Delhi School of Economics and Econometric Society

Winter School 2020

Plenary Lectures

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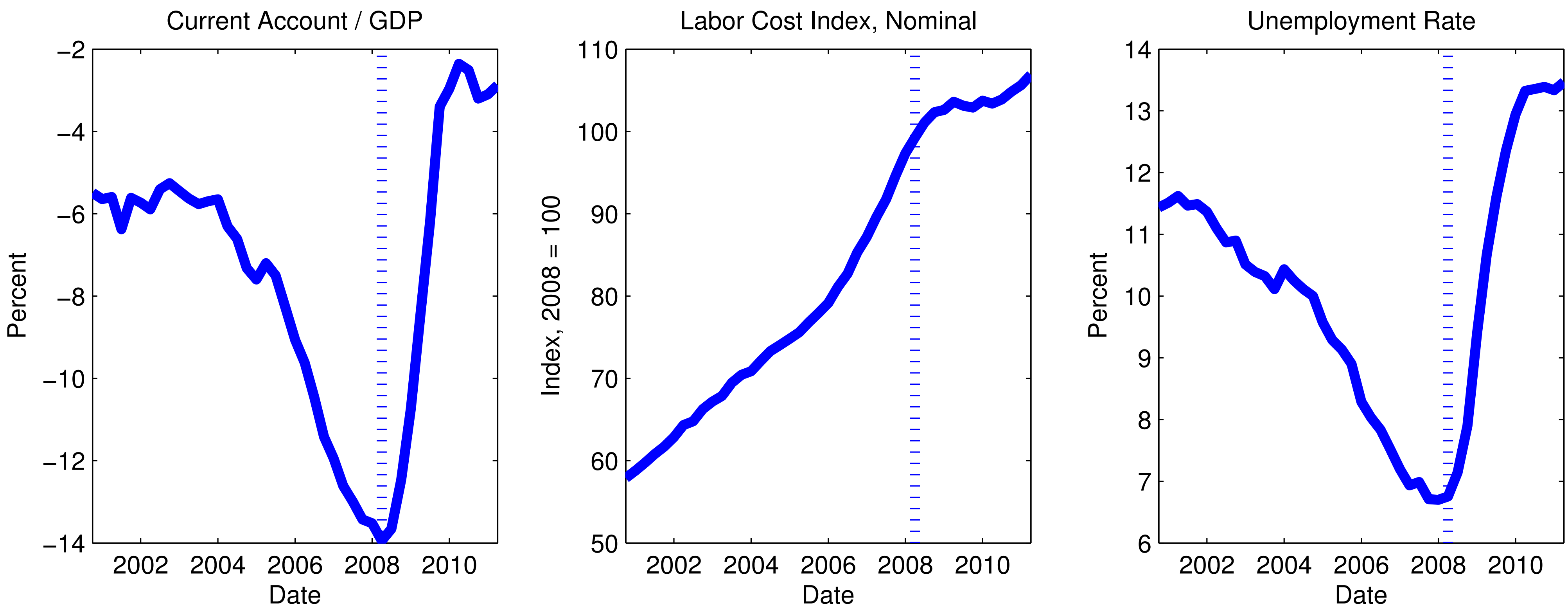
Content

Lecture 1

Nominal Rigity, Exchange Rates, and Unemployment*

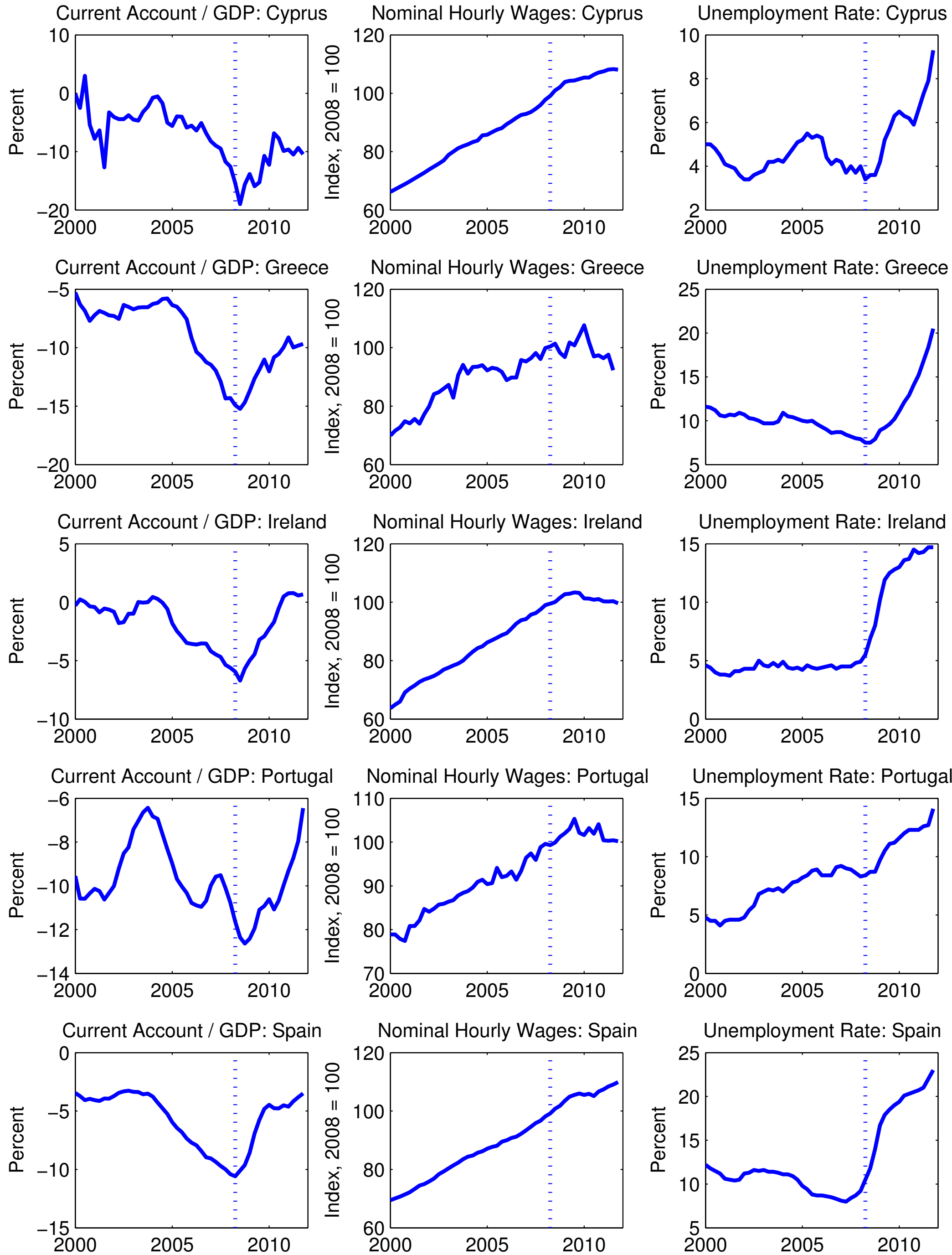
*Background reading: M. Uribe and S. Schmitt-Grohé, *Open Economy Macroeconomics*, chapter 9, Princeton University Press, 2016.

Boom-Bust Cycle in Peripheral Europe: 2000-2011



Data Source: Eurostat. Labor Cost Index, Nominal, is the nominal hourly wage rate in manufacturing, construction and services (including the public sector, but for Spain.)

Data represents arithmetic mean of Bulgaria, Cyprus, Estonia, Greece, Ireland, Lithuania, Latvia, Portugal, Spain, Slovenia, and Slovakia.



The Disaggregated Story: Boom-Bust Cycles in Cyprus, Greece, Ireland, Portugal, and Spain.

An Open Economy with

Downward Nominal Wage Rigidity

(The DNWR Model)

Households

$$\max_{\{c_t^T, c_t^N, d_{t+1}\}} \quad E_0 \sum_{t=0}^{\infty} \beta^t U(c_t)$$

subject to

$$c_t = A(c_t^T, c_t^N)$$

$$c_t^T + p_t c_t^N + d_t = y_t^T + w_t h_t + \frac{d_{t+1}}{1+r_t} + \phi_t$$

$$h_t \leq \bar{h}$$

where c_t = consumption; c_t^T, c_t^N =consumption of tradables/nontradables; h_t = hours worked; p_t = relative price of nontradables in terms of tradables; w_t = real wage; d_t = dollar-denominated debt assumed in $t-1$ and due in t; r_t = real interest rate; y_t^T = endowment of tradables; and ϕ_t = profits.

Optimality Conditions Associated with the Household Problem

$$p_t = \frac{A_2(c_t^T, c_t^N)}{A_1(c_t^T, c_t^N)}$$

$$\lambda_t = U'(A(c_t^T, c_t^N))A_1(c_t^T, c_t^N)$$

$$\lambda_t = \beta(1 + r_t)E_t\lambda_{t+1}$$

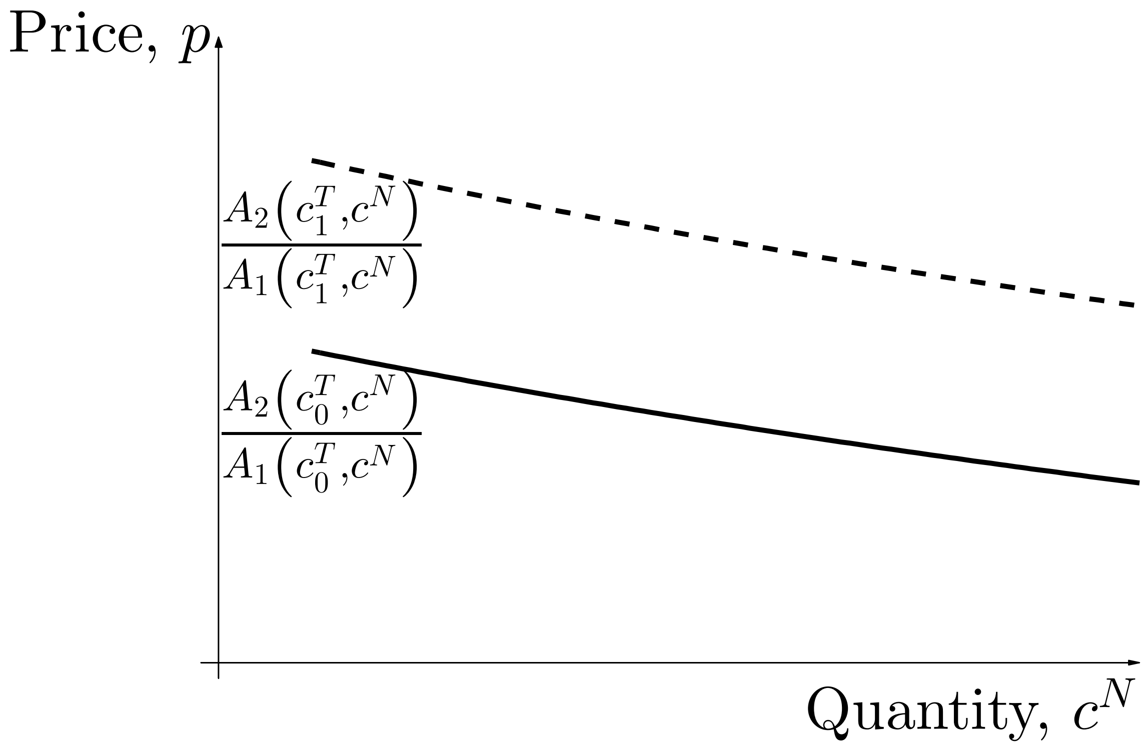
$$c_t^T + p_t c_t^N + d_t = y_t^T + w_t h_t + \frac{d_{t+1}}{1 + r_t} + \phi_t$$

