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RESEARCH INSTITUTE FOR DEVELOPMENT, GROWTH AND ECONOMICS

Sudden Stops and Collateral Constraints: Searching for "Wally"

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Roadmap

I. Motivation

II. Sudden Stops

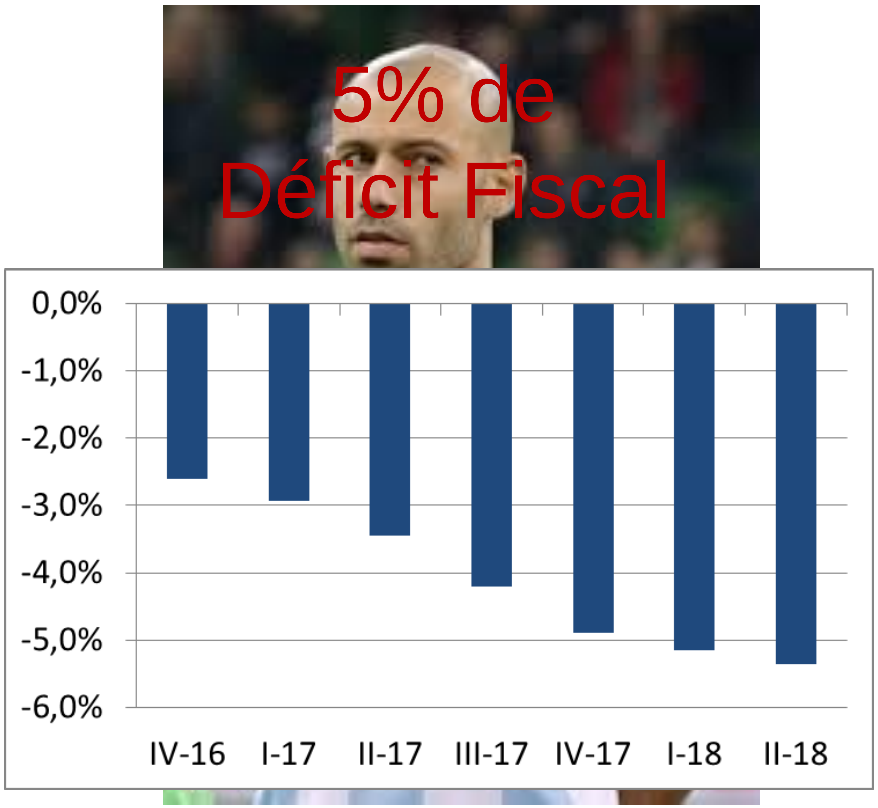
III. Model

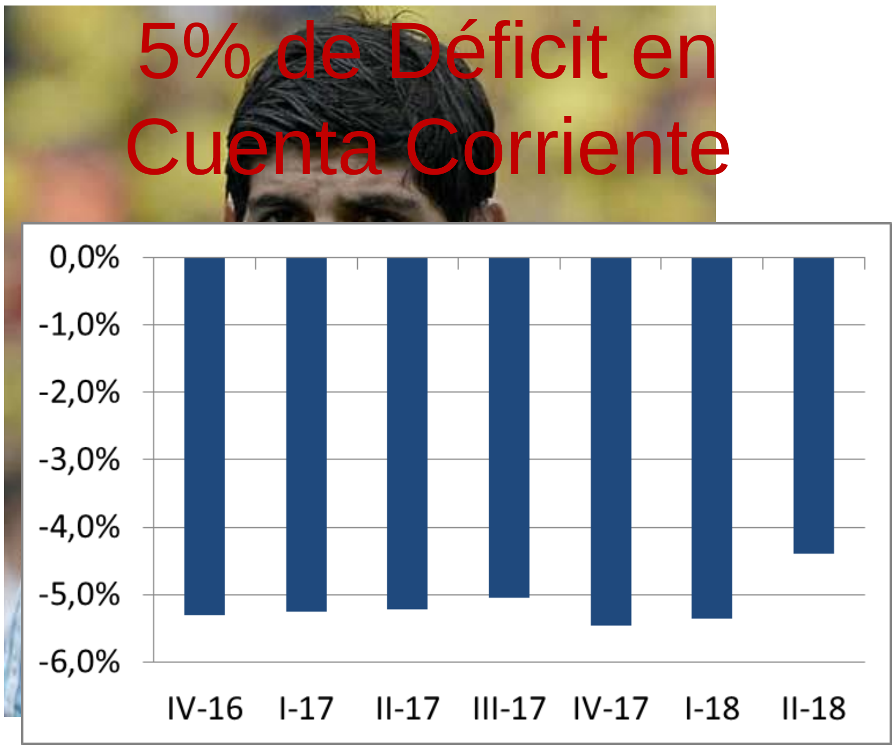
IV. Empirical Strategy

V. Summary

I. Motivation

Argentina llegó al Mundial 2018 con doble 5:





I. Motivation

El Doble Cinco no funcionó ni en el Mundial, ni en la economía…

Unexpected reversal of capital flows after a debt issuance of around 15% of GDP in a time span of less than 1.5 years.

Is there a connection between sudden stops and the amount of external debt issuance per unit of time that took place before the collapse?

I. Motivation

Our answer is Yes

A current account deficit of or above 7% of GDP per year can be sustained for at most 3 years.

Disruption which follows can be measured, roughly, by a 5% drop in consumption and a 4% current account reversal.

Similarly, a deficit of at least 6% can last no more than 5 years.

II. Sudden Stops

What is a Sudden Stop? We look for episodes that comprises the following properties:

(i) a sharp drop in (total) real consumption;
(ii) several years of accumulated current account deficits; and
(iii) an acute correction of the current account following the SS episode.

