# Fiscal Devaluations

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# Motivation

- **Currency devaluation**: response to loss of competitiveness
  - New relevance: crisis in the Euro Area ▸ Quotes
- **Fiscal devaluation**: *set of fiscal policies that lead to the same real outcomes but keeping exchange rate fixed*
  - Old idea (Keynes, 1931): *Uniform tariff cum export subsidy*
  - More recently: *VAT–payroll tax swap*
    - Cavallo and Cottani (2010), IMF Fiscal Monitor (2011)
  - No longer a theoretic curiosity:
    - Germany 2007, France 2012, discussed in Portugal, Spain

# What we do

- Formal analysis of fiscal devaluations
  - New Keynesian open economy model (DSGE)
  - conventional fiscal instruments
  - wage and price stickiness (in local or producer currency)
  - alternative asset market structures
    and currency-denomination of debt

- Example: optimal devaluation, nominal or fiscal

# What we do

- Formal analysis of fiscal devaluations
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  - — alternative asset market structures
    and currency-denomination of debt

- Example: optimal devaluation, nominal or fiscal

- Relate literature
  1. Partial equilibrium: Staiger and Sykes (2010), Berglas (1974)
  2. Fiscal implementation: Adao, Correia and Teles (2009) cf
  3. Quantitative studies of the VAT effects
  4. Taxes under sticky prices: Poterba, Rotemberg, Summers (1986)

# Main Findings

1. **Robust Policies**
   — *Small* set of *conventional* fiscal instruments suffices for exact equivalence across a variety of economic environments

2. **Simple Sufficient Statistic**
   — Size of tax adjustments depends only on the size of desired devaluation and is independent of details of environment

3. **Government Revenue Neutrality**
   — Exact if all tax instruments are used
   — Long-run; proportional to trade deficit in the short run

# Main Findings

1. Two **Fiscal Devaluation** policies:

   (FD′) Uniform increase in import tariff and export subsidy

   **OR**

   (FD″) Uniform increase in value-added tax (with border adjustment) and reduction in payroll tax

2. In general, (FD′) and (FD″) need to be complemented with a reduction in consumption tax and increase in income tax

   — may be dispensed with if devaluation is unanticipated

3. If debt denominated in home currency, equivalence requires partial default (forgiveness)

# Outline

1. Static (one-period) model
2. Full dynamic model
3. Optimal devaluation: an example
4. Implementation issues
   - non-zero initial taxes
   - differential short-run tax pass-through
   - non-uniform VAT and multiple variable inputs
   - labor mobility
   - quantitative assessment
   - the case of monetary union

# Static Model
## Setup I

- Two countries:
  - nominal or fiscal devaluation at Home
  - passive policy in Foreign

- Households:
  - Preferences:

$$U(C, N), \qquad C = C_H^{\gamma} C_F^{1-\gamma}, \quad \gamma \geq 1/2$$

  - Budget constraint

$$\frac{PC}{1+\varsigma^c} + M + T \leq \frac{WN}{1+\tau^n} + \frac{\Pi}{1+\tau^d} + B$$

  - Cash in advance:

$$\frac{PC}{1+\varsigma^c} \leq M$$

# Setup II

- Firms: $Y = AN$

$$\Pi = (1-\tau^v)P_H C_H + (1+\varsigma^x)\mathcal{E}P_H^* C_H^* - (1-\varsigma^p)WN$$

- Government: balanced budget

$$M + T + TR = 0,$$

$$TR = \left(\frac{\tau^n}{1+\tau^n}WN + \frac{\tau^d}{1+\tau^d}\Pi - \frac{\varsigma^c}{1+\varsigma^c}PC\right) + (\tau^v P_H C_H - \varsigma^p WN) + \left(\frac{\tau^v+\tau^m}{1+\tau^m}P_F C_F - \varsigma^x \mathcal{E}P_H^* C_H^*\right)$$

# Equilibrium relationships I

PCP case

1. International relative prices:

$$P_H^* = P_H \frac{1}{\mathcal{E}} \frac{1-\tau^v}{1+\varsigma^x}$$

$$P_F = P_F^* \mathcal{E} \frac{1+\tau^m}{1-\tau^v} \qquad \Rightarrow \qquad \mathcal{S} = \frac{P_F^*}{P_H^*} = \frac{P_F^*}{P_H} \mathcal{E} \frac{1+\varsigma^x}{1-\tau^v}$$

2. Wage and Price setting:

$$W = \bar{W}^{\theta_w} \left[ \mu_w \frac{1+\tau^n}{1+\varsigma^c} P C^\sigma N^\varphi \right]^{1-\theta_w},$$

$$P_H = \bar{P}_H^{\theta_p} \left[ \mu_p \frac{1-\varsigma^p}{1-\tau^v} \frac{W}{A} \right]^{1-\theta_p}$$

3. Demand — cash in advance:

$$PC \leq M(1+\varsigma^c)$$

# Equilibrium relationships II

4. Goods market clearing: $Y = C_H + C_H^*$

5. Exchange rate determination:

   - Budget constraint (allowing for partial default)

$$P^* C^* = P_F^* Y^* - \frac{1-\tau^h}{\mathcal{E}} B^h - B^{f*} \qquad \Rightarrow \qquad \mathcal{E} = \frac{\frac{1-\tau^v}{1+\tau^m} M(1+\varsigma^c) - \frac{1-\tau^h}{1-\gamma} B^h}{M^* + \frac{1}{1-\gamma} B^{f*}}$$

