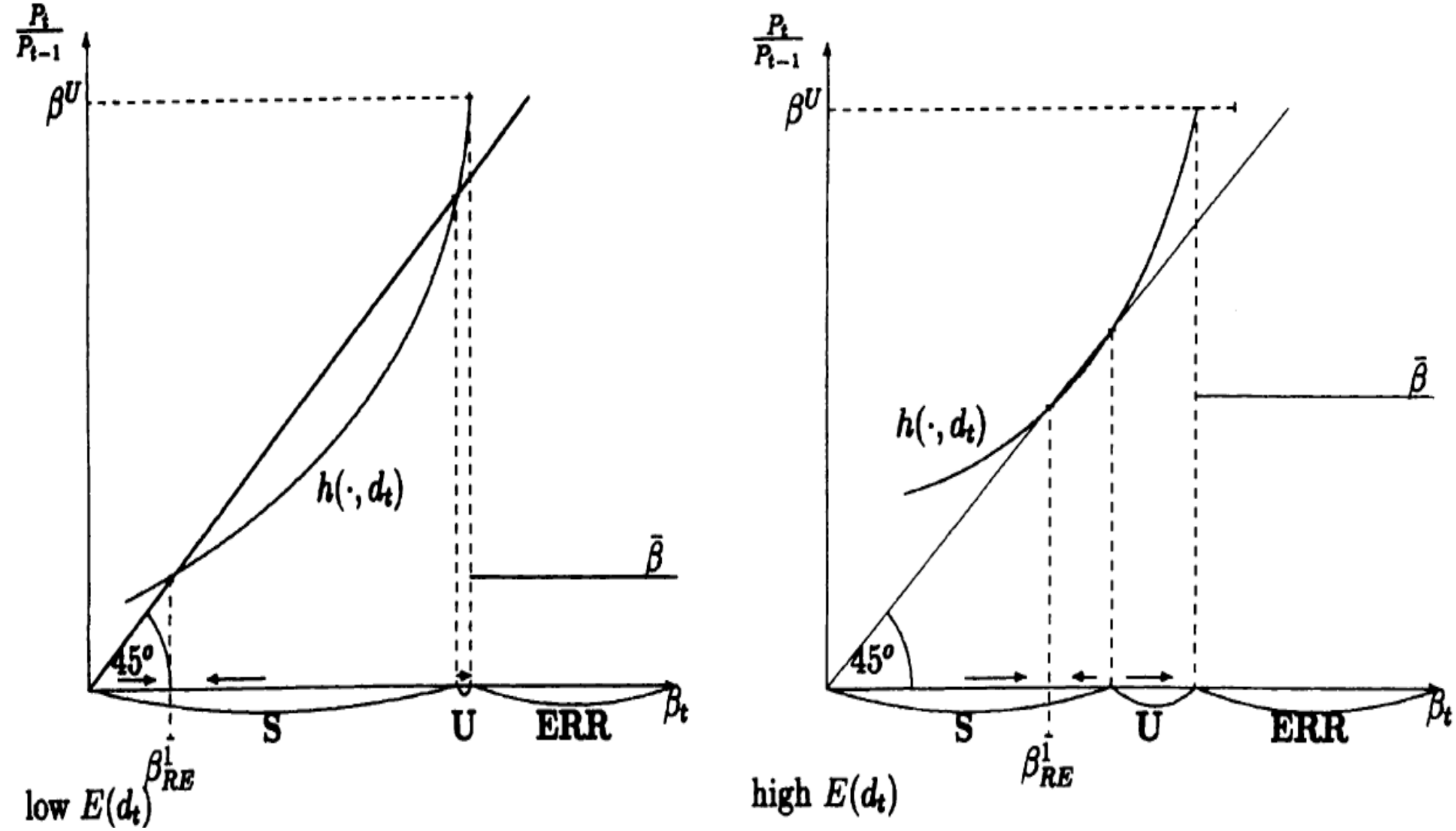
- The money demand determines the level of nominal money demand consistent with that price level

- Given this level of money and d_t, foreign reserves adjust so as to satisfy the government budget constraint.

- Of course, to the extent that there are constraints on the evolution of the government foreign asset position, ERR may not be feasible.

- We assume that the government switches to ERR regime if otherwise $\pi_t > \pi^U$.

Mapping from Perceived to Observed Inflation



Computing ρ_π

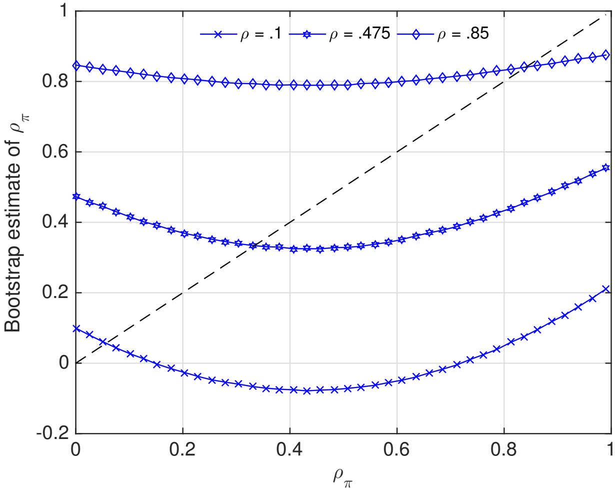
- With RE, the inflation rate inherits the persistency of the process for the deficit.