This is the “Wally” we are eager to find.

II. Sudden Stops

Concept originally developed by Calvo (1998). Several practical definitions:

Mendoza (AER, 2010):
(i) fast reversals of international capital flows,
(ii) declines in production and absorption, and
(iii) corrections in asset prices.

Mendoza and Smith (JIE, 2006):
(i), (ii) and (iii) plus collapses in the price of non-tradable goods relative to tradables

II. Sudden Stops

Calvo et al. (NBER, 2008):

(i), (ii) and sharp rise in aggregate interest-rate spreads

Calvo *et al.* (IADB WP, 2004):

• Capital flows at least two standard deviations below its sample mean.

• SS ends once annual change in capital flows exceeds one standard deviation below its sample mean.

Edwards (NBER, 2004)

• Inflow larger to its region's third quartile during the previous two years prior to the SS,

• Net capital inflows must have declined by at least 5% of GDP in one year.

III. Model

The accumulation of CC deficits with market frictions gives rise to a continuum of potential paths every time the country faces a significant debt issuance. When frictions become relevant, market participants coordinate in a SS.

These facts have to be represented in a tractable model that replicates the main stylized facts of macro variables (specifically, real detrended variables must be bounded).

A typical strategy to solve this problem consists of imposing an exogenous maximum threshold to the external debt the country can borrow. But this ignores the fact that thresholds are related to the business cycle.

Our model avoids this assumption and considers all possible paths, trying to find the one consistent with the data. Pierri-Reffett (2018) is the theoretical antecedent.

III. Model

Assumptions (I)

Small open endowment economy populated by an infinitely lived representative agent who consumes tradable and non-tradable goods.

The agent can borrow from abroad an internationally traded liability d paying a constant interest rate r.

Trade restricted by a borrowing constraint where the ratio of debt to current income, measured in tradable units, must lie below a threshold $\kappa > 0$. So the collateral constraint is a fraction κ of income.

III. Model

Assumptions (II)

Non tradable income is constant. Tradable income follows a Markov process.

Principal paid by the agent is given by $min\{d,\kappa(yT+pyN)\}$

<u>Preferences standard in the literature</u>:

Intertemporal problem: CRRA instantaneous return function with parameter $\sigma > 0$

Intratemporal problem: CES with parameter $\gamma > 0$.

III. Model

We propose the following sequential DSGE model (dimension is infinite).

Problem 1

$$Max\ E_0 \sum_{t=0}^{\infty} \beta^t [C_t^{1-\sigma} - 1] / (1-\sigma)$$

Subject to

$$C_t = [(c_t^T)^\gamma + (c_t^N)^\gamma]^{1/\gamma}$$

flow budget constraint $$c_t^T + P_t c_t^N + (1+r) d_t = y_t^T + P_t y_t^N + d_{t+1}$$

collateral requirement $$d_{t+1} \geq \kappa [y_t^T + P_t y_t^N]$$

$$d_0 \in \mathbb{R}, y_0^T \in Y, y_t^N = y^N > 0$$

III. Model

In order to solve the (general) equilibrium and compute the dynamics of the ER, we can use two definitions:

Definition 1: Sequential Competitive equilibrium (SCE)

A SCE for this economy is composed by 4 progressively $\mathcal{F}_t$-measurable functions p, (c^T, c^N, d) such that:

- Given p, (c^T, c^N, d) solves problem 1
- For each $t, \omega_t \in \mathcal{F}_t$; $c^N(\omega_t) = y^N$

But no numerical solution can be obtain from Definition 1.

III. Model

Definition 2: Recursive Competitive equilibrium (RCE)

Let $z_t \equiv [y_t^T, p_t, d_t]$ *and* Φ *a correspondence mapping* $K \mapsto K$. *We say that* $\Phi(z_t) \in z_{t+1}$ *if for each* $y_{t+1}^T \in Y$ *there exist* $z_{t+1}(y_{t+1}^T) \in K$ *and* $E_t(X_t(z_{t+1}))$ *such that* z_t *satisfies equations (1)-(4). (see below)*

Now, this representation does not depend on t (as in dynamic programming) and transforms a space of sequencies into a space of (stationary) functions.

This gives us flexibility to solve the model, because the state-space *K* is compact (it does not blow up).

III. Model

Our method entails matching, during a SS, the following pattern:

- A decrease in tradable consumption (c^T_{t+1})
- An ER devaluation (reduction in p_{t+1})
- A decrease in debt $(d_{t+2} - d_{t+1})$

All this preceded by:

- An increasing sequence of ER appreciation and rising debt $\{p_{t-i}, d_{t-i}\}_{i=1}^{\tau}$
- A weakly increasing sequence of tradable consumption $\{c^T_{t-i}\}_{i=1}^{\tau}$, where $\tau = 2,..,6$ and $c^T_{t-i} \geq \underline{c} > 0.$

The last assumption captures the idea that the country is borrowing abroad to sustain a minimum level of tradable consumption.

III. Model

We use this information to solve the model. The non-binding versions of equations (1) and (2) can be written as follows:

$$X_t(d_{t+1}) - \beta(1+r)E_t(X_t(d_{t+1})) = 0$$

$$p_t = \left[\frac{y_t^T + d_{t+1} - (1+r)d_t}{y^N}\right]^{1-\gamma}$$

When collateral constraint is non-binding, the SCE is a standard savings problem. Any positive y_t^T -shock will be smoothed, implying an improvement in the current account along with the required exchange rate appreciation to satisfy equation (2) (where p is increasing in c_t^T).