$$h_t \leq \bar{h}$$

The Demand For Nontradables

$$\frac{A_2(c_t^T, c_t^N)}{A_1(c_t^T, c_t^N)} = p_t.$$

The Demand For Nontradables



Firms

Nontraded output, y_t^N, is produced by perfectly competitive firms using labor as the sole input.

Real profits, expressed in units of tradable goods and denoted ϕ_t, are given by

$$p_t F(h_t) - \frac{W_t}{\mathcal{E}_t} h_t$$

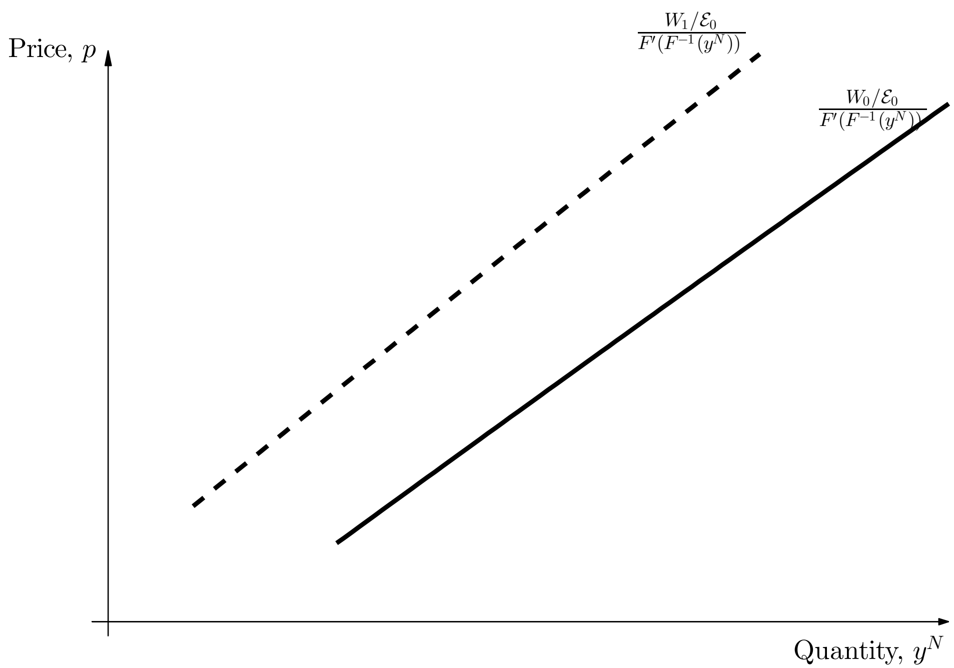
where $\mathcal{E}_t =$ nominal exchange rate (=domestic-currency price of foreign currency).

Two assumptions are implicit in this expression: (1) the LOOP holds for tradables, $P_t^T = \mathcal{E}_t P_t^{T*}$, where P_t^T =domestic price of the tradable good and (in domestic currency) $P_t^{T*} =$ foreign price of tradable (in in foreign currency). (2) $P_t^{T*} = 1$. Then $P_t^T = \mathcal{E}_t$.

The Firm's Optimality Condition (price=marginal cost):

$$p_t = \frac{W_t/\mathcal{E}_t}{F'(h_t)}$$

The Supply Of Nontradables



Downward Nominal Wage Rigidity and the Labor Market

$$W_t \geq \gamma W_{t-1}$$

$$h_t \leq \bar{h}$$

$$(\bar{h} - h_t)(W_t - \gamma W_{t-1}) = 0$$

Think of γ as being close to 1. Letting $w_t \equiv W_t/\mathcal{E}_t$ be the real wage in terms of tradables and $\epsilon_t \equiv \mathcal{E}_t/\mathcal{E}_{t-1}$ the gross devaluation rate, we can rewrite these 3 expressions as

$$w_t \geq \gamma \frac{w_{t-1}}{\epsilon_t}; \qquad h_t \leq \bar{h}; \qquad (\bar{h} - h_t)\left(w_t - \gamma \frac{w_{t-1}}{\epsilon_t}\right) = 0$$

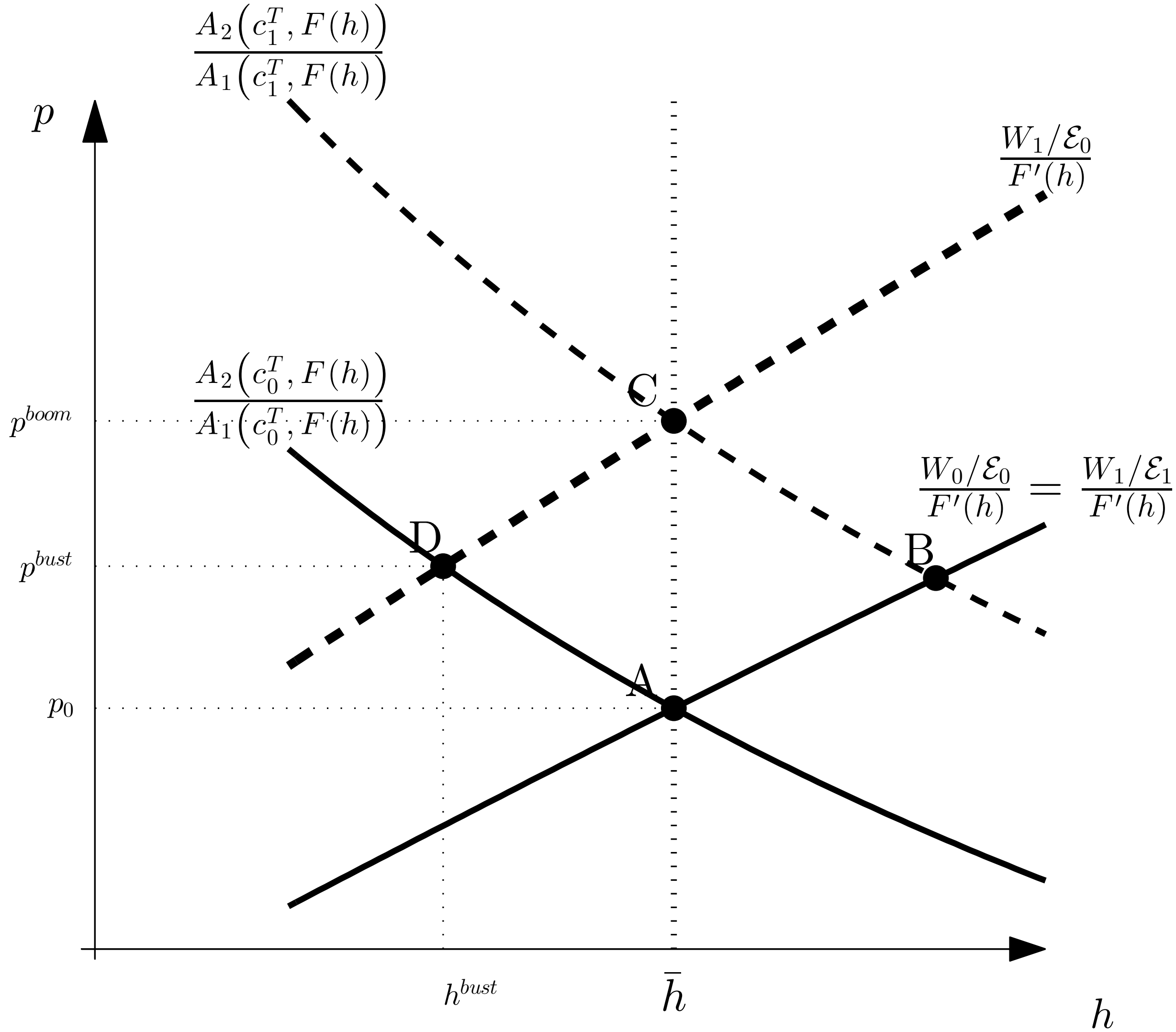
Market Clearing in the Nontraded Sector

$$c_t^N = F(h_t)$$

Currency Pegs

$$\mathcal{E}_t = \mathcal{E}_0; \quad \forall t \geq 0.$$

Adjustment to a Boom-Bust Cycle under a Currency Peg



$$c_1^T > c_0^T$$

Competitive Equilibrium: Stochastic processes $\{c_t^T,\ h_t,\ w_t,\ d_{t+1},\ p_t,\ \lambda_t\}_{t=0}^{\infty}$ satisfying

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t}$$

$$\lambda_t = U'(A(c_t^T, F(h_t)))A_1(c_t^T, F(h_t))$$

$$\frac{\lambda_t}{1+r_t} = \beta E_t \lambda_{t+1}$$

$$p_t = \frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))}$$

$$p_t = \frac{w_t}{F'(h_t)}$$

$$w_t \geq \gamma \frac{w_{t-1}}{\epsilon_t}; \qquad h_t \leq \bar{h}; \qquad (\bar{h} - h_t)\left(w_t - \gamma \frac{w_{t-1}}{\epsilon_t}\right) = 0$$

given an exchange rate policy.