- However, the learning dynamics may impart a bias in that parameter.

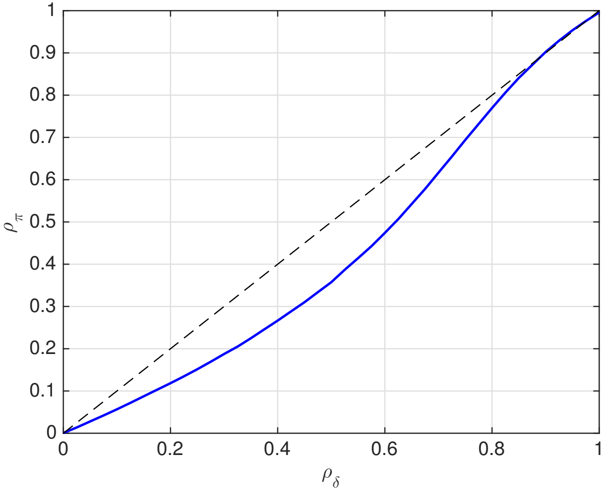
- To illustrate this, and given a value for ρ, we simulate the model for $\rho_\pi \in [0,1]$. Then, for each value of ρ_π, we simulate the model and estimate the persistency of equilibrium inflation, $\rho'_\pi = f(\rho, \rho_\pi)$.

- We then, for each ρ, we pick the value for ρ_π that solves

$$\rho_\pi = \rho'_\pi = f(\rho, \rho_\pi).$$



Inflation persistence - Bootstrap estimate vs True Parameter: The points in which the solid lines cross the dashed line represent the fixed points $\rho_\pi = \hat{\rho}_\pi(N, T)$. For this simulation we set $\delta = 1.5\%$, $N = 1000$ and $T = 1000$.



Inflation persistence vs. Seigniorage Persistence: The solid line represent the fixed points portrayed in the previous figure for different values of ρ_δ. For this simulation we set $\delta = 1.5\%$, $N = 1000$ and $T = 1000$.

Calibration

- We aim at estimating a process for the quarterly deficit on GDP for Greece, Portugal, Italy and Spain, to calibrate ρ and the standard deviation of the shock to the deficit.

- We use the persistency of inflation obtained by the fixed point explained above.

- We use parameters for the money demand that match a maximum of the Laffer of 5% of GDP and an inflation rate that maximizes seignorage of around 60% per quarter. (Argentinean data).

- We also allow for a "structural reform", that occurs with probability 5% (or 10%) per quarter, and such that the deficit mean is distributed as a uniform in $[0, 0.5]$.

Parameters for Baseline Economy

Parameter	Symbol	Value
Persistence of deficit	ρ	.93
SD of shocks to deficit	σ_ϵ	.014
Persistence of inflation	$\rho_\pi^\star$	.92
Money Demand Parameter	ϕ	.36
Money Demand Parameter	γ	.39
Learning Parameter	$1/\overline{\alpha}$	{0,.1,.2,.3}
Learning Parameter	ν	.1
ERR trigger	β^U	4
Mean deficit post-adjustment	-	U(0,0.5)

Policy Analysis under Internal Rationality

- To analyze the effects of leaving the euro, let us say we have

  1. a fully specified model

  2. assumptions about $(\delta, d_0, \rho, \sigma_u^2)$ after leaving the euro

- Under RE we are done, now we could do policy analysis, free from the Lucas critique.

- If we do policy analysis under learning, do we fall in the "jungle of irrationality"? are we subject to the Lucas critique?

- If agents have a "very good" model of inflation we are also effectively free from the Lucas critique.

- Additional degrees of freedom: initial prior inflation β_0, initial prior precision.

- Orthodox economic modelling sees as an advantage that expectations are tied down by RE. But the fact that under learning we can model expectations separately may be an advantage.

Probability of n hyperinflations ($\beta^U = 4.00$, $\lambda = 0.00$)

Deficit mean δ $= 2.0\%$, Initial Deficit d_0 $= 2.0\%$				
$1/\overline{\alpha}$	0	1	2	≥ 3
0.30	0.90	5.80	13.80	79.50
0.20	2.10	9.10	20.80	68.00
0.10	96.20	2.20	0.70	0.90
0	100.00	0.00	0.00	0.00
Deficit mean δ $= 2.0\%$, Initial Deficit d_0 $= 4.5\%$				
$1/\overline{\alpha}$	0	1	2	≥ 3
0.30	0.60	3.50	10.20	85.70
0.20	1.30	6.60	18.20	73.90
0.10	95.80	2.30	1.00	0.90
0	100.00	0.00	0.00	0.00

Probability of n hyperinflations ($\beta^U = 4.00$, $\lambda = 0.05$)

