Unstable Monetary Unions
- The Role of Expectations and Past Experience

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Inflation in the Eurozone

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Research question

Persistent differences in inflation rates across members of MU:

- where do they come from?

- what are their consequences?
Pre- and Post-Euro Introduction Inflation Rates

Deviations from the average in the first eight years

Deviations from the average prior to EMU creation

Belgium
Germany
Ireland
Spain
France
Italy
Luxembourg
Netherlands
Austria
Portugal
Finland
Germany

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Pre-Euro Inflation and Euro CA Imbalances

Deviations from the average inflation prior to EMU
Cum. CA surplusses in the first eight years

Belgium
Germany
Ireland
Spain
France
Italy
Luxembourg
Netherlands
Austria
Portugal
Finland

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Can there be a common cause of inflation and current account imbalances?
Can there be a common cause of inflation and current account imbalances?

Past inflation experience, driving inflation expectations
Main mechanism

- Prior experience influences expectations
- High inflation expectations + Uniform nominal interest rates $\Rightarrow$ Low real interest rates
- Low real rates stimulate economy $\Rightarrow$ High inflation
- (Partially) self-fulfilling expectations dampen learning
- Persistent inflation differences and build-up of external debt
- Potentially: Instability
Inflation Forecasts (IMF WEO)

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Setup of the paper

- Role of (inflation) expectations within a monetary union
- Theoretical model of SOE joining Monetary Union
- Private agents form expectations based on perception of economy
- Need to learn (estimate) the new environment
  - e.g. economic dynamics and policy rules
- Importance of different initial conditions
Related Literature

- **Instability under learning:** Primiceri (QJE 2006), Lubik & Matthes (JME 2016), Cogley, Matthes & Sbordone (JME 2015), Branch & Evans (JMCB 2017)

- **Monetary economics of a monetary union:** Benigno (JIE 2004), Gali & Monacelli (JIE 2008), De Paoli (JIE 2009), Ferrero (JIE 2009)

- **Imbalances within the Eurozone:** Aguiar et al. (QJE 2015), Gopinath et al. (QJE, 2017), Baldwin & Giavazzi (CEPR 2015), Piton (2017), De Ferra (2017)
Outline

1. Motivation
2. Overview
3. Basic model
4. Learning
5. Quantitative analysis
Model setup

Two regions:
- Small Open Economy,
- Rest of the World - Monetary Union,
- Structurally identical,
- Differ in steady-state inflation (targets).
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- Small Open Economy,
- Rest of the World - Monetary Union,
- Structurally identical,
- Differ in steady-state inflation (targets).

Scenario:
- Small Open Economy begins independent, but joins the Union,
- Common monetary policy \(\Rightarrow\) Common inflation target,
- Convergence of inflation rates?
Model economy

Households:
- work and consume,
- home bias in preferences,
- access to incomplete financial markets.
Model economy

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Firms:
- monopolistic competition,
- sticky prices à la Calvo.
Model economy

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Central Bank:
- Taylor rule (inflation targeting).
Households

Maximize expected lifetime utility:

$$\max_{C_t, L_t, B_{H,t}, B_{F,t}} \hat{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{(C_t)^{1-\sigma} - 1}{1 - \sigma} - \phi \frac{(L_t)^{1+\varphi}}{1 + \varphi} \right]$$

subject to

$$P_t^i C_t^i + \frac{B_{H,t}}{1 + i_t} + \frac{S_t B_{F,t}}{(1 + i_t^*) \Psi \left( \frac{S_t B_{F,t}}{P_t} \right)} = B_{H,t-1} + B_{F,t-1} + W_t L_t + \Pi_t,$$

where

- $B_{H,t}, B_{F,t}$ - holdings of home and foreign bonds
- $\Psi(\cdot)$ - cost of international borrowing
- "*" - foreign variables
Households

Consumption is a composite index:

\[ C_t = \left[ \nu \eta (C_{H,t})^{\frac{\eta-1}{\eta}} + (1 - \nu) \eta (C_{F,t})^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \]

where \( \nu > n \) represents home bias in consumption.
Prices

- Goods are priced $P_H$ and $P_F$, depending on origin.
- Law of one price for individual goods: $P_{i,t} = S_t \cdot P_{i,t}^*$
- But not for price indices:

$$P_t = \left[ \nu (P_{H,t})^{1-\eta} + (1 - \nu) (P_{F,t})^{1-\eta} \right]^{\frac{1}{1-\eta}} \neq P_t^*$$
Firms

