Inflation, Debt, and Default

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Conference on Heterogeneity in Currency Areas and Macroeconomic Policies

Motivation

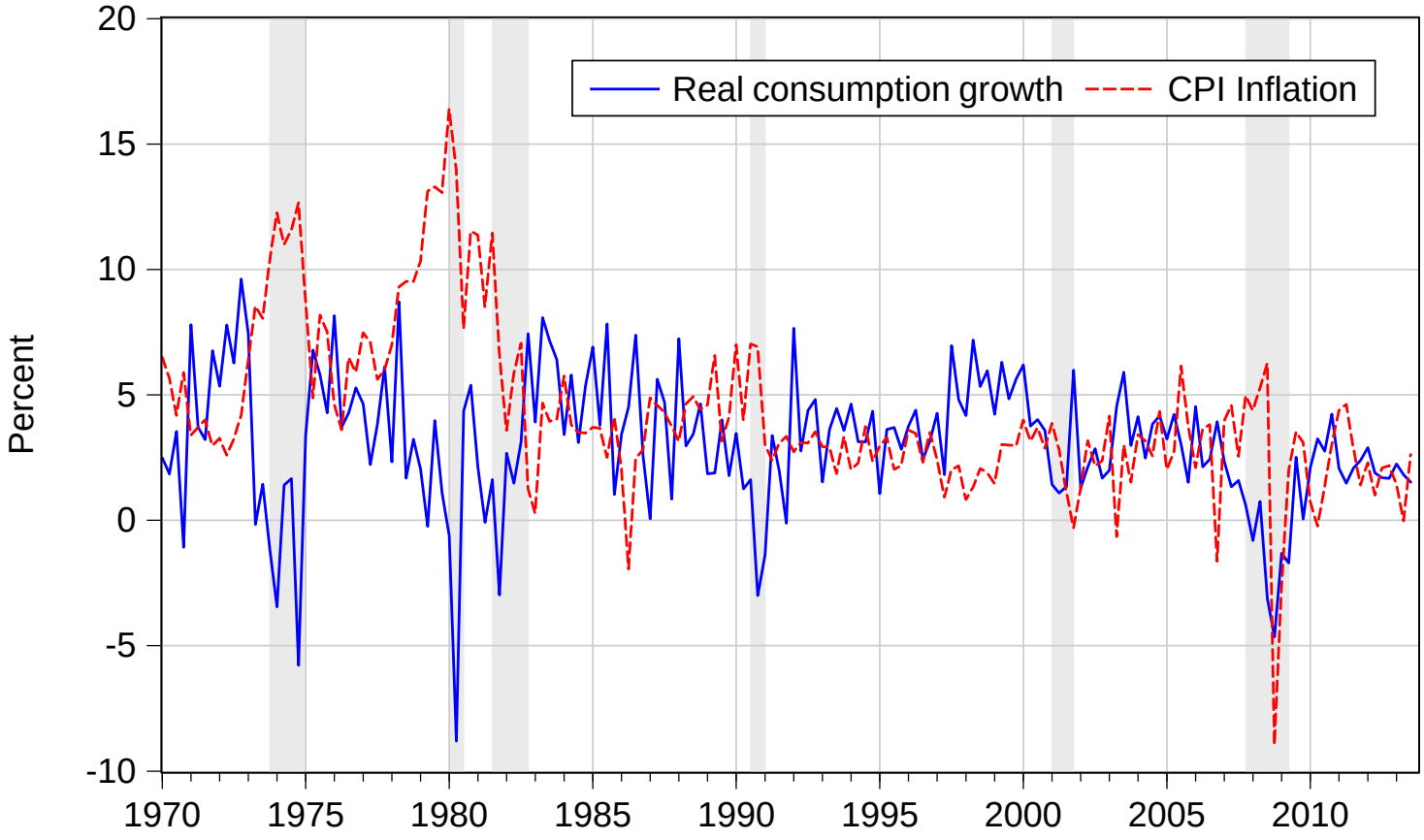

Figure: Inflation and consumption growth co-movement in the U.S.

The question

How does the inflation process - in particular the co-movement of inflation and consumption growth - jointly affect interest rates, debt dynamics, and debt crises?

Why does inflation matter?

- The co-movement of inflation and consumption growth affects the risk of nominal debt

$\Rightarrow$ Pro-cyclical inflation makes nominal debt

  $+$ less risky to domestic lender: receives more in bad times

  $-$ more risky to domestic borrower: pays out more bad times

Why does inflation matter?

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- Inflation affects debt pricing
- Debt pricing $\rightarrow$ debt dynamics $\rightarrow$ debt crises $\rightarrow$ ...

Further evidence

- Inflation and connection to real yields on government debt
- Compute co-movement of inflation innovations and consumption growth innovations
- OECD 1970-2012 using overlapping windows
- Less pro-cyclical inflation is associated with higher yield

Table

This paper

- Understand effects of the inflation process on borrowing costs, debt dynamics and debt crises
- Model of sovereign debt
- New ingredients:
  - Inflation, exogenous
  - Domestic, risk-averse lenders

Results preview

Co-movement of inflation and consumption growth affects

- Interest rates on debt
  significant and uniform across states
- Debt dynamics
  especially during crisis times
  $\Rightarrow$ risky debt and precautionary motives

Related literature

- Sovereign default
  Eaton and Gersovitz (1981), Arellano (2008)
- Domestic default
  Reinhart and Rogoff (2011), D'Erasmo and Mendoza (2013)
- Default and inflation
  Aguiar, Amador, Farhi and Gopinath (2012), Sunder-Plassman (2013)
- Cyclicality of inflation
  Boudoukh (1993), Ang, Bekaert, and Wei (2008)
- Nominal assets, monetary union and incomplete markets
  Neumeyer (1998)