Deficit mean δ $= 2.0\%$, Initial Deficit d_0 $= 2.0\%$				
$1/\overline{\alpha}$	0	1	2	≥ 3
0.30	59.70	23.00	10.40	6.90
0.20	63.30	22.70	10.00	4.00
0.10	98.70	0.70	0.50	0.10
0	100.00	0.00	0.00	0.00
Deficit mean δ $= 2.0\%$, Initial Deficit d_0 $= 4.5\%$				
$1/\overline{\alpha}$	0	1	2	≥ 3
0.30	44.10	32.90	13.40	9.60
0.20	48.80	32.50	12.50	6.20
0.10	98.60	1.00	0.30	0.10
0	100.00	0.00	0.00	0.00

Probability of n hyperinflations ($\beta^U = 4.00$, $\lambda = 0.10$)

Deficit mean $\delta = 2.0\%$, Initial Deficit $d_0 = 2.0\%$				
$1/\overline{\alpha}$	0	1	2	≥ 3
0.30	77.80	18.10	3.50	0.60
0.20	82.00	15.50	1.90	0.60
0.10	99.90	0.10	0.00	0.00
0	100.00	0.00	0.00	0.00
Deficit mean $\delta = 2.0\%$, Initial Deficit $d_0 = 4.5\%$				
$1/\overline{\alpha}$	0	1	2	≥ 3
0.30	61.20	31.20	6.10	1.50
0.20	66.70	28.90	3.50	0.90
0.10	99.50	0.40	0.10	0.00
0	100.00	0.00	0.00	0.00

Unconditional Statistics of Inflation Rate ($\beta^U = 8.0, \lambda = 0.05$)

Mean	$1/\alpha = 0.0$		$1/\alpha = 0.3$	
	$d_0 = 0.0\%$	$d_0 = 4.0\%$	$d_0 = 0.0\%$	$d_0 = 4.0\%$
$\delta = 1.0\%$	6.63	9.18	9.92	14.64
$\delta = 3.0\%$	8.83	11.76	13.34	20.04
$\delta = 4.0\%$	10.28	13.40	15.06	19.78
Standard Deviation	$1/\alpha = 0.0$		$1/\alpha = 0.3$	
	$d_0 = 0.0\%$	$d_0 = 4.0\%$	$d_0 = 0.0\%$	$d_0 = 4.0\%$
$\delta = 1.0\%$	8.10	11.62	31.46	50.88
$\delta = 3.0\%$	9.82	13.61	41.91	69.22
$\delta = 4.0\%$	10.85	14.81	43.18	54.29

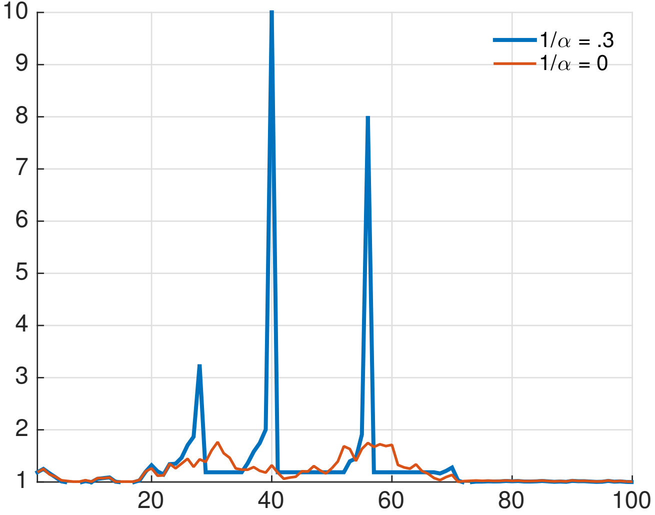


Figure 1: Sample Path for Inflation ($\beta^U = 4$, $\delta = 3\%$, $d_0 = 4\%$, $\lambda = .05$)

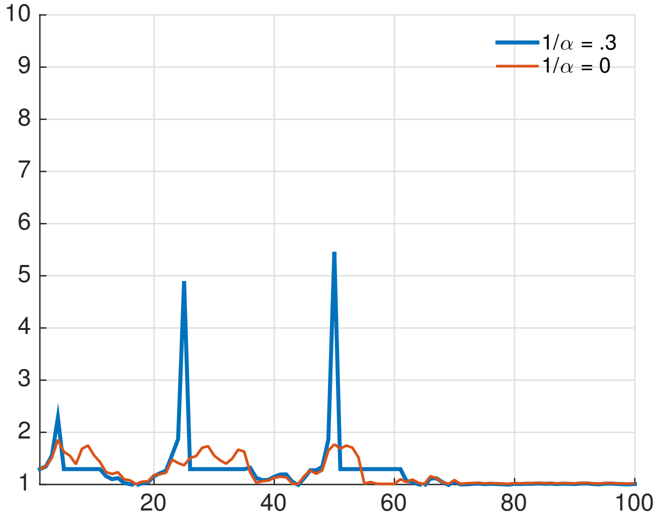


Figure 2: Sample Path for Inflation ($\beta^U = 4$, $\delta = 4\%$, $d_0 = 4\%$, $\lambda = .05$)

Conclusions

- Leaving the Euro in the midst of a sovereign debt crisis is risky!!!