Special Case: Equal Intra- and Itertemporal Elasticities

$$U(c) = \frac{c^{1-\sigma}}{1-\sigma}$$

$$A(c^T, c^N) = \left[a {c^T}^{1-\frac{1}{\xi}} + (1-a) {c^N}^{1-\frac{1}{\xi}} \right]$$

Suppose that $\xi = 1/\sigma$. (The case $\sigma = 1/\xi = 2$ is of much empirical relevance.) Then

$$U(A(c^T, c^N)) = a \frac{{c^T}^{1-\sigma}}{1-\sigma} + (1-a) \frac{{c^N}^{1-\sigma}}{1-\sigma}$$

is separable. Then c_t^T is the solution to the block

$${c_t^T}^{-\sigma} = \beta(1+r_t) E_t {c_{t+1}^T}^{-\sigma}$$

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t}$$

This is a relatively simple dynamic programming problem to solve. The other equations of the model are static and easy to solve.

Adjustment to a Temporary Fall in the Interest Rate

To illustrate the source of the peg-induced externality, consider the following analytical example.

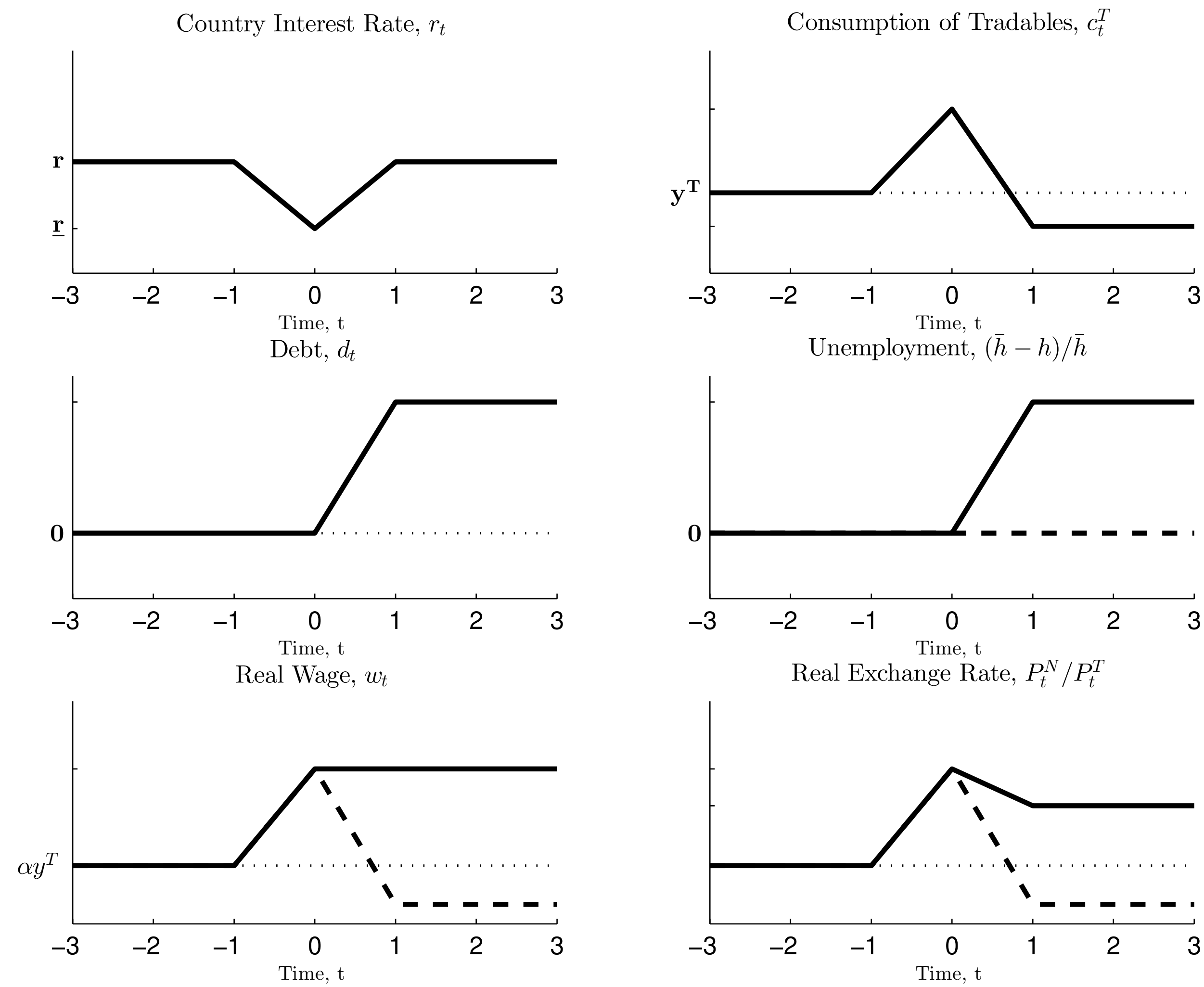
$$U(A(c_t^T, c_t^N)) = \ln c_t^T + \ln c_t^N$$

$$F(h_t) = h_t^\alpha; \quad 0 < \alpha < 1$$

$$\bar{h} = 1; \quad y_t^T = y^T > 0; \quad \gamma = 1; \quad \beta(1+r) = 1; \quad d_0 = 0; \quad w_{-1} = \alpha y^T$$

$$r_t = \begin{cases} r & t > 0 \\ \underline{r} < r & t = 0 \end{cases}$$

A Temporary Decline in the Country Interest Rate



____ currency peg   _ _ _ _ flexible wage economy or optimal exchange rate economy

Optimal Exchange Rate Policy

Motivation

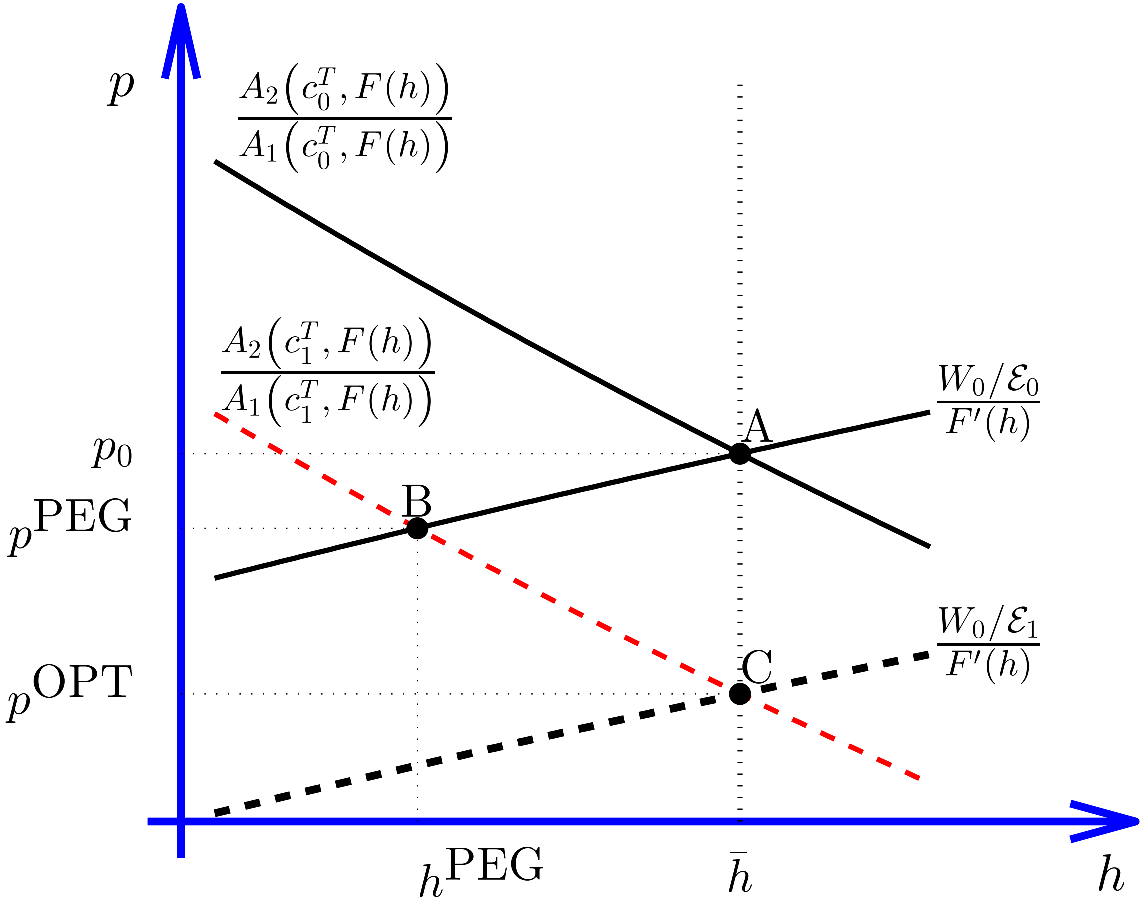
• We have just seen that under an exchange rate peg a negative external shock may lead to involuntary unemployment. How would optimal exchange rate policy look like?

• In this section we show that under optimal policy there is (1) full employment and (2) negative external shocks call for devaluations.

• We begin with a graphical explanation.

Optimal Exchange-Rate Policy

(again, assume $\gamma = 1$)



$c_1^T < c_0^T$ (negative shock, possibly $r_t \uparrow$)

$\mathcal{E}_1 > \mathcal{E}_0$ (optimal devaluation)

The Ramsey Optimal Exchange-Rate Policy Pick a process ϵ_t to

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U(A(c_t^T, F(h_t))) \quad \text{subject to}$$

$$\boxed{c_t^T + d_t = y_t^T + \tfrac{d_{t+1}}{1+r_t}}$$

$$\lambda_t = U'(A(c_t^T, F(h_t)))A_1(c_t^T, F(h_t))$$

$$\frac{\lambda_t}{1+r_t} = \beta E_t \lambda_{t+1}$$

$$p_t = \frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))}$$

$$p_t = \frac{w_t}{F'(h_t)}$$

$$w_t \geq \gamma \frac{w_{t-1}}{\epsilon_t}; \qquad \boxed{h_t \leq \bar{h}}; \qquad (\bar{h} - h_t)\left(w_t - \gamma \frac{w_{t-1}}{\epsilon_t}\right) = 0$$

The Optimal Depreciation Rate

The Ramsey optimal real wage rate, denoted $\omega(c_t^T)$, is

$$\omega(c_t^T) \equiv \frac{A_2(c_t^T, F(\bar{h}))}{A_1(c_t^T, F(\bar{h}))} F'(\bar{h}); \quad \omega'(c_t^T) > 0$$

Then, the optimal depreciation rate is any process satisfying

$$\epsilon_t \geq \frac{\gamma W_{t-1}/\mathcal{E}_{t-1}}{\omega(c_t^T)}$$

Note: There is a whole family of optimal exchange-rate policies. Under any member of this policy, $h_t = \bar{h}$ and $w_t = \omega(c_t^T)$ for all t.