Model

- Builds on standard sovereign debt model (Arellano 2008)
- Government borrows on behalf of *domestic* poor agents from *domestic* rich agents
- Both lenders and borrowers *risk-averse*

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- Government borrows on behalf of *domestic* poor agents from *domestic* rich agents
- Both lenders and borrowers *risk-averse*
- Nominal bonds randomly lose/gain value (exogenous inflation process)

Model

- Closed economy, discrete time $t = 0, 1, 2, ...$, one good
- Endowments y and inflation π follow correlated processes
- Agents
  - hand-to-mouth households (poor, impatient)
  - lenders (high income, patient)
  - government
- Government
  - borrows from and defaults on domestic lenders, on behalf of poor households, using nominal bonds
  - maximizes welfare of poor households

Government

- Given the option to default, the government chooses

$$V^o(B,y) \quad = \quad \max_{c,d} \left\{ V^c(B,y), V^d(y) \right\}$$

where B is incoming assets and y is endowment shock

Government

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$$V^o(B,y) \quad = \quad \max_{c,d} \left\{ V^c(B,y), V^d(y) \right\}$$

  where B is incoming assets and y is endowment shock
- The value of default is given by

$$V^d(y) \quad = \quad u(y^{def}) + \beta \mathbf{E}_{y'} \left[\theta V^o(0,y') + (1-\theta) V^d(y') \right]$$

  where θ is the probability that the government will regain access to credit markets, β the discount factor of the borrower/government, and

$$y^{def} \quad = \quad \begin{cases} \hat{y} & \text{if } y > \hat{y} \\ y & \text{if } y \leq \hat{y} \end{cases}$$

Government

- The value, conditional on not defaulting is given by

$$V^c(B,y) = \max_{B'} \left\{ U\left(y - q(B,y,B')B' + B\right) + \beta \mathbf{E}_{y'}\left[V^o\left(\frac{B'}{1+\pi(y',y)}, y'\right)\right] \right\}$$

  where $q(B,y,B')$ is the bond price, $\pi(y',y)$ is inflation

- Real return on government debt is stochastic (even in absence of default)

Lenders

- Lenders take as given the policy functions of the government
- Lender's value function is given by

$$
\begin{aligned}
W(b;y,s,B) \quad = \quad & \max_{b'} \Bigg\{ u(c_\ell) \\
& + \widehat{\beta}\mathbf{E}_{y',s'} \left[W\left(\frac{b'}{1+\pi(y',y)}; y', s', \frac{B'}{1+\pi(y',y)} \right) \right] \Bigg\}
\end{aligned}
$$

$$
\text{s.t.} \quad c_\ell = \begin{cases} \alpha y + b - q(B,y,B'(B,y))b' & \text{if } s = 0 \\ \alpha y^{def} & \text{if } s = 1 \end{cases}
$$

where $s = 0, 1$ denotes the government having access to credit markets, $\widehat{\beta}$ the discount factor of the domestic lender, and $\alpha > 1$.

Pricing kernel

- In this environment, the bond price satisfies

$$q(B,y,B') = \mathbf{E}_{y'}\left[\frac{1-d\left(\frac{B'}{1+\pi(y',y)},y'\right)}{1+\pi(y',y)} m_\ell\left(y,y',B,B'\right)\right]$$

where

$$m\left(y,y',B,B'\right) = \widehat{\beta}\frac{u'\left(c_\ell^*\left(\frac{B'}{1+\pi(y',y)},y',B^*\left(\frac{B'}{1+\pi(y',y)},y'\right)\right)\right)}{u'\left(c_\ell^*\left(B,y,B'\right)\right)}$$

Cyclicality of inflation and borrowing costs

- The bond price can be written as

$$q(B,y,B') = \widehat{\beta}\mathbf{E}_{y'}\left[\frac{1-d\left(\frac{B'}{1+\pi(y',y)},y'\right)}{1+\pi(y',y)}\right]\mathbf{E}_{y'}\left[\frac{u'(c'_\ell)}{u'(c_\ell)}\right]$$
$$+\widehat{\beta}\,\mathbf{cov}_{y'}\left[\frac{1-d\left(\frac{B'}{1+\pi(y',y)},y'\right)}{1+\pi(y',y)},\frac{u'(c'_\ell)}{u'(c_\ell)}\right]$$

- Default and inflation increase borrowing costs; so does countercyclical default (standard effects)
- Pro-cyclical inflation *reduces* borrowing costs (new channel).

Cyclicality of inflation and debt dynamics

- Consider the borrower's Euler equation in the absence of default

$$q(B,y,B')\,u'(c) = \beta \mathbf{E}_{y'}\left[\frac{1}{1+\pi(y',y)}\right]\mathbf{E}_{y'}\left[u'(c')\right] + \beta\,\mathbf{cov}_{y'}\left[\frac{1}{1+\pi(y',y)},u'(c')\right]$$

- Pro-cyclical inflation *increases* incentives to borrow more due to lower borrowing costs (lender's channel)
- However, pro-cyclical inflation also *reduces* borrower's incentive to take on more debt (riskier asset)

Quantitative experiment

- In the model with no default, assess impact of different inflation processes on interest rates
- In the full model, assess impact of different inflation processes on interest rates, debt dynamics, and crises

Functional forms

- Functional forms

$$
\begin{aligned}
u(c) &= \frac{c^{1-\gamma}}{1-\gamma} \\
\log y' &= \rho \log y + \varepsilon \text{ where } \varepsilon \sim N(0, \sigma_y^2)
\end{aligned}
$$