III. Model

Fortunately, the presence of a binding collateral constraint allows new possibilities. When collateral is present, equations (1) and (2) become:

$$X_t(p_t) \geq E_t\left[X_{t+1}(p_t)\right](1+r)\beta$$

$$p_t = \left[\frac{y_t^T + \kappa\left(y_t^T + p_t y^N\right) - (1+r)d_t}{y^N}\right]^{1-\gamma}$$

The standard procedure to solve is to assume that the collateral binds only for one period d_{t+1}. However, what we typically observe in a SS is a significant drop in consumption in period $t+1$ (because the CC reaches a threshold in period t), so the event involves two consecutive budget constraint periods. Thus, both d_{t+1} *and* d_{t+2} becomes relevant to describe the anatomy of the SS.

III. Model

$$X_t(p_t) \geq E_t\left[X_{t+1}(p_t)\right](1+r)\beta$$

$$p_t = \left[\frac{y_t^T + \kappa\left(y_t^T + p_t y^N\right) - (1+r)d_t}{y^N}\right]^{1-\gamma}$$

Two main strategies to get an empirically meaningful solution:

1. Change κ arbitrarily (a lot). Not too realistic because κ is endogenous (investors typically do not anticipate SSs).
2. Saturate the collateral for two consecutive periods (two years of agony after the SS). This procedure renders a collateral constrain depending on the ER. With this setup, we can get a backward sequence and solve the system.

So, empirical data and theory work back and forth to solve the model and match the anatomy of the SS.

IV. Wally

Model Prediction. A positive relationship between dollar (current) consumption and dollar income because of liquidity constraints. Then, we look for a clear and significant discontinuity in consumption (in constant dollar terms).

Panel Data. 34 countries for the period 1970-2016 (annual data).

Variables. Current account in (current) dollars and % of GDP; consumption and GDP in (constant) dollars; real multilateral exchange rates.

Sources. World Bank, the Economic Commission for Latin America and the Caribbean, the REER database of Darvas (2012), and specific data from national statistical offices.

IV. Wally

We evaluate ΔlnC_{t+1} for different configurations of (γ, h), where γ correspond to different CA_t threshold magnitudes, i.e., $CA_t < -\gamma$, and h to the number of periods for which the current account deficit was below that given value, so $CA_t < -\gamma, CA_{t-1} < -\gamma, CA_{t-2} < -\gamma, \ldots., CA_{t-h+1} < -\gamma$.

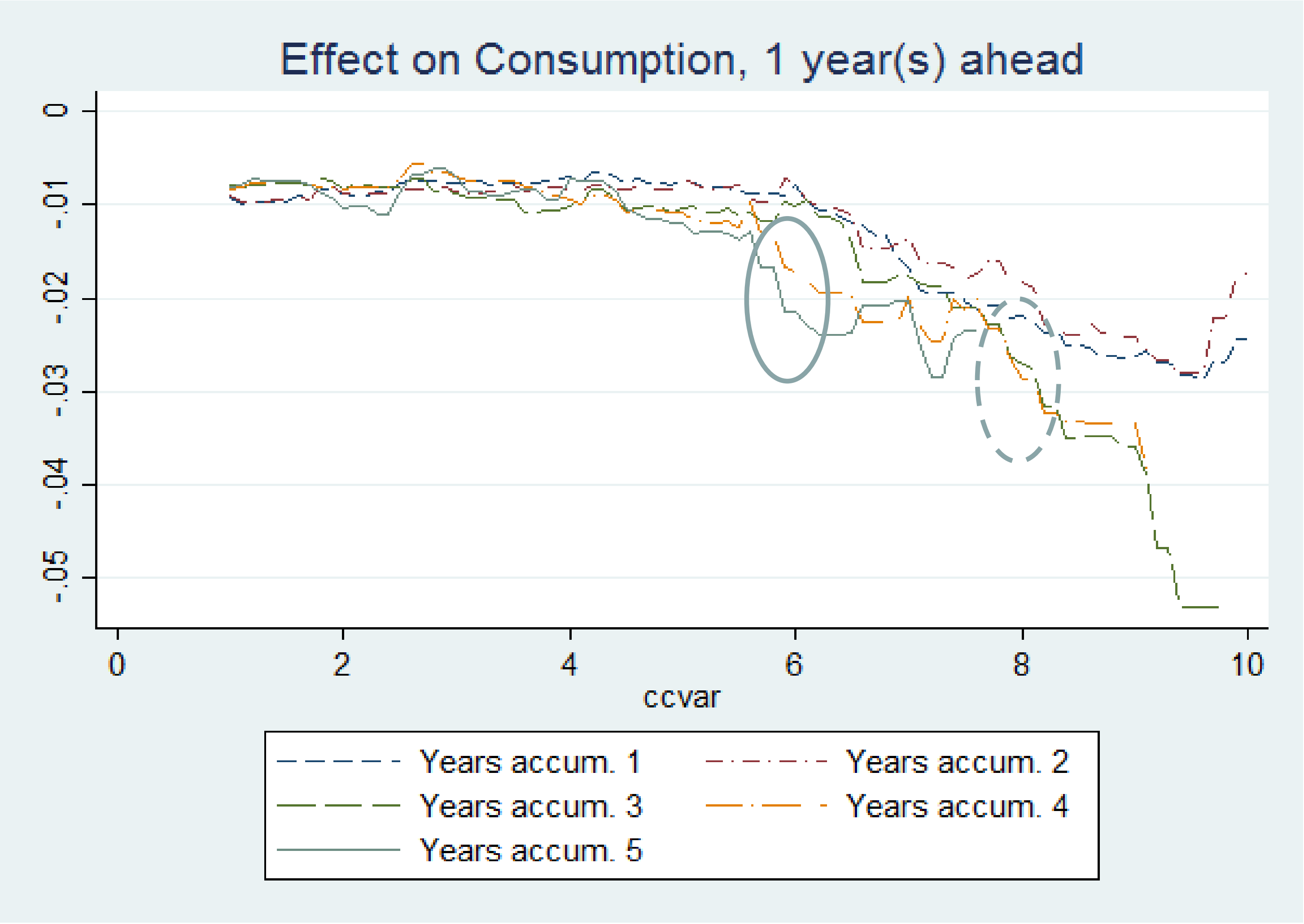
We then define dummy variables for whether each observation of country *i* at period *t* satisfy the above condition, defined as $H_t(\gamma, h)$.