When is it inevitable to devalue?

Optimal exchange rate policy is:

$$\epsilon_t \geq \frac{\gamma W_{t-1}/\mathcal{E}_{t-1}}{\omega(c_t^T)}$$

Because $\omega'(c_t^T) > 0$, optimal devaluations occur in periods of contraction of aggregate demand. It follows that contractions are devaluatory as opposed to devaluations being contractionary.

Empirical Evidence On

Downward Nominal Wage Rigidity

A.) Evidence From Micro Data from Developed Countries

A1.) United States, 1986-1993, SIPP panel data

Probability of Decline, Increase, or No Change in Wages

	Interviews One Year apart	
	Males	Females
Decline	5.1%	4.3%
Constant	53.7%	49.2%
Increase	41.2%	46.5%

Source: Gottschalk (2005). Note: Male and female hourly workers not in school, 18 to 55 at some point during the panel. All nominal-wage changes are within-job wage changes, defined as changes while working for the same employer. SIPP panel data.

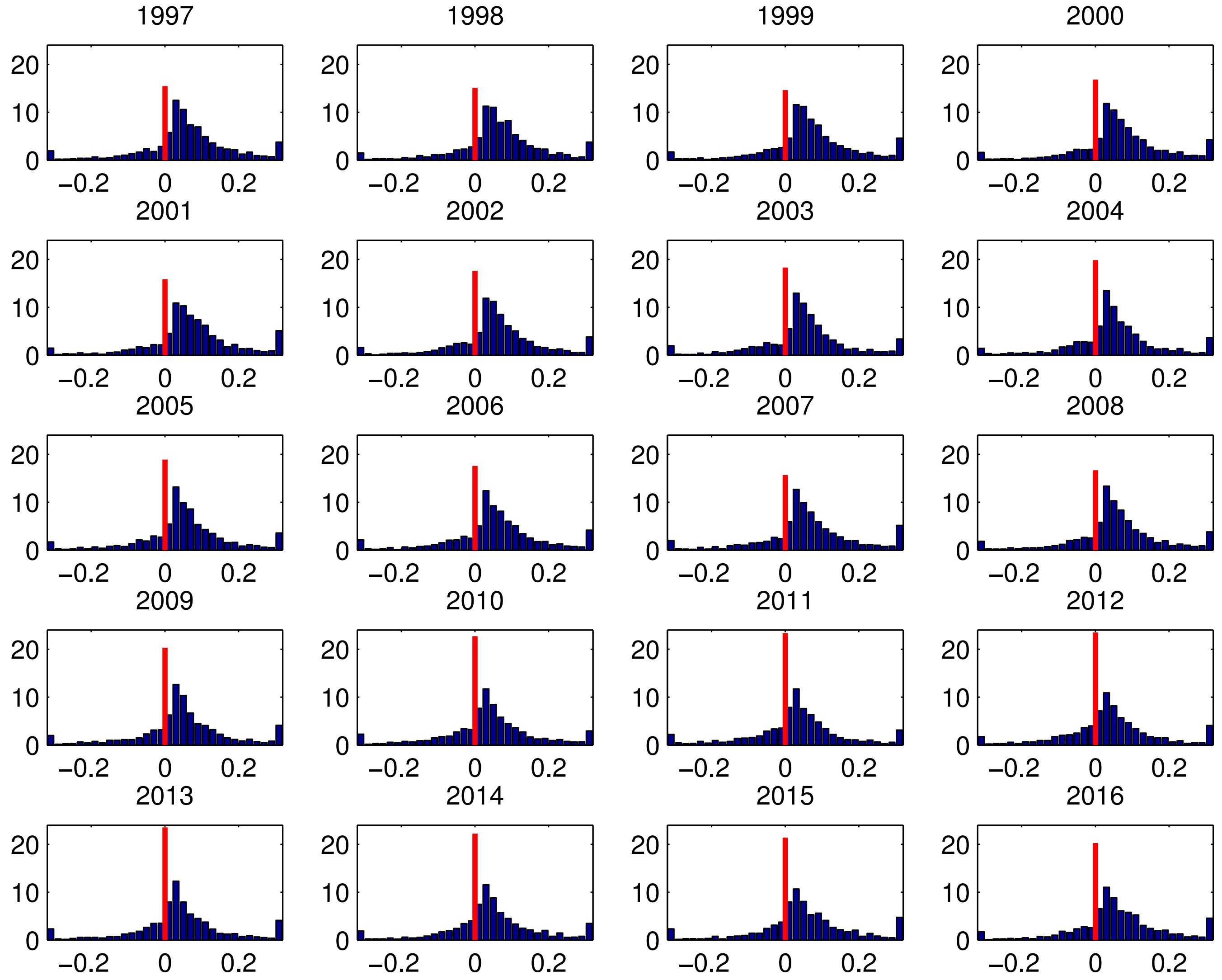
- Large mass at ‘Constant’ suggests nominal wage rigidity.
- Small mass at ’Decline’ suggests downward nominal wage rigidity.

A2.) United States 1996-1999, SIPP panel data

Distribution of Non-Zero Nominal Wage Changes

Source: Barattieri, Basu, and Gottschalk (2012). SIPP panel data.

A3.) United States, 1997-2016, CPS panel data



Source: Jo, Schmitt-Grohé, and Uribe (2017).

B.) Evidence From Informal Labor Markets

• Kaur (2012) examines the behavior of nominal wages, employment, and rainfall in casual daily agricultural labor markets in rural India (500 districts from 1956 to 2008).

• Finds asymmetric nominal wage adjustment:

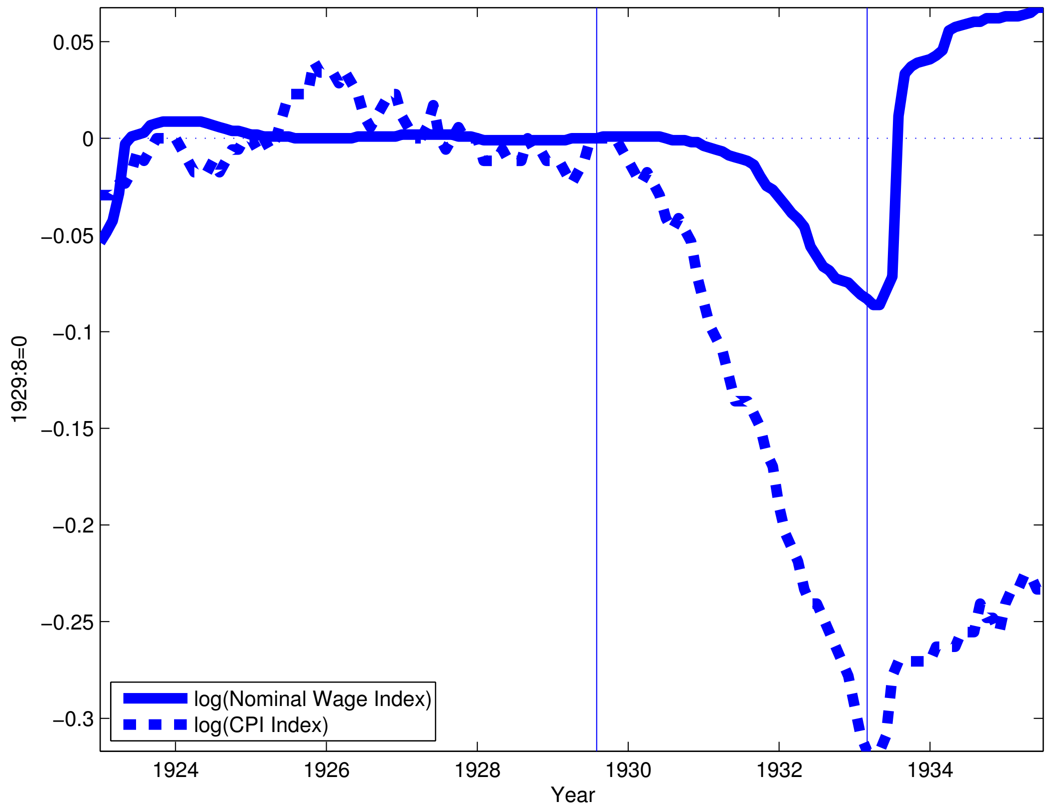
— W_t increases in response to positive rainfall shocks

— W_t fails to fall, labor rationing, and unemployment are observed in response to negative rain shocks.

• Inflation (uncorrelated with local rain shocks) tends to moderate rationing and unemployment during negative rain shocks, suggesting downward rigidity in nominal rather than real wages.

C.) Evidence From the Great Depression in the U.S.

Nominal Wage Rate and Consumer Prices, United States 1923:1-1935:7



Solid line: natural logarithm of an index of manufacturing money wage rates. Broken line: logarithm of the consumer price index.

D.) Evidence From Peripheral Europe (2008-2011)

Country	Unemployment Rate 2008Q1 (in percent)	Unemployment Rate 2011Q2 (in percent)	Wage Growth $\frac{W_{2011Q2}}{W_{2008Q1}}$ (in percent)	Implied Value of γ in $W_t \geq \gamma W_{t-1}$
Bulgaria	6.1	11.3	43.3	1.028
Cyprus	3.8	6.9	10.7	1.008
Estonia	4.1	12.8	2.5	1.002
Greece	7.8	16.7	-2.3	0.9982
Ireland	4.9	14.3	0.5	1.0004
Italy	6.4	8.2	10.0	1.007
Lithuania	4.1	15.6	-5.1	0.996
Latvia	6.1	16.2	-0.6	0.9995
Portugal	8.3	12.5	1.91	1.001
Spain	9.2	20.8	8.0	1.006
Slovenia	4.7	7.9	12.5	1.009
Slovakia	10.2	13.3	13.4	1.010

Note. W is an index of nominal average hourly labor cost in manufacturing, construction, and services, including the public sector (except for Spain). Source: Schmitt-Grohé and Uribe (2016)

How To Infer γ From European Data

The slackness condition of the model, $(W_t - \gamma W_{t-1})(\bar{h} - h_t)$, implies that if unemployment increases form one period to the next, then nominal wages must be growing at the rate γ: $\frac{W_t}{W_{t-1}} = \gamma$.