Functional forms

- Functional forms

$$\begin{aligned} u(c) &= \frac{c^{1-\gamma}}{1-\gamma} \\ \log y' &= \rho \log y + \varepsilon \text{ where } \varepsilon \sim N(0, \sigma_y^2) \\ \pi(y', y) &= \bar{\pi} + \frac{\eta}{v_y}\left[\log\left(\frac{y'}{y}\right) - \mu_y\right] \end{aligned}$$

where $\mu_y = \mathbf{E}_{y'|y}\left[\log\left(\frac{y'}{y}\right)\right]$ and $v_y = \mathbf{var}_{y'|y}\left[\log\left(\frac{y'}{y}\right)\right]$

- This process for inflation satisfies
  1. $\mathbf{E}_{y'|y}\left[\pi(y', y)\right] = \bar{\pi}$
  2. $\mathbf{cov}_{y'|y}\left[\log\left(\frac{y'}{y}\right), \pi(y', y)\right] = \eta$

Parameters

Discount factors	$\beta = 0.953$
	$\widehat{\beta} = 0.983$
Inflation process	$\bar{\pi} = 0$
	$\eta \in \{\pm 0.0005, \pm 0.0010\}$
Risk aversion	$\gamma = 2$
Endowment process	$\rho = 0.95,\ \sigma_y = 0.02$
Lender endowment	$\alpha \in \{10, 100\}$
Probability of re-entry	$\theta = 0.282$

- We compare borrowing costs and debt dynamics for
  - $+$ $\eta > 0$ (pro-cyclical inflation)
  - $-$ $\eta < 0$ (countercyclical inflation)

Model with no default

- Borrowing costs are lower with pro-cyclical inflation

Table: Difference in Borrowing Costs

	$r_{-\eta} - r_{\eta}$ (in percent)	
	$\eta = 0.0005$	$\eta = 0.0010$
$\alpha = 10$	0.83	1.56
$\alpha = 100$	0.85	2.22

- The difference is larger with more risk aversion

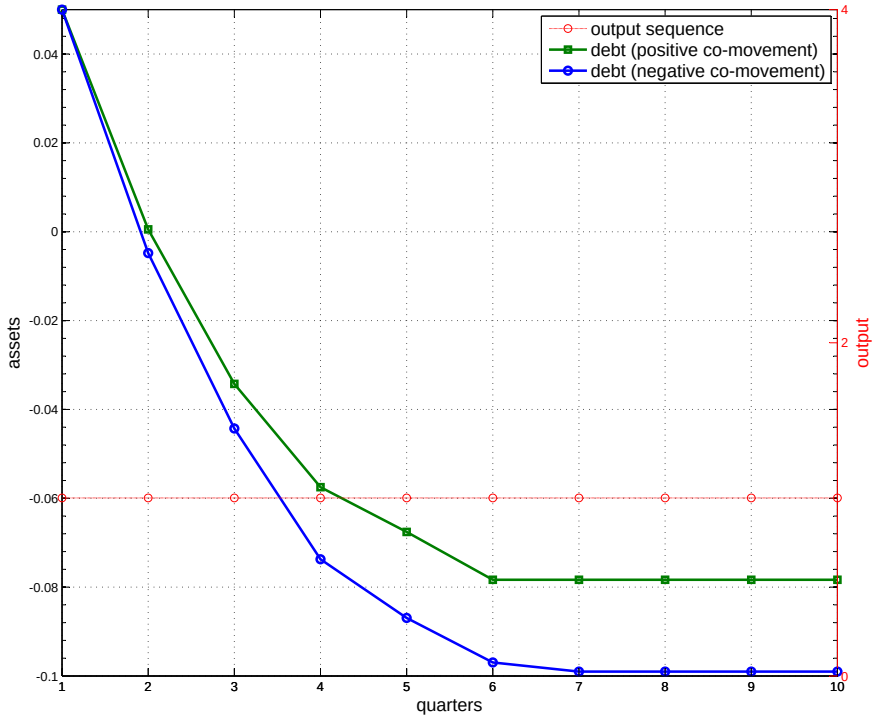
Model with default

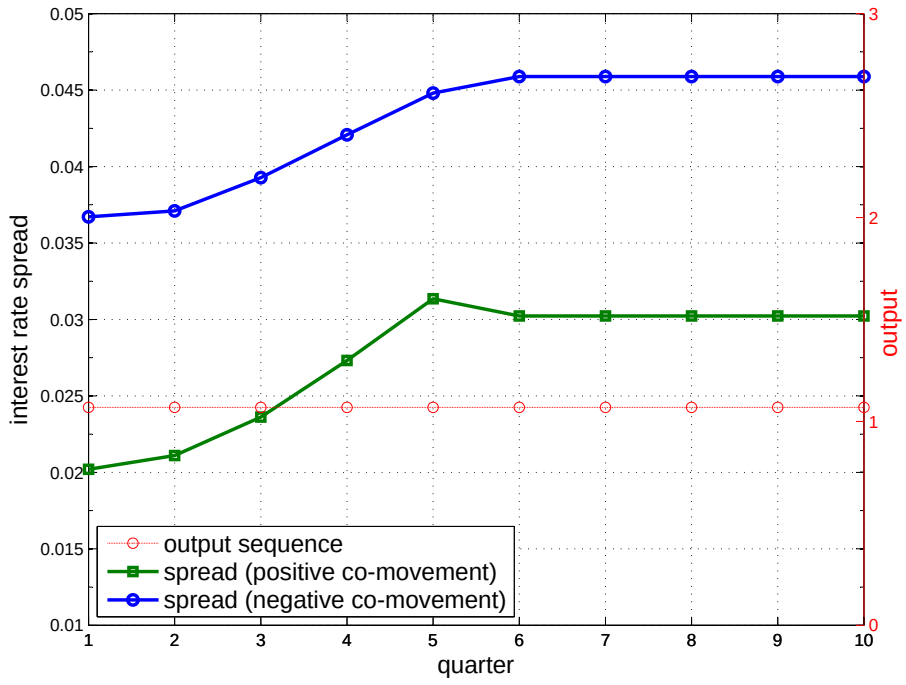
- Borrowing costs are lower with pro-cyclical inflation
- Yet, debt is also lower with pro-cyclical inflation
- So are default rates