Now we compute the differences in consumption dynamics for countries with a particular configuration of current account deficits with $H(\gamma, h) = 1$ (the "treatment" group), with those that with $H(\gamma, h) = 0$ (the "control" group):

$$\mu_1(\gamma, h) = E[\Delta lnC_{t+1} | H(\gamma, h) = 1] - E[\Delta lnC_{t+1} | H(\gamma, h) = 0],$$

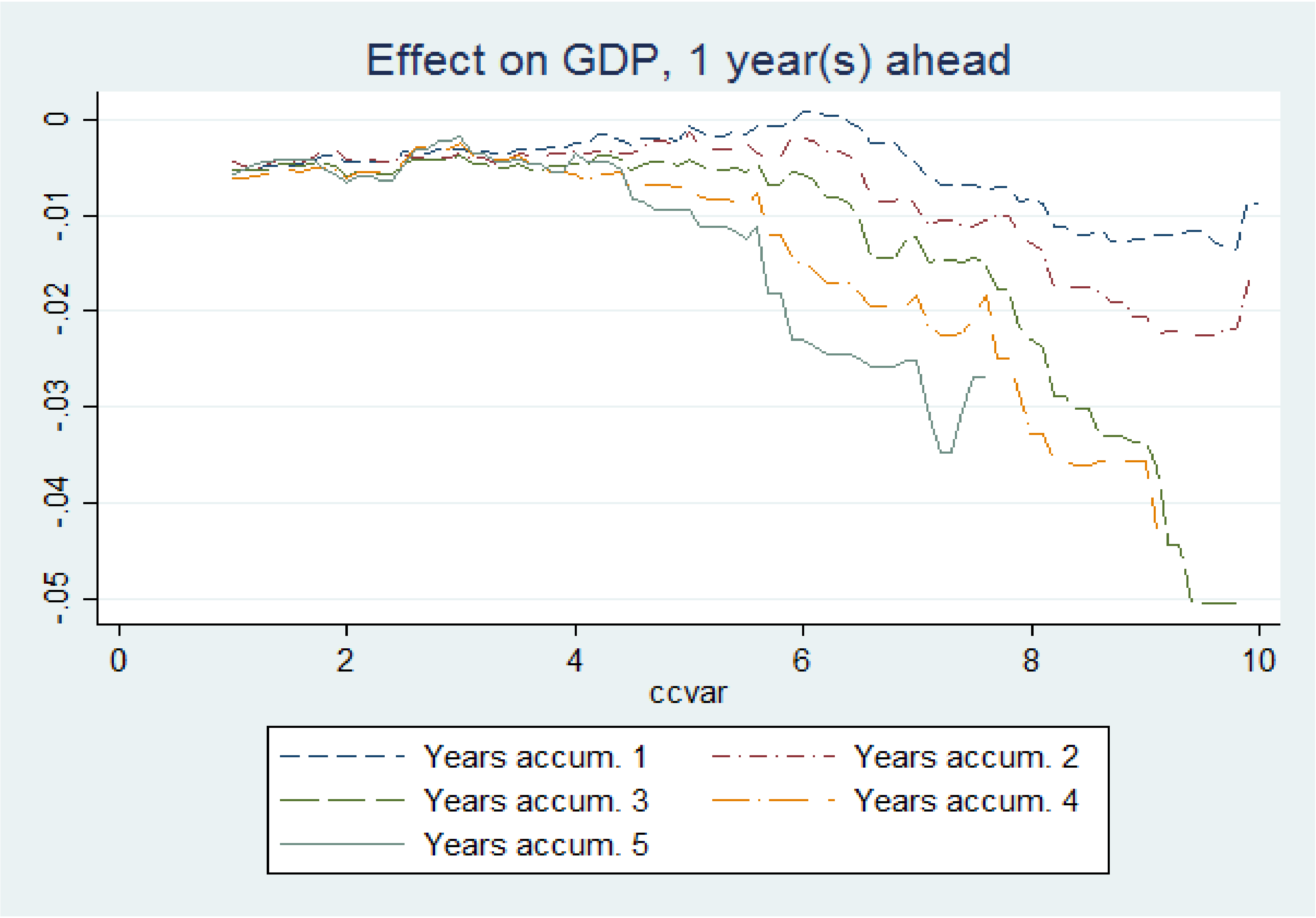
for $h = 1,2,3,4,5$ and for $\gamma \in \{1, 1.1, 1.2, \ldots., 10\}$ for a dense grid of 0.1% intervals in CA_t.