Simple production function:

\[ y_t(i) = A_t \cdot n_t(i) \]

Firms face monopolistic competition

Price rigidities - Calvo pricing:

- each period fraction \( 1 - \theta \) of firms resets prices
- others keep old price
Monetary Policy

Monetary authority:
- chooses interest rate, $i_t$
- to control domestic inflation, $\pi_t$

Simple Taylor rule:

$$i_t = \bar{i} + \phi_\pi (\pi_t - \bar{\pi}) + m_t$$

- $\bar{i}$ - steady state interest rate
- $\phi_\pi$ - policy reaction coefficient, $> 1$
- $m$ - monetary policy shock
Equilibrium

A set of choices made by households, firms and monetary policy, such that:

- goods markets,
- labor markets,
- capital markets

clear.
Equilibrium

A set of choices made by households, firms and monetary policy, such that:

- goods markets,
- labor markets,
- capital markets

clear.

**Expectations** are hidden in the equilibrium definition - agents use their expectations when making decisions.
Learning

Private agents:
  - know the structure of the economy
  - but not the coefficients
  - like econometricians - estimate parameters
Learning

Private agents:

- know the structure of the economy
- but not the coefficients
- like econometricians - estimate parameters

Each period:

- use new observations to update estimates
- form expectations as forecasts
- make decisions (based on expectations)
- receive new data
The model:

\[ X_t = a_0 + a_1 E_t X_{t+1} + a_2 X_{t-1} + a_3 Z_t, \]
The model:

\[ X_t = a_0 + a_1 E_t X_{t+1} + a_2 X_{t-1} + a_3 Z_t, \]

The law of motion for the model:

\[ X_t = b_0 + b_1 X_{t-1} + b_2 Z_t. \]
Model dynamics - Adaptive Learning

The model:

\[ X_t = a_0 + a_1 \hat{E}_t X_{t+1} + a_2 X_{t-1} + a_3 Z_t, \]
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The Perceived Law of Motion is estimated:

\[ X_t = \hat{b}_{t,0} + \hat{b}_{t,1} X_{t-1} + \hat{b}_{t,2} \hat{Z}_t, \]
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Formed expectations

\[ \hat{E}_t X_{t+1} = \hat{b}_{t,0} + \hat{b}_{t,1} X_t + \hat{b}_{t,2} \hat{E}_t \hat{Z}_{t+1}, \]
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Formed expectations

\[ \hat{E}_t X_{t+1} = \hat{b}_{t,0} + \hat{b}_{t,1} X_t + \hat{b}_{t,2} \hat{E}_t \hat{Z}_{t+1}, \]

The Actual Law of Motion depends on PLM:

\[
X_t = a_0 + a_1 \hat{E}_t X_{t+1} + a_2 X_{t-1} + a_3 Z_t \\
= a_0 + a_1 \left( \hat{b}_{t,0} + \hat{b}_{t,1} X_t + \hat{b}_{t,2} \hat{E}_t \hat{Z}_{t+1} \right) + a_2 X_{t-1} + a_3 Z_t.
\]
Adaptive Learning - Updating

\[
\hat{b}_{t+1} = \hat{b}_t + g_t R_t^{-1} X_{t-1} \cdot (X_t - \hat{b}_t X_{t-1})
\]

\[
R_t = R_{t-1} + g_t \cdot (X_{t-1} X_{t-1}^T - R_{t-1})
\]
Adaptive Learning - Updating

\[
\hat{b}_{t+1} = \hat{b}_t + g_t R_{t-1}^{-1} X_{t-1} \cdot (X_t - \hat{b}_t X_{t-1})
\]

\[
R_t = R_{t-1} + g_t \cdot (X_{t-1} X_{t-1}^T - R_{t-1})
\]

Learning algorithms:
- Recursive Least Squares Learning: \( g_t = \frac{1}{t} \)
- Constant Gain Learning: \( g_t = g \)
Adjustment channels in the SOE

1. Monetary Policy
2. Nominal Exchange Rate
3. Relative Prices (Real Exchange Rate) - Trade channel
Joining Monteray Union

1. Common monetary policy - zero weight on SOE inflation
Joining Monteray Union

1. Common monetary policy - zero weight on SOE inflation
2. Fixed (nominal) exchange rate - less flexibility
Joining Monteray Union

1. Common monetary policy - zero weight on SOE inflation
2. Fixed (nominal) exchange rate - less flexibility
3. Only left: trade channel
Independence vs Monetary Union