Table: Debt and Default

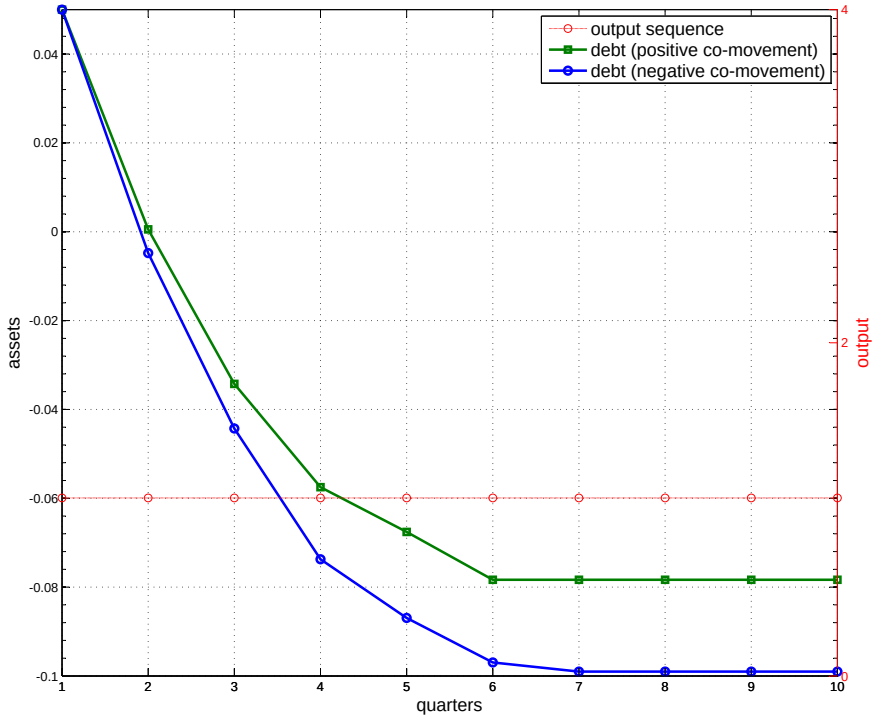
	Positive co-movement ($\eta = +0.0010$)	Negative co-movement ($\eta = -0.0010$)
Default prob. (percent)	2.52	3.04
Spreads (percent)	2.81	3.52
Debt (percent)	4.29	5.48

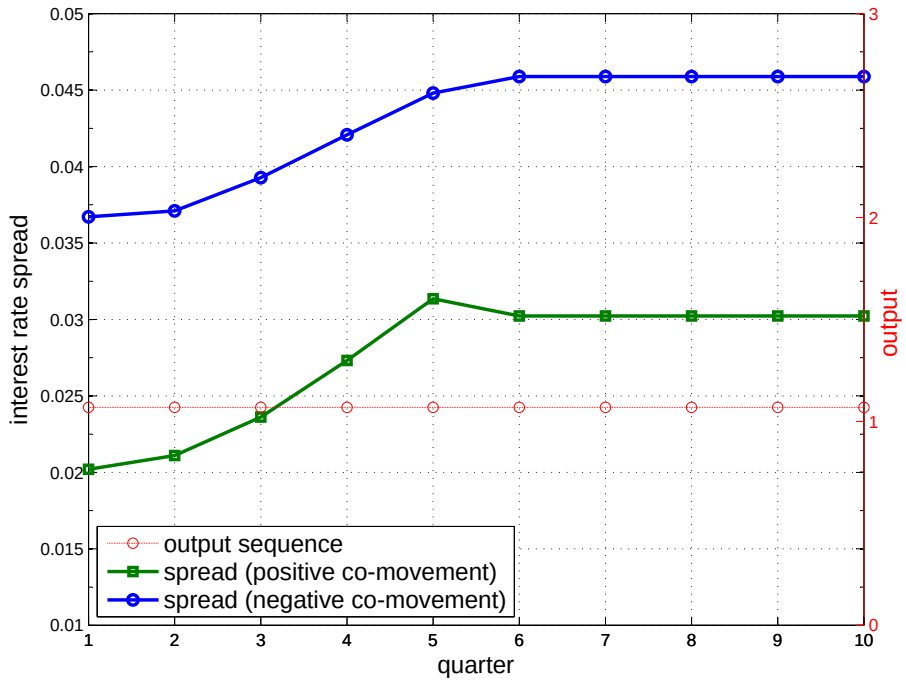
Inflation and debt dynamics: precautionary motives