IV. Wally



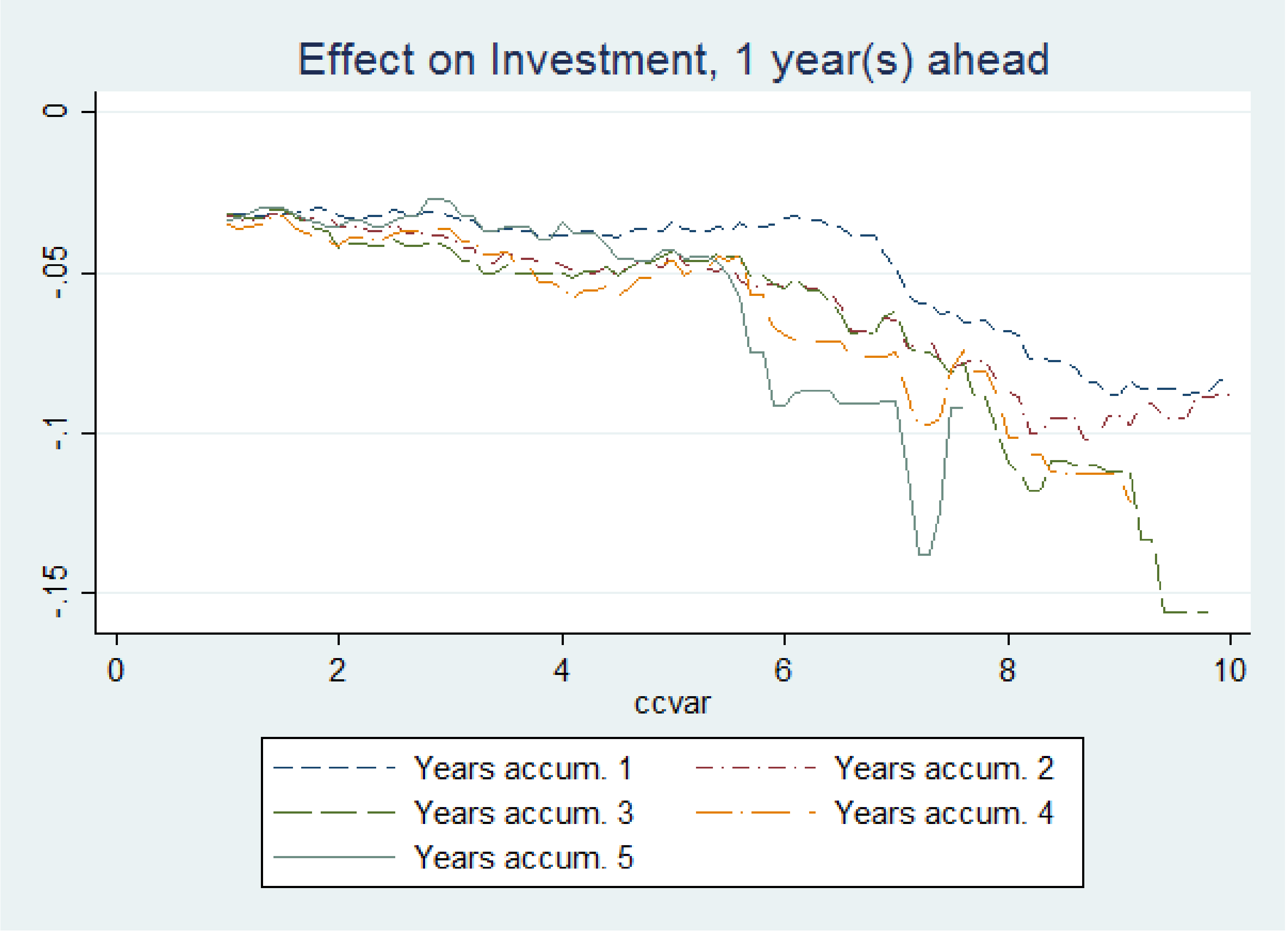
Effect on Consumption, 1 year(s) ahead
0
-.01
-.02
-.03
-.04
-.05
0
2
4
6
8
10
ccvar
Years accum. 1
Years accum. 2
Years accum. 3
Years accum. 4
Years accum. 5

IV. Wally



Effect on GDP, 1 year(s) ahead
0
-.01
-.02
-.03
-.04
-.05
0
2
4
6
8
10
ccvar
Years accum. 1
Years accum. 2
Years accum. 3
Years accum. 4
Years accum. 5

IV. Wally


Effect on Investment, 1 year(s) ahead
0
-.05
-.1
-.15
0
2
4
6
8
10
ccvar
Years accum. 1
Years accum. 2
Years accum. 3
Years accum. 4
Years accum. 5

IV. Wally

If a SS occurs, we expect that the current account experiences a reverse and consumption drops. So now we estimate:

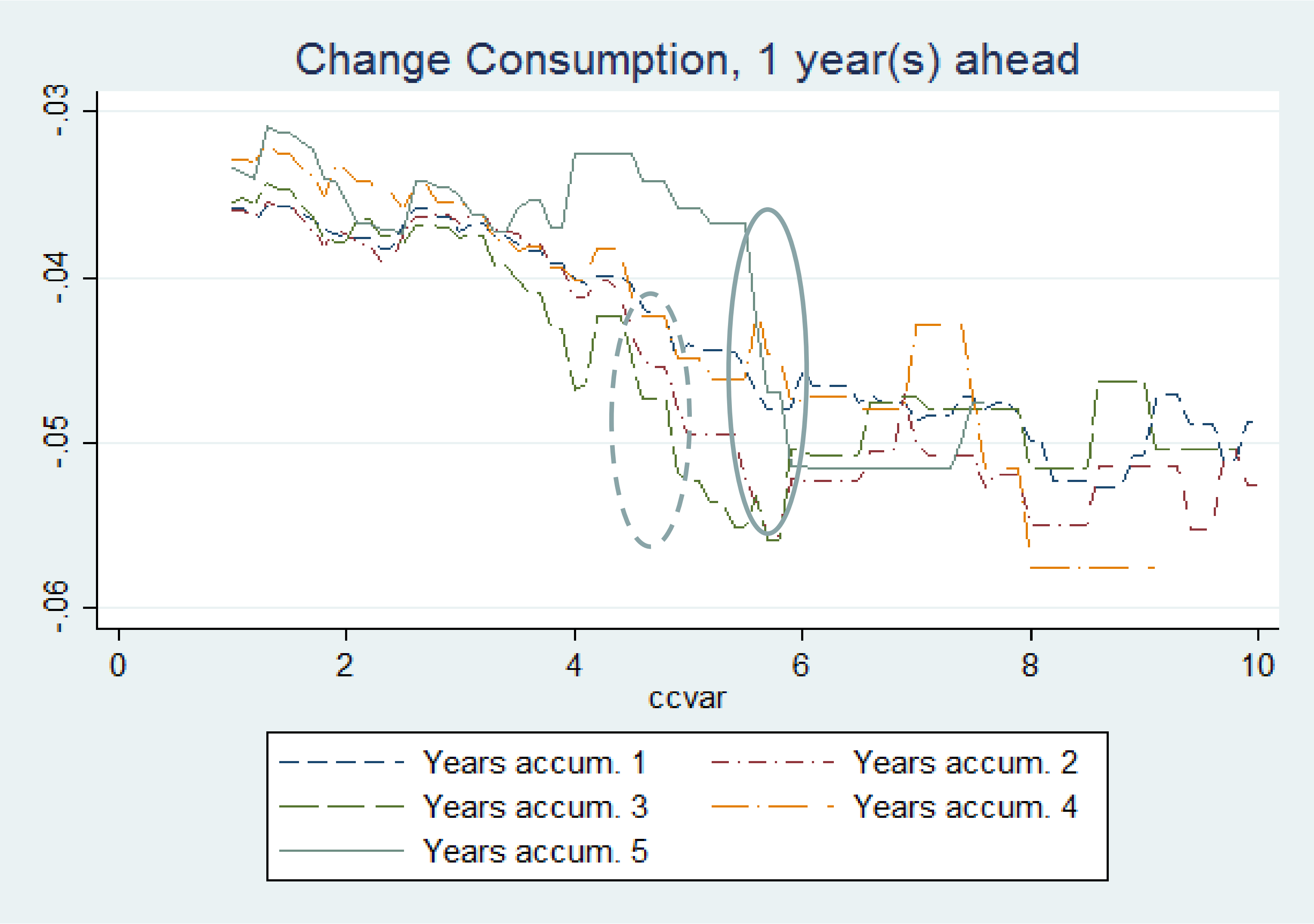
$$\mu_2(\gamma, h) = E[\Delta lnC_{t+1} \mid H(\gamma, h) = 1\& \, E\Delta CA_{t+1} > 0 \, \& \, \Delta lnC_{t+1} < 0]$$

$$\mu_3(\gamma, h) = E[\Delta CA_{t+1} | H(\gamma, h) = 1\& \, E\Delta CA_{t+1} > 0 \, \& \, \Delta lnC_{t+1} < 0].$$

$\mu_2(\gamma, h)$ corresponds to the actual consumption drop that we estimate that is associated with a SS. $\mu_3(\gamma, h)$ corresponds to the current account reversal that should be observed after a SS.

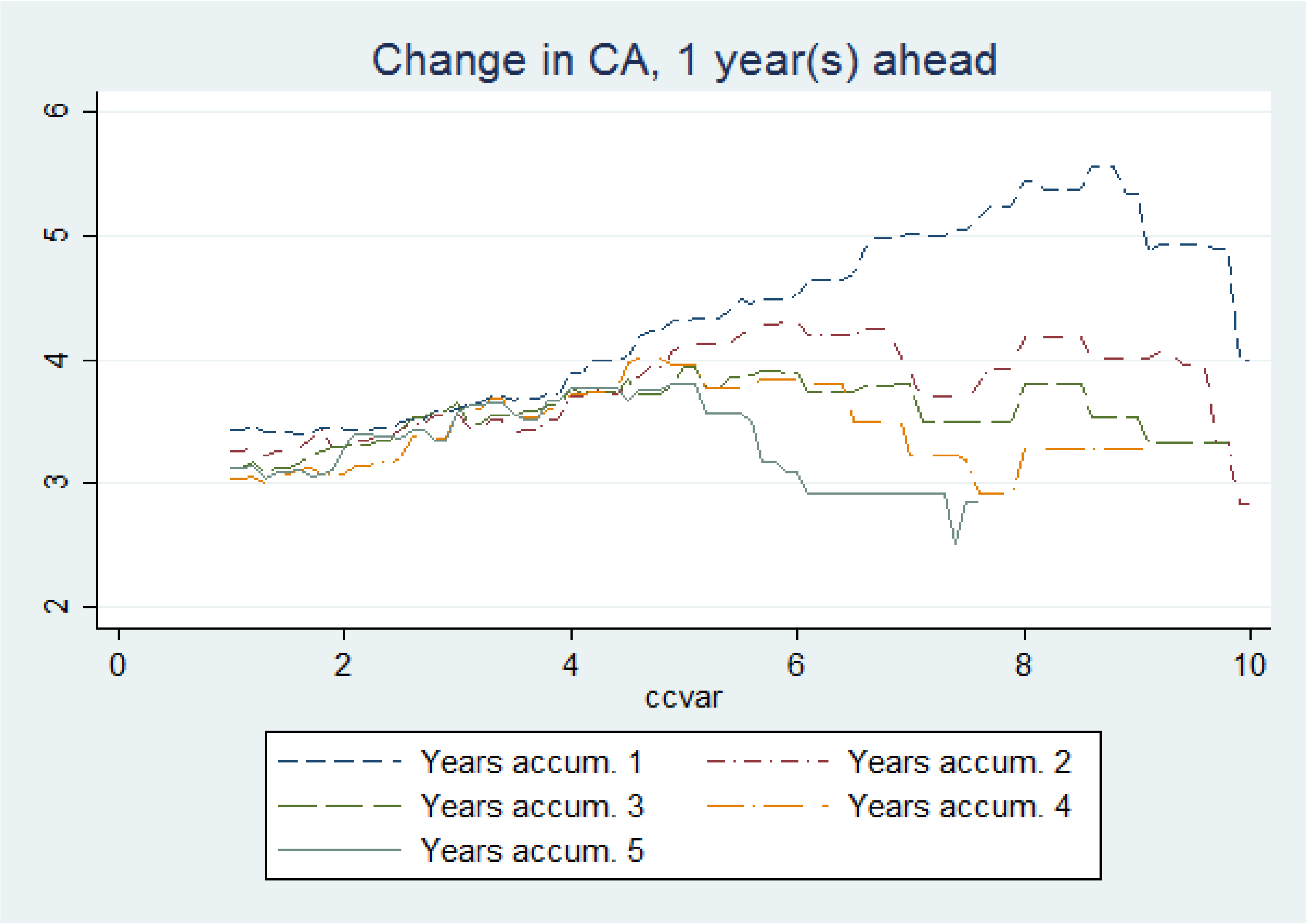
"Wally" must be hidden in a clear discontinuity of $\mu_1(\gamma, h)$ in the direction of γ for different fixed values of h. We try to identify it by looking at the maximum numerical derivatives of the form $\mu_1(\gamma, h) - \mu_1(\gamma - \varepsilon, h) | \varepsilon$ for $\varepsilon = 0.1, 0.2, 0.3, 0.4, 0.5$. Table 1 reports the 3 maximum numerical derivatives found. For each case we also report $\mu_2(\gamma, h)$ and $\mu_3(\gamma, h)$.