How to calculate γ from the wage and unemployment data of the previous table:

$$\gamma = \left(\frac{W_{2011:Q2}}{W_{2008:Q1}}\right)^{\frac{1}{13}}$$

Subtract 0.6% per quarter to adjust for foreign inflation and long-run growth (because they are not explicitly incorporated in the model) to obtain the estimate:

$$\gamma \in [\mathbf{0.99}, \mathbf{1.022}]$$

Quantitative Analysis

Replication files: `usg_dnwr.zip` available online with the materials for this chapter.

Functional Forms

Assume a CRRA form for preferences, a CES form for the aggregator of tradables and nontradables, and an isoelastic form for the production function of nontradables:

$$U(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}$$

$$A(c^T, c^N) = \left[a(c^T)^{1-\frac{1}{\xi}} + (1-a)(c^N)^{1-\frac{1}{\xi}}\right]^{\frac{1}{1-\frac{1}{\xi}}}$$

$$F(h) = h^{\alpha},$$

with $\sigma, \xi, a, \alpha > 0$.

The Driving Process:

Data: Argentine data over the period 1983:Q1—2001:Q3. Exclude the period 2001:Q4 to present, because of the default episode in 2002 (no default in the model).

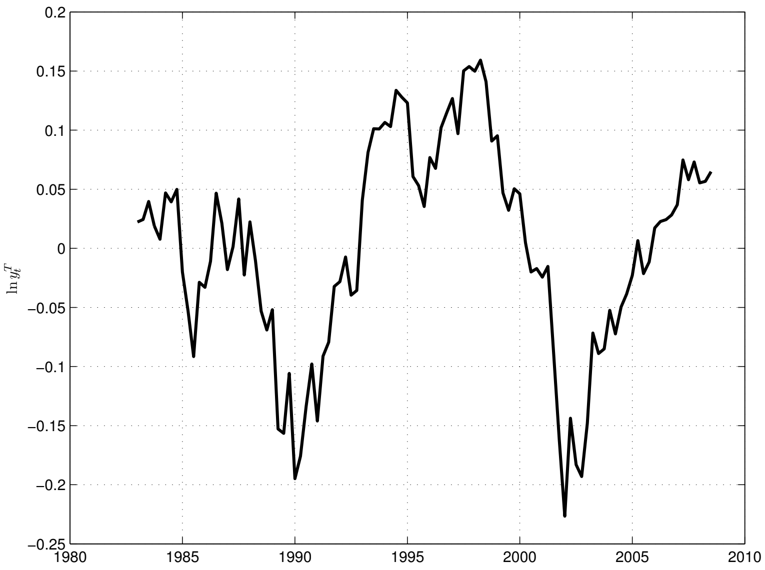
Empirical Measure of y_t^T: sum of GDP in agriculture, manufacturing, fishing, forestry, and mining. Quadratically detrended.

Empirical Measure of r_t: Sum of Argentine EMBI+ plus 90-day Treasury-Bill rate minus a measure of U.S. expected inflation.

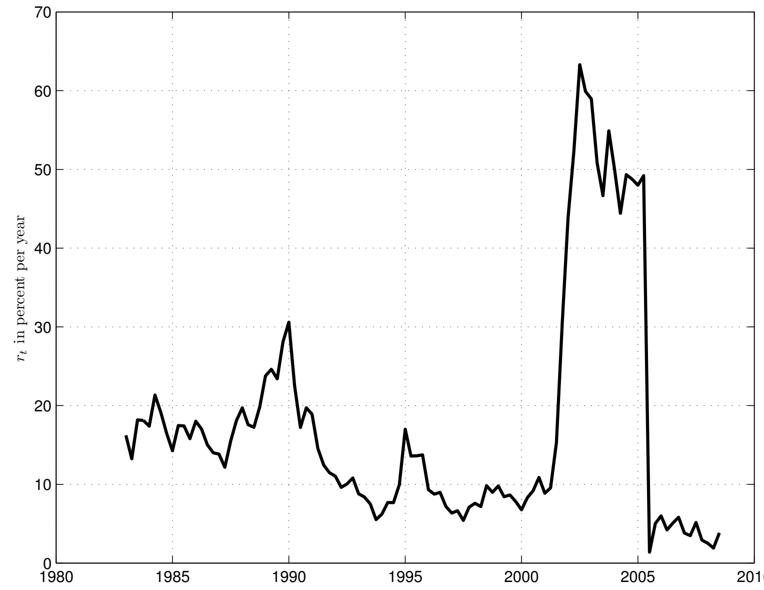
The following slide displays the two time series.

Tradable Output and Country Interest Rate Argentina 1983:Q1 to 2001:Q3

Traded Output



Country Interest Rate



Estimate the AR(1) system

$$\begin{bmatrix} \ln y_t^T \\ \ln \frac{1+r_t}{1+r} \end{bmatrix} = A \begin{bmatrix} \ln y_{t-1}^T \\ \ln \frac{1+r_{t-1}}{1+r} \end{bmatrix} + \epsilon_t,$$

OLS Estimate of the Driving Process

$$A = \begin{bmatrix} 0.79 & -1.36 \\ -0.01 & 0.86 \end{bmatrix}; \qquad \Sigma_\epsilon = \begin{bmatrix} 0.00123 & -0.00008 \\ -0.00008 & 0.00004 \end{bmatrix};$$

$r = 0.0316$ (3.16% per quarter).

Some Unconditional Summary Statistics

Statistic	y^T	r
Std. Dev.	12%	6%yr
Serial Corr.	0.95	0.93
Corr(y_t^T, r_t)	-0.86	
Mean	1	12%yr

Observations:
(1) High volatility of both y_t^T and r_t;
(2) negative correlation between y_t^T and r_t (when it rains it pours);
(3) High mean country interest rate.

Calibration

Parameter	Value	Description
γ	0.99	Degree of downward nominal wage rigidity
σ	2	Inverse Intertemp. elast. of subst.
y^T	1	Steady-state tradable output
$\bar{h}$	1	Labor endowment
a	0.26	Share of tradables
ξ	0.5	Intratemp. elast. of subst.
α	0.75	Labor share in nontraded sector
β	0.9635	Quarterly subjective discount factor

Note: $\sigma = 2$ is widely used in business cycle analysis, and $\xi = 0.5$ is within the range of values estimated for emerging countries (see the survey by Akinci, 2011). Consequently, the restriction $\xi = 1/\sigma$ is quite compelling on empirical and computational grounds.

Approximating Equilibrium Dynamics

When $\xi = 1/\sigma$, the dynamics in the traded sector are independent of the exchange-rate regime. The equilibrium processes $\{c_t^T, d_{t+1}\}$ solve the Bellman equation problem

$$v(y_t^T, r_t, d_t) = \max_{\{d_{t+1}, c_t^T\}} \left\{ U(A(c_t^T, F(\bar{h}))) + \beta E_t v(y_{t+1}^T, r_{t+1}, d_{t+1}) \right\}$$

$$\text{subject to} \qquad c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t} \qquad \text{and } d_{t+1} \leq \bar{d}.$$

Solve by value function iteration over a discretized state space (y_t^T, r_t, d_t). Use 21 values for y_t^T and 11 for r_t (the estimated joint process (y_t^T, r_t) is the one given above). Use 501 equally spaced points for d_t between 1 and 8.34. The solution are policy functions $c^T = C^T(y_t^T, r_t, d_t)$ and $d_{t+1} = D(y_t^T, r_t, d_t)$.

The other variables of the model do depend on the exchange-rate regime.

Approximating Equilibrium Under the Optimal Exchange-Rate Policy

We know that $h_t = \bar{h}$. Then, given the solution for c_t^T, we have

$$p_t = \frac{A_2(c_t^T, F(\bar{h}))}{A_1(c_t^T, F(\bar{h}))},$$

$$w_t = p_t F'(\bar{h}),$$

From the family of optimal devaluation policies, we pick

$$\epsilon_t = \frac{w_{t-1}}{w_t}.$$

Properties: (1) It fully stabilizes W_t and P_t^N; (2) Zero average inflaiton and devaluation.

Approximating Equilibrium Under a Currency Peg

The solution is in two steps:

(1) Given the process c_t^T, try the guess $h_t = \bar{h}$. Then, p_t and w_t are given by

$$p_t = \frac{A_2(c_t^T, F(\bar{h}))}{A_1(c_t^T, F(\bar{h}))} \qquad \text{and} \qquad p_t = \frac{w_t}{F'(\bar{h})}.$$

If $w_t \geq \gamma w_{t-1}$, then the equilibrium values of w_t and p_t have been found.

(2) If $w_t < \gamma w_{t-1}$, then in equilibrium $w_t = \gamma w_{t-1}$, and the equilibrium values of p_t and h_t are the solution to

$$p_t = \frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))} \qquad \text{and} \qquad p_t = \frac{w_t}{F'(h_t)}.$$

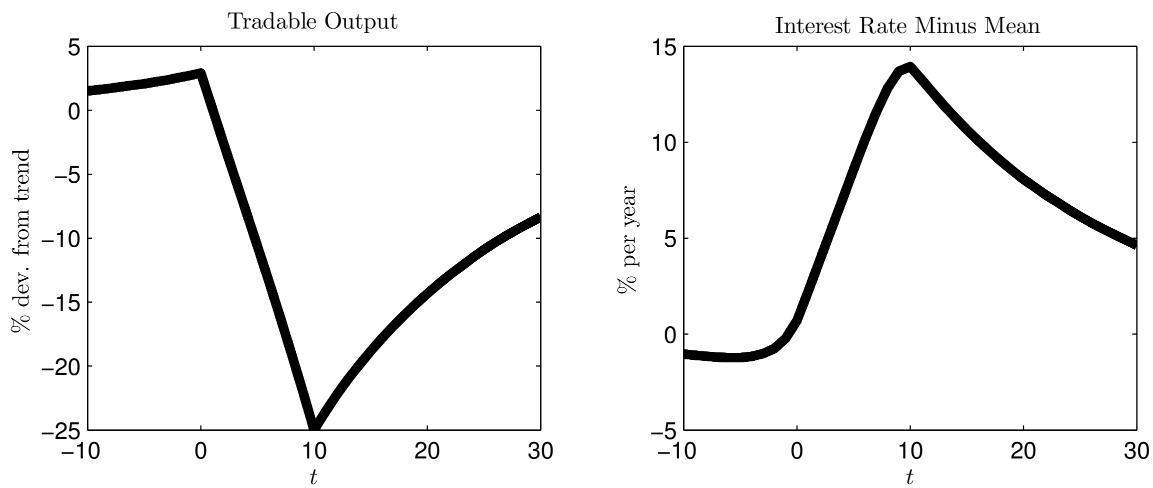
Crisis Dynamics Under A Currency Peg and Under Optimal Exchange-Rate Policy

We are interested in characterizing quantitatively the response of the model economy to large contractions like the ones observed in Argentina in 2001 and in the periphery of Europe in 2008. In Argentina, for instance, traded output fell by 2 standard deviations in a period of two and a half years (10 quarters). Accordingly, we use the following operational definition of an external crisis.