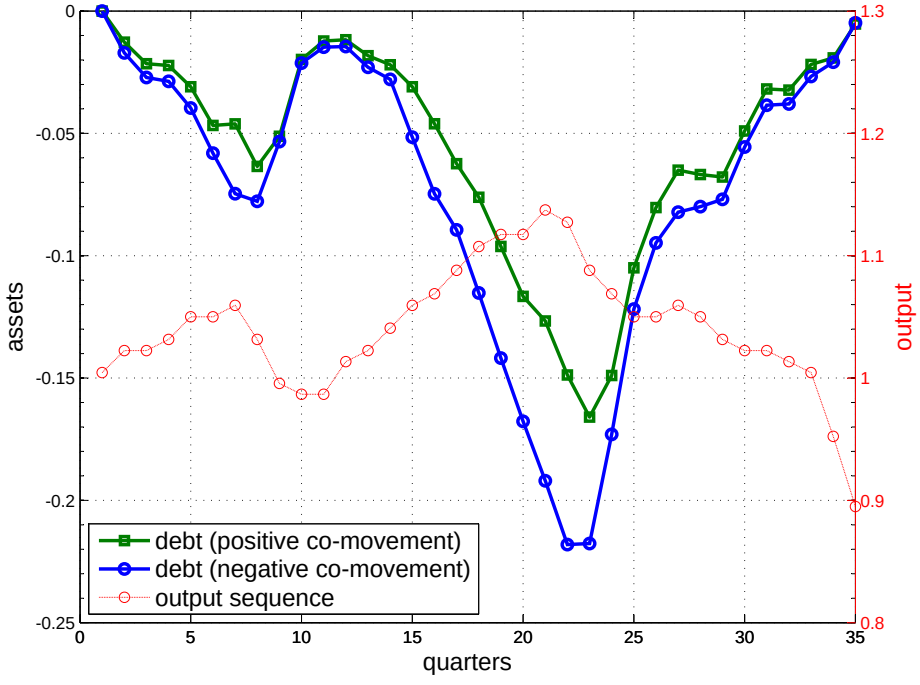
Inflation and debt dynamics: precautionary motives

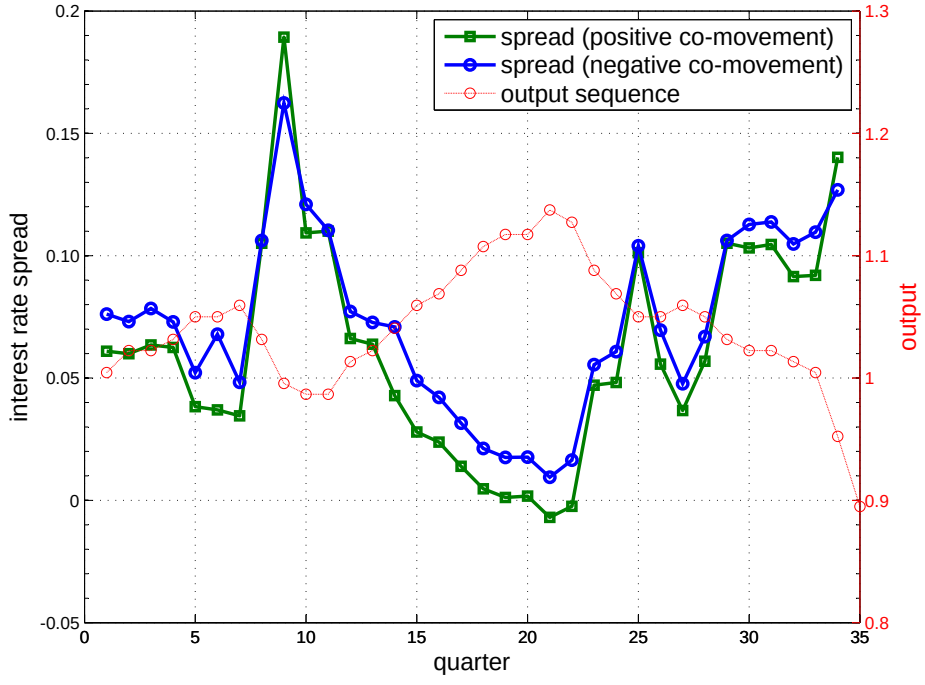




- Precautionary motives from pro-cyclical inflation increase with debt (i.e. as the borrower gets poorer)
- Meanwhile, lenders uniformly demand lower yield

Inflation and debt dynamics: a Pyrrhic victory?





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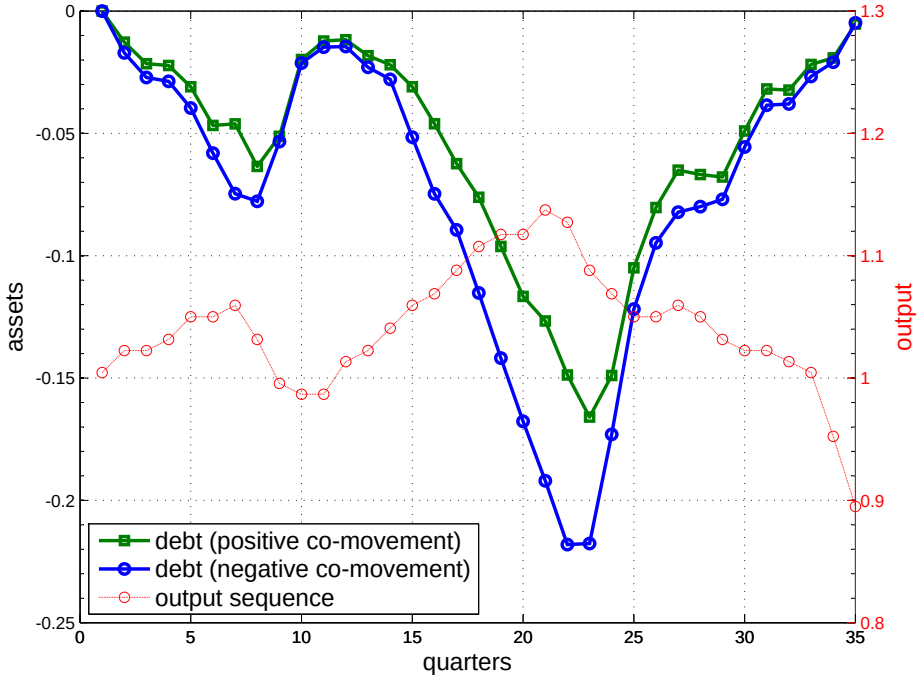