IV. Wally



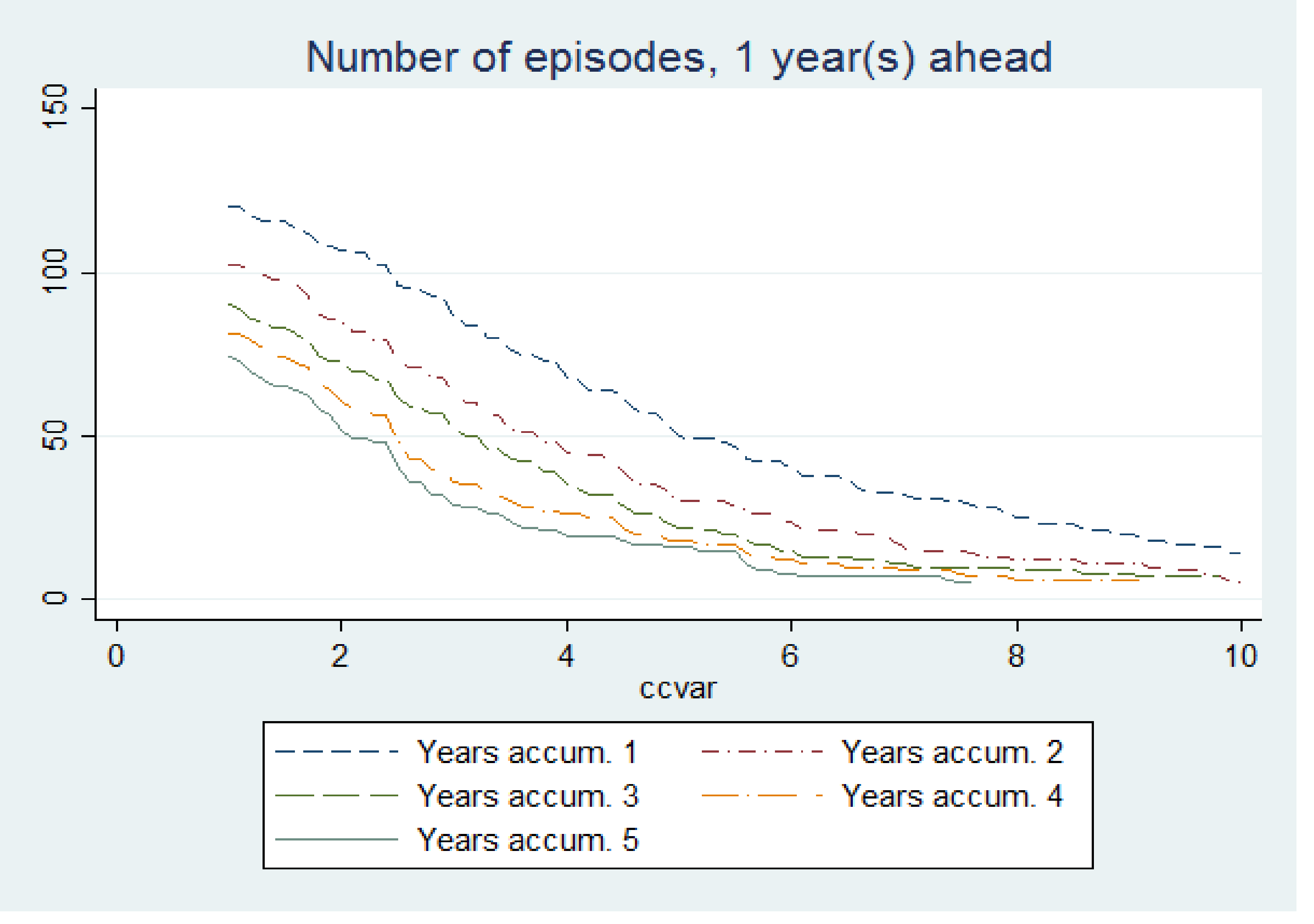
Change Consumption, 1 year(s) ahead
-.03
-.04
-.05
-.06
0
2
4
6
8
10
ccvar
Years accum. 1
Years accum. 2
Years accum. 3
Years accum. 4
Years accum. 5