1. NK Philips curve (SOE)

\[ \hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa_1 \hat{y}_t - \kappa_2 \hat{y}^*_t - \kappa_3 \hat{q}_t - \kappa_4 \varepsilon_t \]

2. (Dynamic) IS curve (SOE)

\[ E_t \Delta \hat{y}_{t+1} = \lambda E_t \Delta \hat{y}^*_t + \frac{1 - \lambda}{\sigma} [\hat{\nu}_t - E_t \hat{\pi}_{t+1}] + \frac{\lambda + \gamma \sigma}{\sigma} E_t \Delta \hat{q}_{t+1} \]

3. Household budget constraint (SOE)

\[ \beta \hat{b}_t = \hat{b}_{t-1} - \frac{\lambda}{1 - \lambda} (\hat{y}_t - \hat{y}^*_t) + \frac{\gamma + \lambda}{1 - \lambda} \hat{q}_t \]
No-arbitrage condition

\[
\hat{i}_t = \hat{i}_t^* - \delta \hat{b}_t + \frac{1}{1 - \lambda} E_t \Delta \hat{q}_{t+1} + E_t \left[ \hat{\pi}_{t+1} - \hat{\pi}_{t+1}^* \right]
\]
No-arbitrage condition

\[ \hat{i}_t = \hat{i}_t^* - \delta \hat{b}_t + \frac{1}{1 - \lambda} E_t \Delta \hat{q}_{t+1} + E_t \left[ \hat{\pi}_{t+1} - \hat{\pi}_{t+1}^* \right] \]

simplifies to

\[ \hat{i}_t = \hat{i}_t^* - \delta \hat{b}_t \]
Independence vs Monetary Union

4. No-arbitrage condition

\[ \hat{i}_t = \hat{i}^*_t - \delta \hat{b}_t + \frac{1}{1 - \lambda} E_t \Delta \hat{q}_{t+1} + E_t \left[ \hat{\pi}_{t+1} - \hat{\pi}^*_t \right] \]

simplifies to

\[ \hat{i}_t = \hat{i}^*_t - \delta \hat{b}_t \]

5. Taylor rule (SOE)

\[ \hat{i}_t = \phi_\pi \hat{\pi}_t + m_t \]
Independence vs Monetary Union

4 No-arbitrage condition

\[ \hat{i}_t = \hat{i}^*_t - \delta \hat{b}_t + \frac{1}{1 - \lambda} E_t \Delta \hat{q}_{t+1} + E_t [\hat{\pi}_{t+1} - \hat{\pi}^*_{t+1}] \]

simplifies to

\[ \hat{i}_t = \hat{i}^*_t - \delta \hat{b}_t \]

5 Taylor rule (SOE)

\[ \hat{i}_t = \phi_\pi \hat{\pi}_t + m_t \]

is replaced by evolution of the real exchange rate

\[ \hat{q}_t = \hat{q}_{t-1} + (1 - \lambda) [\hat{\pi}_t - \hat{\pi}^*_t] \]
IRF to technology shock

Inflation

Output

RER

NFA

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IRF to cost-push shock

**Inflation**

**Output**

- **independent**
- **union**

**RER**

**NFA**
Simulation exercise

Setup:
- Training period: 60 quarters (initial estimates) - outside of MU
- Start of exercise: SOE joins MU
Simulation exercise

Setup:

- Training period: 60 quarters (initial estimates) - outside of MU
- Start of exercise: SOE joins MU
- Agents need to learn the new environment
Simulation exercise

Setup:

- Training period: 60 quarters (initial estimates) - outside of MU
- Start of exercise: SOE joins MU
- Agents need to learn the new environment
- Rational Expectations vs Learning
- Two economies differ only in inflation history:
  - low inflation - prior to joining MU inflation at the MU steady state level
  - high inflation - prior to joining MU inflation 1pp above MU steady state (satisfies convergence criteria)
Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.99</td>
<td>Discount factor</td>
</tr>
<tr>
<td>$\omega$</td>
<td>2</td>
<td>CRRA coefficient</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>2</td>
<td>Inverse Frish elasticity</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.25</td>
<td>Openness to trade</td>
</tr>
<tr>
<td>$\theta$</td>
<td>1.5</td>
<td>Intratemporal elasticity of substitution</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>10</td>
<td>Elasticity of substitution between diff products</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.01</td>
<td>Sensitivity of borrowing costs to NFA</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.66</td>
<td>Calvo price stickiness parameter</td>
</tr>
</tbody>
</table>
## Calibration