Definition of an External Crisis. A crisis is a situation in which in period t tradable output, y_t^T, is at or above average, and 10 quarters later, in period $t+10$, it is at least two standard deviations below trend.

The Typical External Crisis: Simulate the model for 20 million periods. Extract all windows of time in which y_t^T conforms to the definition of a crisis. For each variable of interest, average all windows and subtract its unconditional mean (i.e., the mean taken over the 20 million observations).

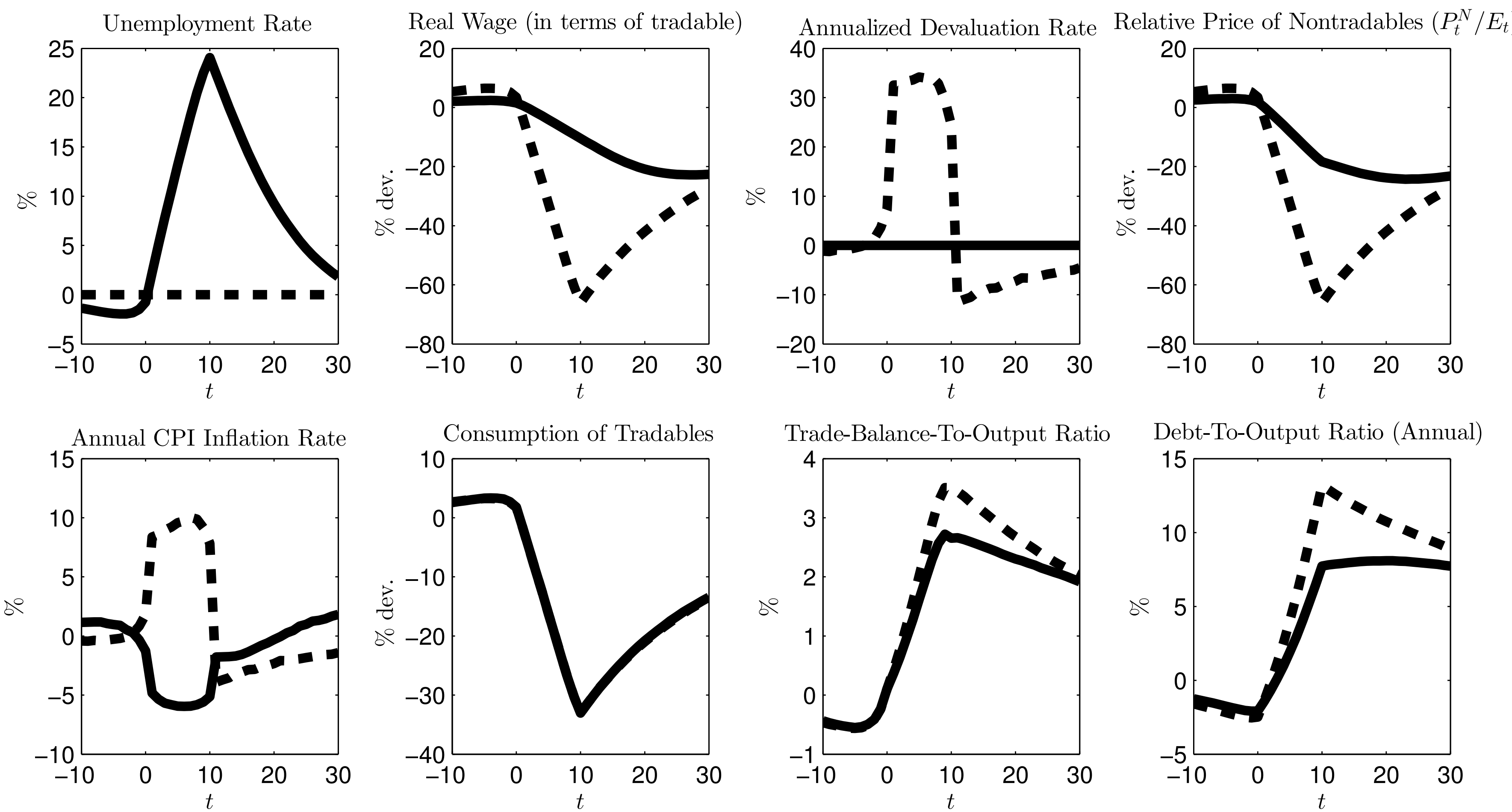
Sources of an External Crisis



Note. Replication file plot_ir.m in usg_dnwr.zip.

Comments: (1) Because y_t^T and r_t are negatively correlated, the collapse in y_t^T coincides with a sharp increase in the country interest rate. (2) The response of y_t^T and r_t are exogenous to the model, so this plot is independent of the exchange-rate policy. The next slide displays the response of the endogenous variables.

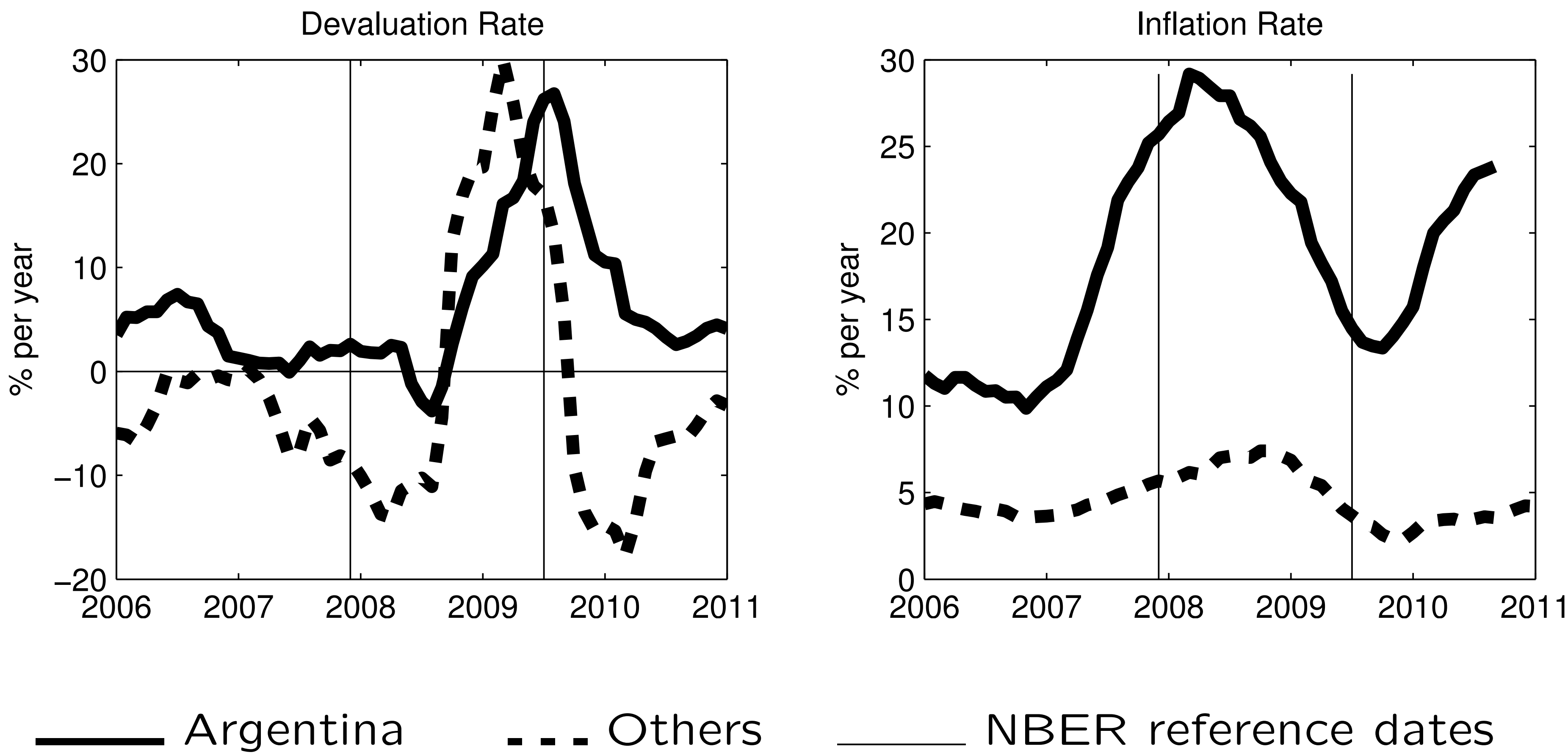
Pegs Amplify Negative External Shocks



——— Currency Peg _ _ _ Optimal Exchange-Rate Policy

Note. Replication file plot_ir.m in usg_dnwr.zip.