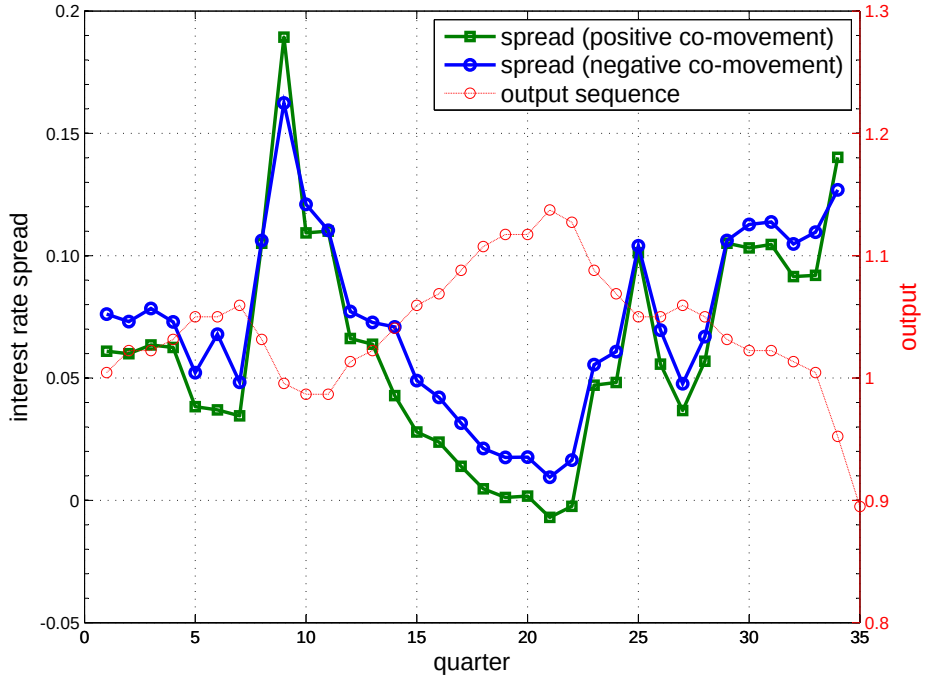

- On average lower rates, debt, and default with pro-cyclicality
- But more volatile rates: riskier debt precisely in bad times Default

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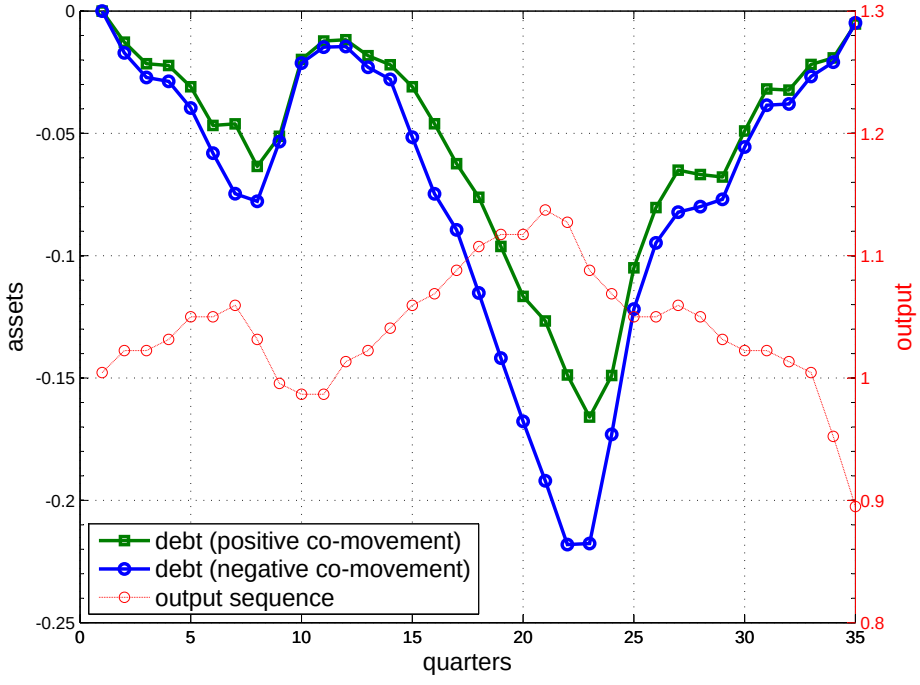