IV. Wally



Change in CA, 1 year(s) ahead
6
5
4
3
2
0
2
4
6
8
10
ccvar
Years accum. 1
Years accum. 2
Years accum. 3
Years accum. 4
Years accum. 5

IV. Wally



Number of episodes, 1 year(s) ahead
150
100
50
0
0
2
4
6
8
10
ccvar
Years accum. 1
Years accum. 2
Years accum. 3
Years accum. 4
Years accum. 5

IV. Wally

Table 1: Maximum numerical derivatives - 3 years accumulated of CA deficit

ε	Rank	Slope	γ	h	ΔlnC(t+1)	ΔCA(t+1)	# Episodes
0.1	1	-0,080	9.2	3	-0,0505	3,3	7
	2	-0,063	9.4	3	-0,0505	3,3	7
	3	-0,042	6.6	3	-0,0476	3,8	12
0.2	1	-0,032	9.4	3	-0,0505	3,3	7
	2	-0,025	9.2	3	-0,0505	3,3	7
	3	-0,018	8.2	3	-0,0515	3,8	9
0.3	1	-0,048	9.4	3	-0,0505	3,3	7
	2	-0,025	8.4	3	-0,0515	3,8	9
	3	-0,021	9.6	3	-0,0505	3,3	7
0.4	1	-0,068	9.4	3	-0,0505	3,3	7
	2	-0,048	9.6	3	-0,0505	3,3	7
	3	-0,038	8.4	3	-0,0515	3,8	9
0.5	1	-0,092	9.6	3	-0,0505	3,3	7
	2	-0,084	9.4	3	-0,0505	3,3	7
	3	-0,053	8.4	3	-0,0515	3,8	9

Notes: Identification of SS using maximum derivatives of $\mu_1(\gamma, h)$ in the direction of γ.

IV. Wally

Table 2: Maximum numerical derivatives - 4 years accumulated of CA deficit

ε	Rank	Slope	γ	h	ΔlnC(t+1)	ΔCA(t+1)	# Episodes
0.1	1	-0,0532	9.1	4	-0,0575	3,3	6
	2	-0,0372	8.2	4	-0,0575	3,3	6
	3	-0,0357	5.7	4	-0,0447	3,8	13
0.2	1	-0,0322	5.7	4	-0,0447	3,8	13
	2	-0,0310	7.1	4	-0,0428	3,2	9
	3	-0,0277	7.5	4	-0,0472	3,2	8
0.3	1	-0,0334	5.7	4	-0,0447	3,8	13
	2	-0,0331	7.5	4	-0,0472	3,2	8
	3	-0,0310	7.1	4	-0,0428	3,2	9
0.4	1	-0,0424	5.9	4	-0,0475	3,8	12
	2	-0,0367	7.7	4	-0,0515	2,9	7
	3	-0,0360	5.7	4	-0,0447	3,8	13
0.5	1	-0,0740	5.9	4	-0,0475	3,8	12
	2	-0,0650	7.7	4	-0,0515	2,9	7
	3	-0,0567	7.9	4	-0,0515	2,9	7

Notes: Identification of SS using maximum derivatives of $\mu_1(\gamma, h)$ in the direction of γ.

IV. Wally

Table 3: Maximum numerical derivatives - 5 years accumulated of CA deficit

E	Rank	Slope	γ	H	ΔlnC(t+1)	ΔCA(t+1)	# Episodes
0.1	1	-0,0497	7.1	5	-0,0515	2,9	7
	2	-0,0477	5.9	5	-0,0514	3,1	8
	3	-0,0395	5.7	5	-0,0469	3,2	9
0.2	1	-0,0248	7.1	5	-0,0515	2,9	7
	2	-0,0248	5.7	5	-0,0469	3,2	9
	3	-0,0238	5.9	5	-0,0514	3,1	8
0.3	1	-0,0291	5.9	5	-0,0514	3,1	8
	2	-0,0236	7.5	5	-0,0476	2,9	5
	3	-0,0221	5.7	5	-0,0469	3,2	9
0.4	1	-0,0441	5.9	5	-0,0514	3,1	8
	2	-0,0390	6.1	5	-0,0515	2,9	7
	3	-0,0221	5.7	5	-0,0469	3,2	9
0.5	1	-0,0677	6.1	5	-0,0515	2,9	7
	2	-0,0664	5.9	5	-0,0514	3,1	8
	3	-0,0327	7.3	5	-0,0515	2,9	7

Notes: Identification of SS using maximum derivatives of $\mu_1(\gamma, h)$ in the direction of γ.

V. Summary

Motivation

Many crisis events seem to show a connection between a sudden stop and the pace of debt issuance per year.

Theory

Novel recursive equilibrium model that match typical SS events; captures the multiplicity of equilibria latent in the sequential equilibrium and provides evidence in favor of interpreting a SS as a coordination event, similar to a bank run.

Empirical Findings

Countries with a CC deficit of 7% or more during 2 to 3 years will suffer a SS measured by a 4.7% / 5.0% consumption drop and a 4.0% CC reversal.

Countries that experienced a current account deficit of 6% of GDP or more during 4 to 5 years will suffer a sudden consumption drop ranging between 4.4% and 4.9% and a current account reversal between 3.2 and 3.8%.

Thanks for Finding Me!

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