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<tr>
<td>$\phi_{\pi}$</td>
<td>1.5</td>
<td>Coefficient on inflation in the SOE Taylor rule</td>
</tr>
<tr>
<td>$\phi_{\pi}^*$</td>
<td>1.5</td>
<td>Coefficient on inflation in the union-wide Taylor rule</td>
</tr>
<tr>
<td>std($\varepsilon$)</td>
<td>0.013</td>
<td>Standard deviation of the technological shock</td>
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<td>0.013</td>
<td>Standard deviation of the technological shock</td>
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<tr>
<td>std($m$)</td>
<td>0.001</td>
<td>Standard deviation of the monetary policy shock</td>
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<td>std($m^*$)</td>
<td>0.001</td>
<td>Standard deviation of the monetary policy shock</td>
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<tr>
<td>$g$</td>
<td>0.025</td>
<td>Gain parameter for the learning algorithm</td>
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</table>
Simulation - Inflation

- Robustness

**Rational Expectations vs. Learning**

- 5-95% conf. intervals

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Simulation - Net Foreign Assets

- **rational expectations**
- **learning**

- **5-95% conf. intervals**
Simulation - Instability

High inflation SOE after 10 years:
- Probability of negative NFA is 90%.

High inflation SOE after 25 years:
- Probability of negative NFA is 96%,
- Probability of strictly downward path of NFA is 15%
Why care about inflation and inflation expectations?
Why care about inflation and inflation expectations?

May shed some light on the dynamics leading to the Eurozone Crisis
Potential causes of the Eurozone Crisis

- Fiscal profligacy (public debt build-up)
- Reckless banks (bank assets relative to GDP)
- Large current account imbalances
- Loss of competitiveness (relative price and wage levels)
Deep causes of the Eurozone Crisis

<table>
<thead>
<tr>
<th>Public Debt</th>
<th>Budget Deficit</th>
<th>Bank Assets</th>
<th>Δ Bank Assets</th>
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Policy implications

- Lack of pre-EMU convergence may cause instability
- Need for better Convergence Criteria
- Potentially: role for stabilizing fiscal policy
Conclusions

- Inflation differences important for Eurozone Crisis
- Role of inflation expectations
- Structural change requires learning
- Simulation replicates (patterns of) key macro variables for Eurozone imbalances
- Generalization: currency pegs require credibility and change of expectations
Appendix
Fiscal Profligacy?

The diagram illustrates the government debt (%GDP) for various countries over the years from 1997 to 2007. The countries included are Belgium, Austria, France, Germany, Luxembourg, Ireland, Spain, Portugal, Italy, and Greece.

The graph shows a trend where the government debt as a percentage of GDP has generally decreased over the years for most countries. However, there are some countries that show an increase or relatively stable debt levels during the observed period.

The countries are color-coded and labeled on the graph for easy identification.

The x-axis represents the year, ranging from 1997 to 2007, while the y-axis shows government debt as a percentage of GDP, ranging from 0 to 100%.
Current Account Imbalances

- France
- Belgium
- Austria
- Finland
- Netherlands
- Germany
- Luxembourg

- Greece
- Portugal
- Spain
- Ireland
- Italy

- EA

Current Account (%GDP)


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Unstable Monetary Unions
Pre- and Post-Euro Introduction Inflation Rates
Inflation Expectations - IMF forecasts

IMF forecasts figure
Monetary Union - Foreign Region

1. NK SOE Philips curve

\[ \hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa_1^* \hat{y}_t - \kappa_2^* \varepsilon_t \]

2. NK SOE IS curve

\[ E_t \Delta \hat{y}_{t+1} = \frac{1}{\sigma} \left[ \hat{i}^*_t - E_t \hat{\pi}^*_t \right] \]

3. No arbitrage condition

\[ \hat{i}^*_t = \phi_\pi^* \hat{\pi}^*_t + m^*_t \]
Simulation - Inflation ($g = 0.05$)

![Graph showing inflation simulation with rational expectations and learning models, along with 15-85% confidence intervals.](image)
Simulation - Inflation ($g = 0.02$)
Simulation - Inflation \((g = 0.01)\)
Simulation - Net Foreign Assets ($g = 0.05$)
Simulation - Net Foreign Assets ($g = 0.02$)
Simulation - Net Foreign Assets \((g = 0.01)\)

![Graph of Net Foreign Assets simulation with rational expectations and learning models, showing 15-85% confidence intervals.](image)