Devaluations and Revaluations in Reality:
Latin America: 2006-2011



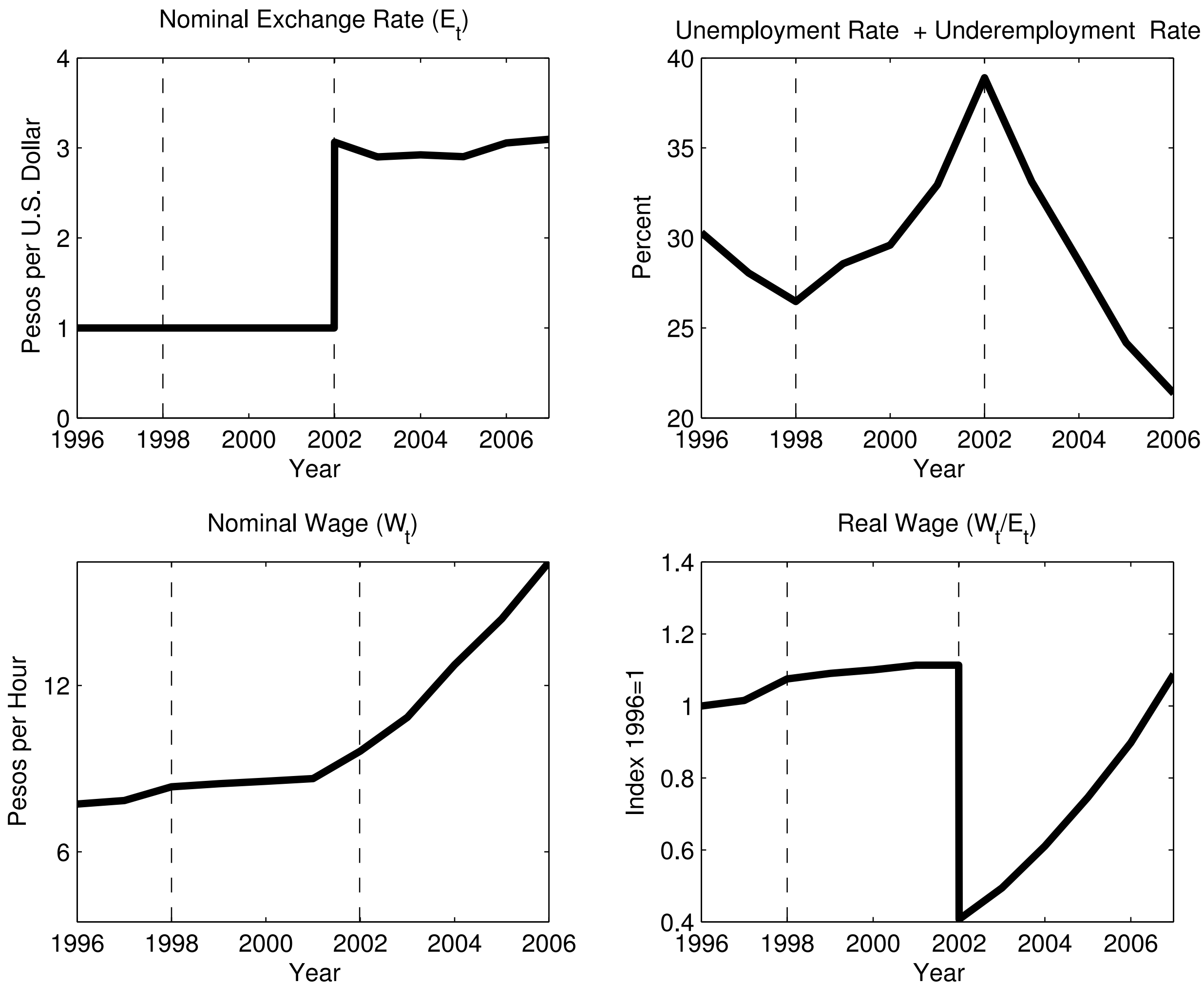
Observation. During the global financial crisis, all countries devalued significantly. However, during the recovery, all countries but Argentina revalued their currencies. The countries that revalued experienced lower inflation than Argentina.

Are devaluations expansionary as predicted by the DNWR model?

To address this issue, let's take a look at two episodes of exiting a currency peg:

- Ending Convertibility: Argentina 1996-2006
- Exiting the Gold Standard: Europe 1929-1935

The End of the Argentine Convertibility: 1996-2006



Memo: Average annual CPI inflation 1998-2001: -0.86%.

Exiting the Gold Standard: Europe 1929 to 1935

- Friedman and Schwartz (1963) observe that countries that left gold early (the sterling bloc) enjoyed more rapid recoveries than countries that stayed on gold longer (the gold bloc).

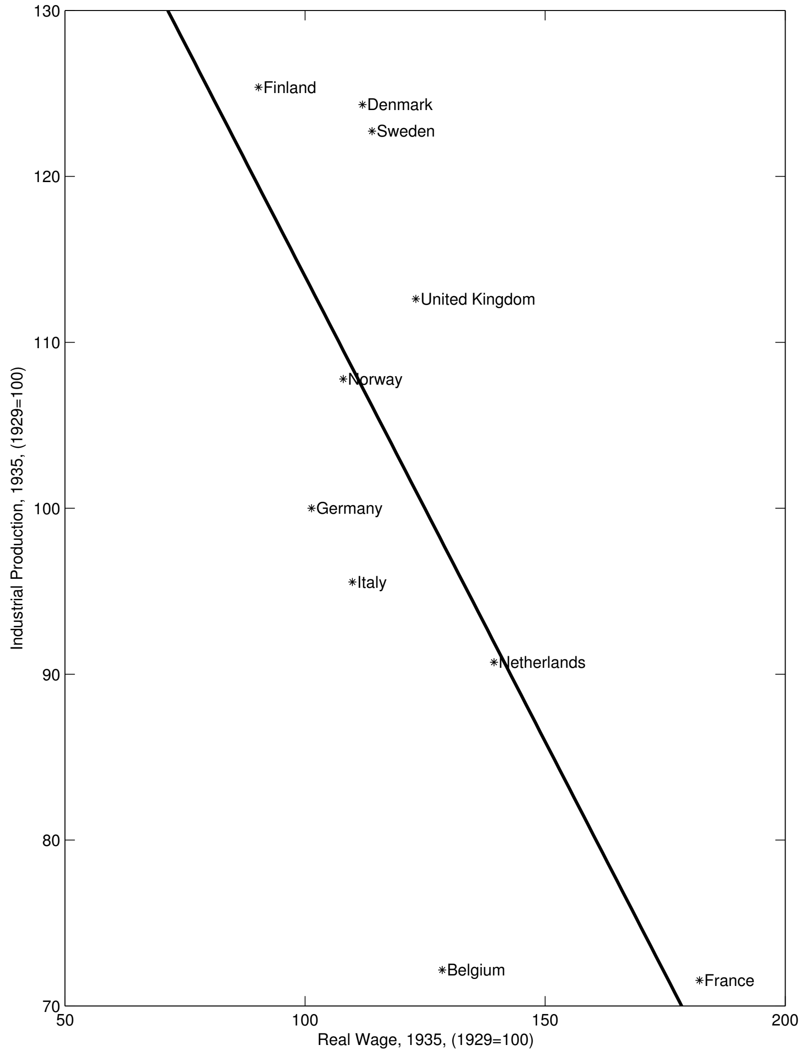
- Sterling bloc: United Kingdom, Sweden, Finland, Norway, Denmark.

- Gold bloc: France, Belgium, the Netherlands, and Italy.

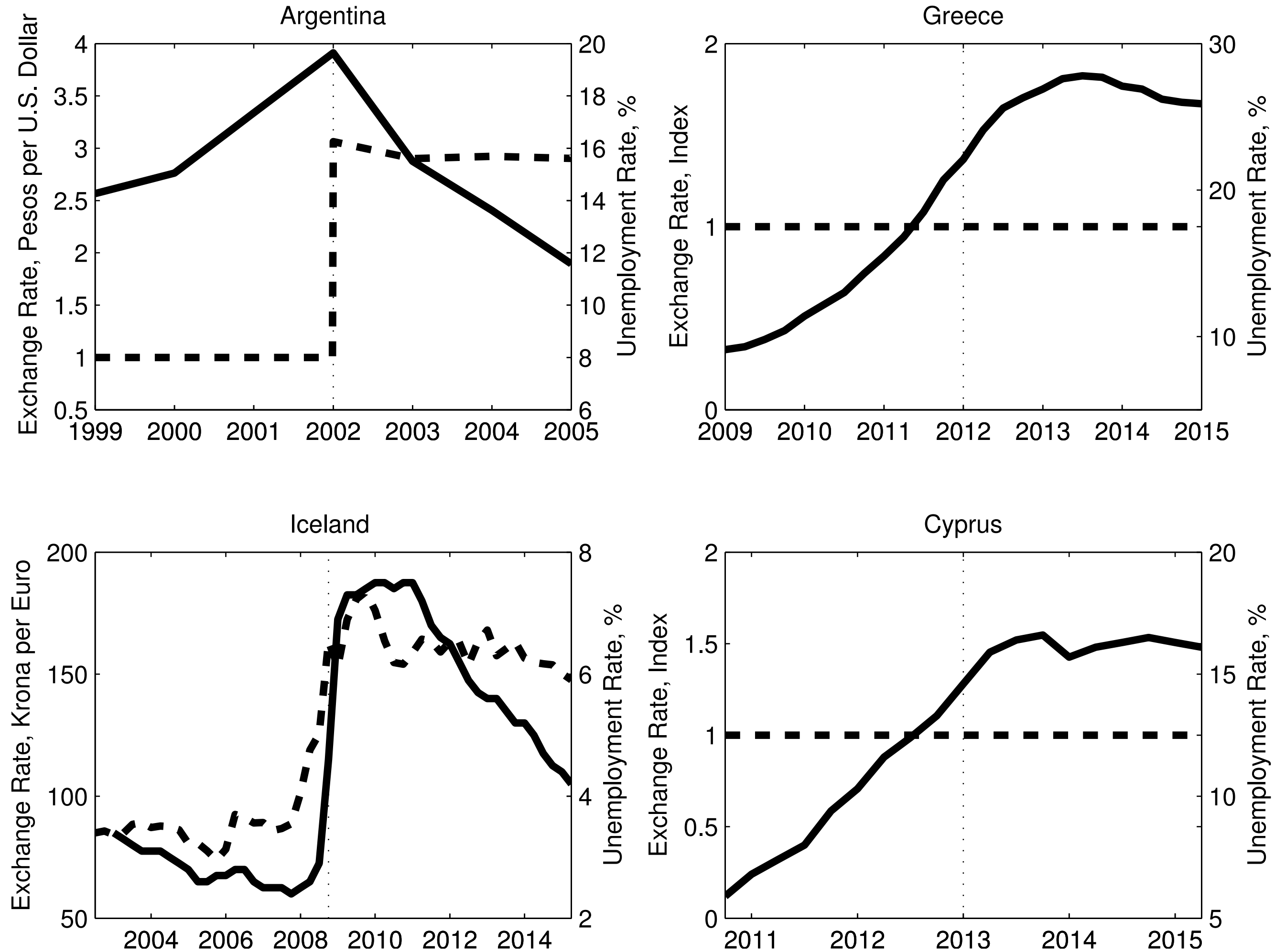
- Eichengreen and Sachs (1986) observe that real wages behaved differently in countries that left gold early (ie devalued) and in countries that stayed on gold longer (ie stayed on the peg). Take a look at the next figure, which is redrawn from Eichengreen and Sachs.