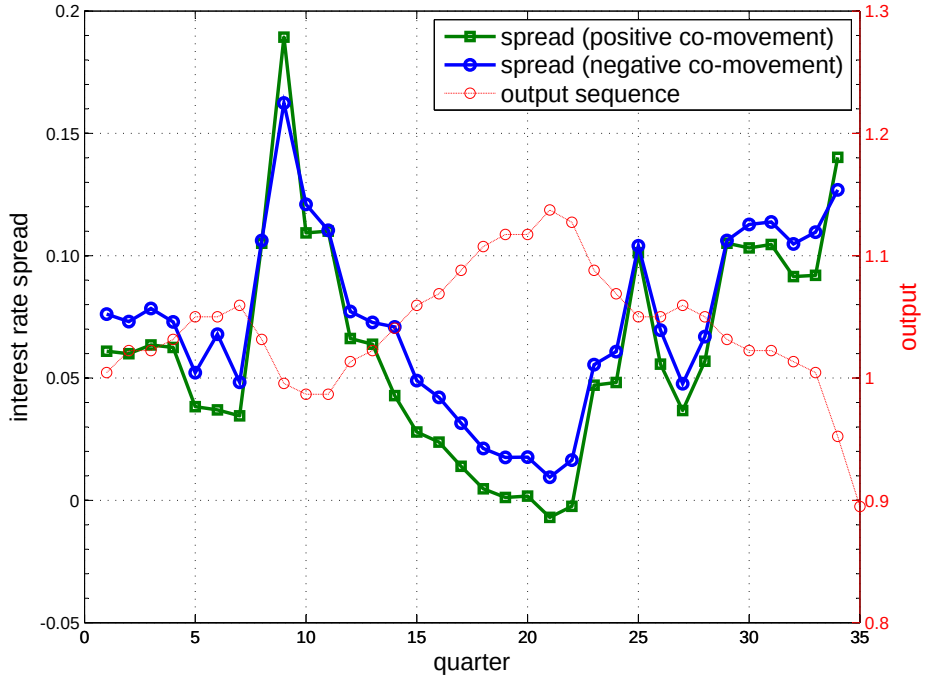

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... a tale of periphery EMU accession?

Conclusion

- Model of sovereign debt with risk averse domestic lenders and borrowers
- Inflation pro-cyclicality can be important in explaining the observed cross section of government debt, interest rates, and debt crises
- Our findings are relevant for the debate on the costs and benefits of joining a monetary union

appendix

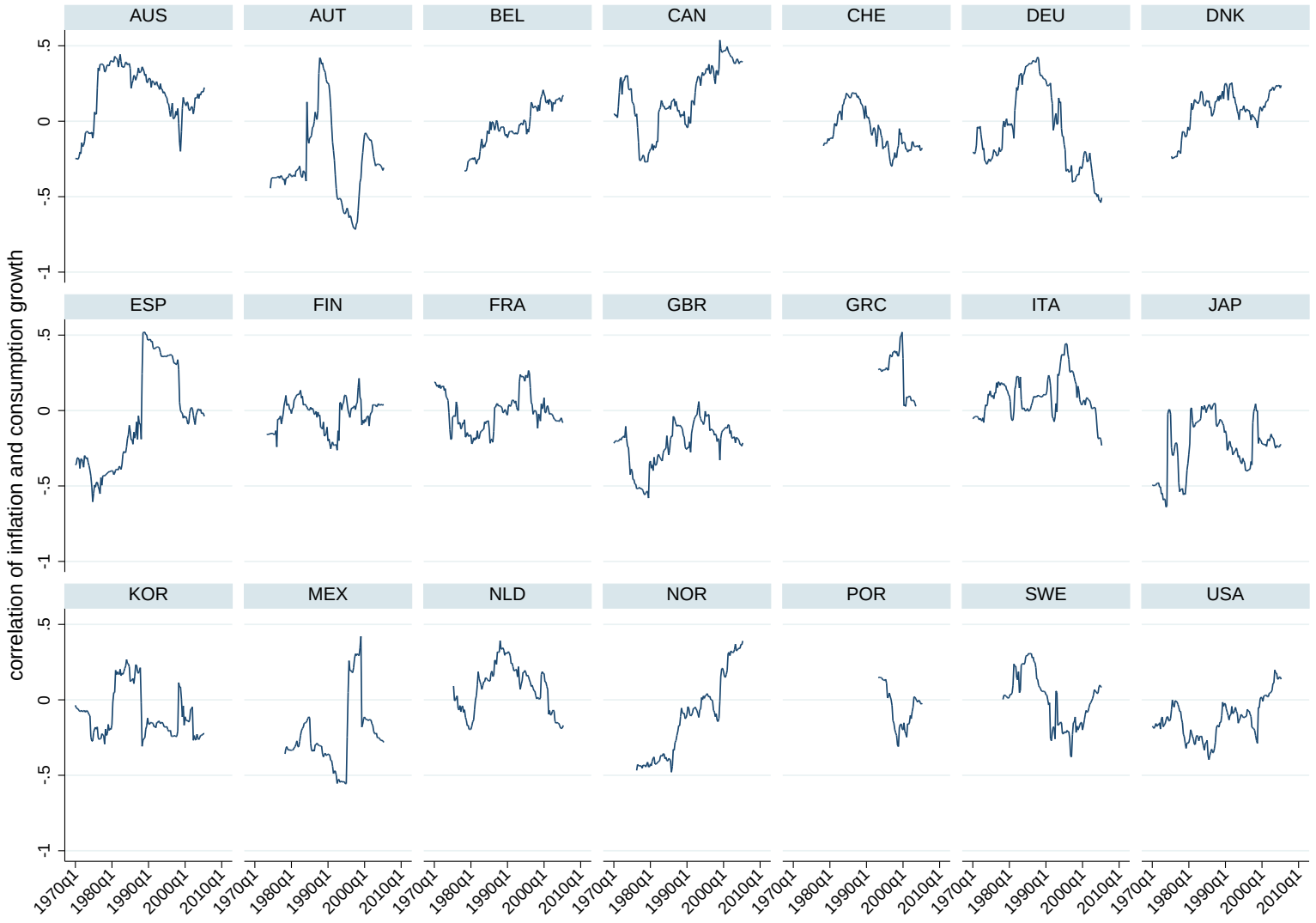
Conditional co-movement between inflation and consumption growth