Changes In Real Wages and Industrial Production

Europe, 1929 to 1935



Default, Devaluation, and Unemployment:



—— Unemployment Rate - - - - Nominal Exchange Rate

Note. Vertical line indicates the year of default. Own calculations based on data from INDEC (Argentina), EuroStat, and the Central Bank of Iceland.

The Welfare Costs of Currency Pegs

Find the compensation, measured as percent increase in the stream of consumption in the peg economy, denoted $\Lambda(s_t)$, that makes agents indifferent between living under a peg or under the optimal exchange-rate policy, given the current state $s_t = (y_t^T, r_t, d_t, w_{t-1})$. This compensation is implicitly given by

$$E\left\{\sum_{j=0}^{\infty} \beta^j U\left(c_{t+j}^{\text{PEG}}(1+\Lambda(s_t)/100)\right)\Bigg| s_t\right\} = E\left\{\sum_{j=0}^{\infty} \beta^j U\left(c_{t+j}^{\text{OPT}}\right)\Bigg| s_t\right\},$$

Solve for $\Lambda(s_t)$ to obtain

$$\Lambda(s_t) = 100\left\{\left[\frac{v^{OPT}(y_t^T, r_t, d_t)(1-\sigma)+(1-\beta)^{-1}}{v^{PEG}(y_t^T, r_t, d_t, w_{t-1})(1-\sigma)+(1-\beta)^{-1}}\right]^{1/(1-\sigma)} - 1\right\},$$

where $v^{OPT}(y_t^T, r_t, d_t) \equiv E\left\{\sum_{j=0}^{\infty} \beta^j U\left(c_{t+j}^{\text{OPT}}\right)\Big| s_t\right\}$
and $v^{PEG}(y_t^T, r_t, d_t, w_{t-1}) \equiv E\left\{\sum_{j=0}^{\infty} \beta^j U\left(c_{t+j}^{\text{PEG}}\right)\Big| s_t\right\}$,
with the expectation taken over the distribution of s_t in the peg economy. The welfare cost of a peg, $\Lambda(s_t)$, is a random variable as it is a function of the state in period t, s_t.

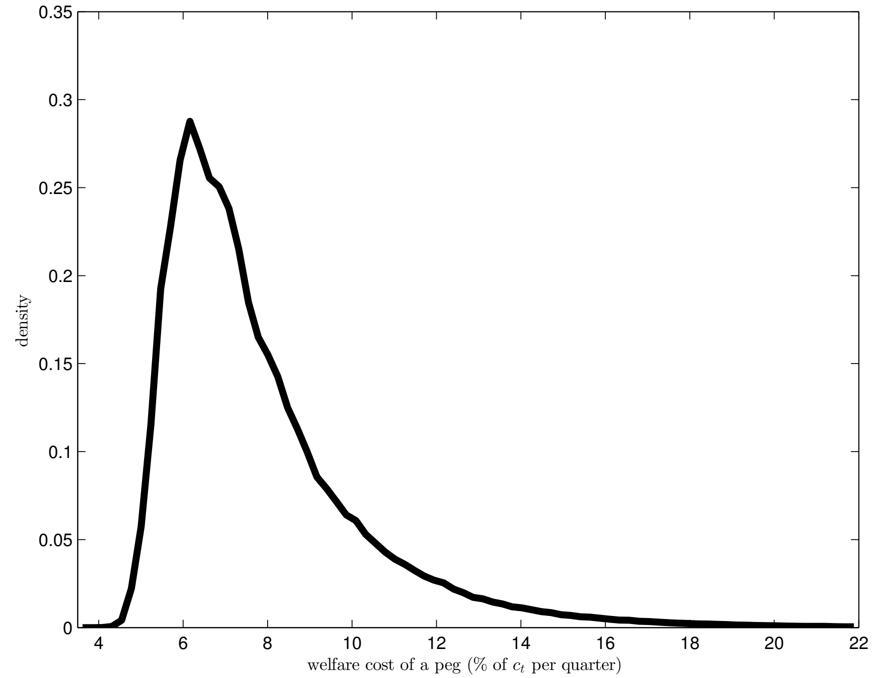
The Welfare Costs of Currency Pegs

Model	Welfare Cost Mean	Welfare Cost Median	Unemployment Mean Rate
Baseline ($\gamma = 0.99$)	7.8	7.2	11.7

Note. The welfare cost of a currency peg is expressed in percent of consumption. Welfare costs are computed over the distribution of the state $(y_t^T, r_t, d_t, w_{t-1})$ induced by the peg economy. Replication files: simu_welf.m (welfare cost) and simu.m (unemployment) in usg_dnwr.zip.

Observation: Large welfare costs of currency pegs. All of the cost is explained by lost consumption of nontradables due to unemployment in that sector.

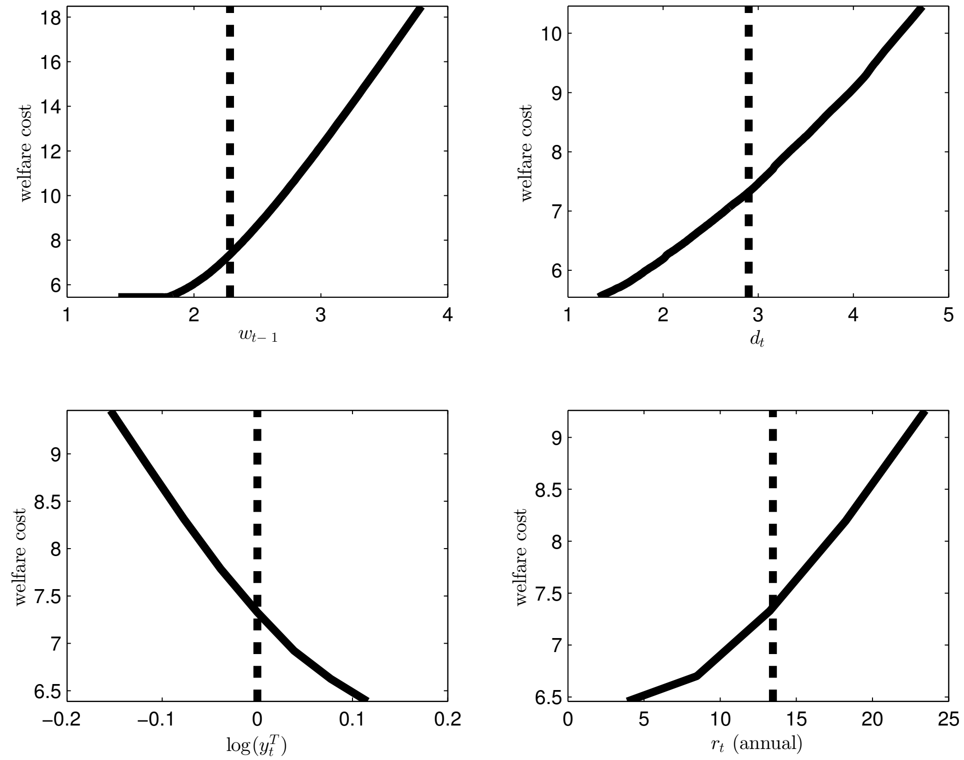
Probability Density Function of the Welfare Cost of Currency Pegs



Replication file plot_welf.m in usg_dnwr.zip.

Observation: The distribution of welfare costs of pegs is highly skewed to the right, suggesting the existence of initial states, (y_t^T, $r_t, d_t,\ w_{t-1}$), in which pegs are highly costly in terms of unemployment. The next slide identifies such states.

Welfare Cost of Currency Pegs and the Initial State



Note. In each plot, all states except the one shown on the horizontal axis are fixed at their unconditional mean values. The dashed vertical lines indicate the unconditional mean of the state displayed on the horizontal axis (under a currency peg if the state is endogenous). Replication file plot_welf.m in usg_dnwr.zip.

Observation: Currency pegs are more costly the higher the initial past wage, the higher the initial stock of external debt, the lower the initial endowment of tradables, and the higher the initial country interest rate.

Alternative Parameterizations and Model Specifications

- Varying the Degree of Wage Rigidity
- Symmetric Wage Rigidity
- Endogenous Labor Supply item Production in the Traded Sector
- Product Price Rigidity

Varying the Degree of Downward Wage Rigidity

Model	Welfare Cost Mean	Welfare Cost Median	Unempl. Rate
Baseline ($\gamma = 0.99$)	7.8	7.2	11.7
Lower Downward Wage Rigidity			
$\gamma = 0.98$	5.7	5.3	8.9
$\gamma = 0.97$	3.5	3.3	5.6
$\gamma = 0.96$	2.8	2.7	4.6
Higher Downward Wage Rigidity			
$\gamma = 0.995$	14.3	13.0	19.5

Observation: Sizable welfare costs and unemployment even for highly flexible wages, e.g., $\gamma = 0.96$. Recall, $\gamma = 0.96$ means that wages can fall frictionlessly by 16% per year.

Symmetric Wage Rigidity

Is more wage flexibility always welfare increasing?

Not always. We have just seen that the welfare costs of a currency peg increase as the degree of downward wage rigidity, γ, increases. So the answer here is Yes.

We now consider a different way of increasing wage rigidity, namely, bi-directional wage rigidity:

$$\frac{1}{\gamma} \geq \frac{W_t}{W_{t-1}} \geq \gamma$$

We will see that this increase in wage rigidity is welfare enhancing.

The Welfare Costs of Pegs: Symmetric Wage Rigidity

($\gamma = 0.99$)

	Welfare Cost Mean	Unempl. Rate
Downward only: $\frac{W_t}{W_{t-1}} \geq \gamma$	7.8	11.7
Upward and downward: $\frac{1}{\gamma} \geq \frac{W_t}{W_{t-1}} \geq \gamma$	3.3	5.2

• Welfare costs under symmetric rigidity, while still large, are half that under downward wage rigidity. Thus greater wage flexibility is welfare decreasing. Why? Symmetric wage rigidity alleviates the peg-induced externality (we saw this theoretically).

• To the extent that downward wage rigidity is the case of greatest empirical relevance, this result suggests that models with upward and downward wage rigidity underestimate the welfare costs of currency pegs.