- Follow Boudoukh (1993)
- VAR country by country on quarterly data

$$\begin{bmatrix} \pi_{it} \\ g^c_{it} \end{bmatrix} = A_i \begin{bmatrix} \pi_{it-1} \\ g^c_{it-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{\pi it} \\ \varepsilon_{git} \end{bmatrix}$$

- Compute conditional co-movement between $\varepsilon_{\pi it}$ and ε_{git} using overlapping five-year windows

Conditional correlation between inflation and consumption growth



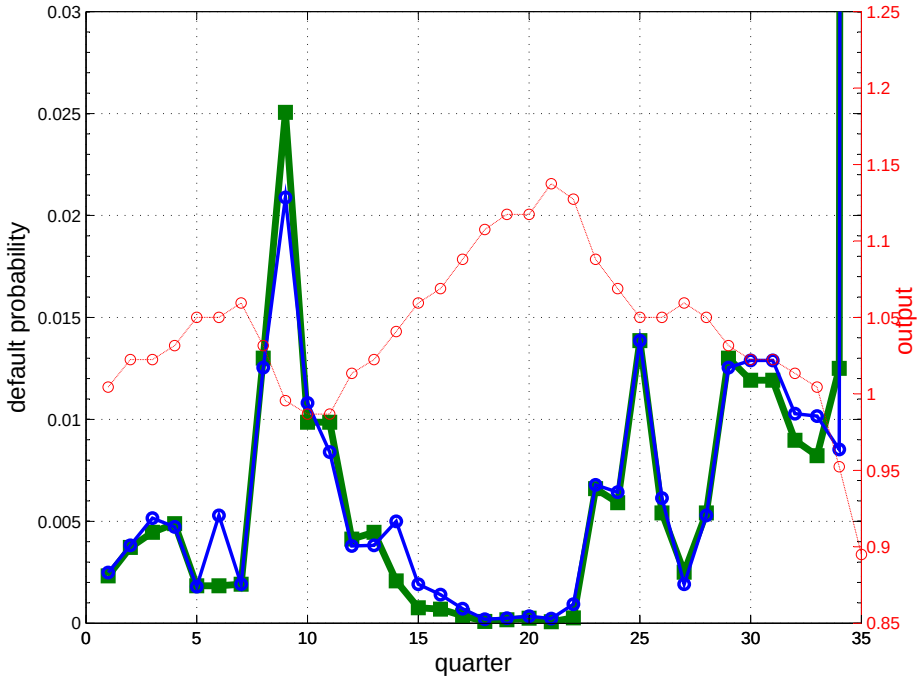
Inflation cyclicality and real interest rates

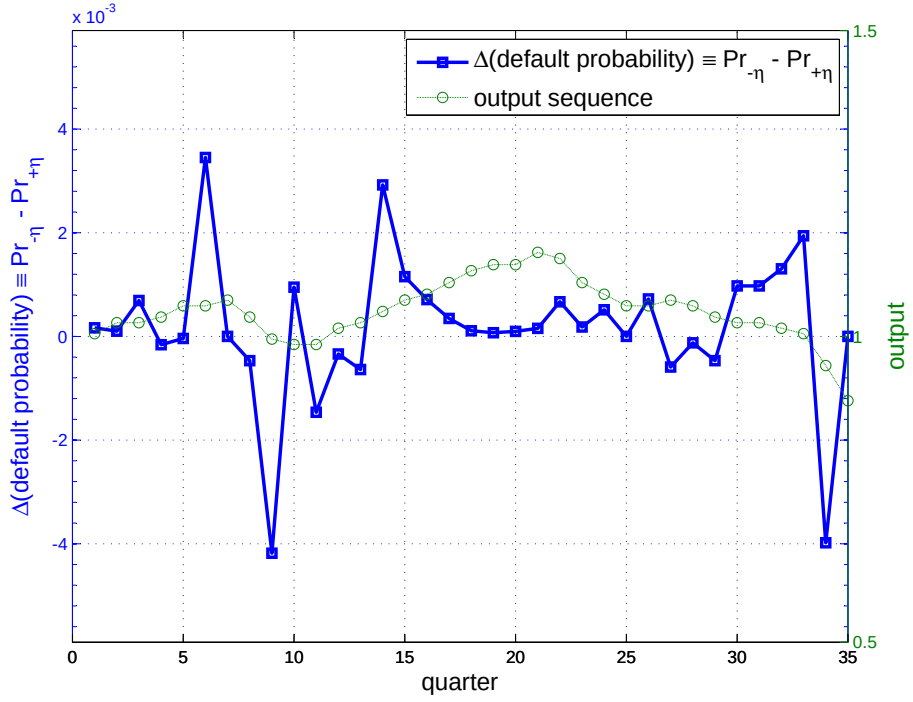
Back

	Real yield on government debt		
	(1)	(2)	(3)
Inflation co-movement: cov$(\varepsilon_\pi, \varepsilon_{g_c})$	-1.379**	-2.007***	-2.066***
	(0.576)	(0.504)	(0.636)
Variance of inflation: var(ε_π)	0.418	0.721***	0.211
	(0.313)	(0.222)	(0.256)
Inflation: π	1.979***		2.392***
	(0.302)		(0.338)
Public debt (percent of GDP)		0.00281	0.0104
		(0.0107)	(0.00765)
adj. R^2	0.897	0.871	0.917
N	2394	2049	2049

Standard errors in parentheses. All regressions include country and year fixed effects.

Default probabilities





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