   - Perfect risk-sharing:

$$\left(\frac{C}{C^*}\right)^\sigma = \frac{P^* \mathcal{E}}{P/(1+\varsigma^c)} \equiv \mathcal{Q} \qquad \Rightarrow \qquad \mathcal{E} = \frac{M}{M^*} \mathcal{Q}^{\frac{\sigma-1}{\sigma}}$$

## Results I

### Proposition

*The following policies constitute a fiscal $\delta$-devaluation*

1. *under balanced trade or foreign-currency debt:*

$$\left.\begin{array}{ll} (\mathrm{FD}') & \tau^m = \varsigma^x = \delta \\ (\mathrm{FD}'') & \tau^v = \varsigma^p = \frac{\delta}{1+\delta} \end{array}\right] \quad \text{and} \quad \varsigma^c = \tau^n = \epsilon, \quad \frac{\Delta M}{M} = \frac{\delta - \epsilon}{1+\epsilon} \quad \forall \epsilon$$

2. *under home-currency debt supplement with partial default:*

$$\tau^h = \delta/1 + \delta$$

3. *under complete international risk-sharing need to set:*

$$\epsilon = \delta \qquad \text{and} \qquad \frac{\Delta M}{M} = -\frac{\sigma - 1}{\sigma}\frac{\Delta \mathcal{Q}}{\mathcal{Q}}$$

# Results II

4. Local currency pricing
   - Result: *Same as under PCP.*

— Law of one price does not hold ▸ details

$$P_H^* = \bar{P}_H^{*\theta_p} \left[ \mu_p \frac{1-\varsigma^p}{1+\varsigma^x} \frac{1}{\mathcal{E}} \frac{W}{A} \right]^{1-\theta_p}$$

— Real effects differ under PCP and LCP

# Results III

❺ Revenue neutrality

- Result: (FD$'$) *and* (FD$''$) *are fiscal revenue-neutral.*

- When $\varsigma^c = \tau^n = \epsilon$, revenue neutrality holds in the long run

$$TR = \left[\frac{\delta}{1+\delta} - \frac{\epsilon}{1+\epsilon}\right]\left(P_F C_F - (1+\delta)\mathcal{E}_0 P_H^* C_H^*\right)$$

- Fiscal surplus in periods of trade deficit

- Revenue neutrality is relative to the fiscal effect of a nominal devaluation

# Dynamic model

- Dynamic Calvo price and wage setting ▸ show
- Endogenous savings and portfolio decisions
- Dynamic (interest-elastic) money demand
- More general preferences

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- Dynamic Calvo price and wage setting ▸ show
- Endogenous savings and portfolio decisions
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- Definition: *Consider an equilibrium path of the economy with*

$$\mathcal{E}_t = \mathcal{E}_0(1+\delta_t), \qquad \text{given} \quad \{M_t\}.$$

*Fiscal $\{\delta_t\}$-devaluation is a sequence*

$$\{M_t', \tau_t^m, \varsigma_t^x, \tau_t^v, \varsigma_t^p, \varsigma_t^c, \tau_t^n, \tau_t^d\}$$

*that leads to the same real allocation, but with $\mathcal{E}_t' \equiv \mathcal{E}_0$.*

— Anticipated and unanticipated devaluations

# Three steps of the proof

1. Given $(C_t, C_t^*)$ and relative prices, the rest of the allocation is unchanged

2. Given $(C_t, C_t^*)$, for relative prices to be unchanged, we need:
   (i) for wages: $\varsigma_t^c \equiv \tau_t^n$
   (ii) for domestic price setting:

$$(1+\varsigma_t^c)(1-\tau_t^v)/(1+\tau_t^d) \equiv (1+\varsigma_t^c)(1-\varsigma_t^p)/(1+\tau_t^d) \equiv 1$$

   (iii) for international price setting:

$$(1+\tau_t^m)/(1-\tau_t^v) \equiv (1+\varsigma_t^x)/(1-\tau_t^v) \equiv 1+\delta_t$$

3. For $(C_t, C_t^*)$ to be unchanged, we need unchanged:
   (i) terms of trade and deviations from law of one price
   (ii) real exchange rate
   (iii) real payoffs of assets

# Two Key Equations

- Flow budget constraint of a country:

$$\sum_{j\in\Omega_t} \frac{Q_t^{j*}}{P_t^*} B_{t+1}^j - \sum_{j\in\Omega_{t-1}} \frac{Q_t^{j*} + D_t^{j*}}{P_t^*} B_t^j = \frac{P_{Ht}^*}{P_t^*}\left[C_{Ht}^* - C_{Ft}\mathcal{S}_t\right],$$

where $C_{Ht}^* = (P_{Ht}^*/P_t^*)^{-\zeta} C_t^*$ and $C_{Ft} = (P_{Ft}/P_t)^{-\zeta} C_t$

- International risk sharing condition:

$$\mathbb{E}_t \left\{ \frac{Q_{t+1}^{j*} + D_{t+1}^{j*}}{Q_t^{j*}} \frac{P_t^*}{P_{t+1}^*} \left[ \left(\frac{C_{t+1}}{C_t}\right)^{-\sigma} \frac{\mathcal{Q}_{t+1}}{\mathcal{Q}_t} - \left(\frac{C_{t+1}^*}{C_t^*}\right)^{-\sigma} \right] \right\} = 0 \quad \forall j \in \Omega_t$$

- where Terms of Trade and Real Exchange Rate are:

$$\mathcal{S}_t = \frac{P_{Ft}}{P_{Ht}^*} \frac{1}{\mathcal{E}_t} \frac{1-\tau_t^v}{1+\tau_t^m} \qquad \text{and} \qquad \mathcal{Q}_t = \frac{P_t^* \mathcal{E}_t}{P_t/(1+\varsigma_t^c)}$$

# Result I
## Complete markets

### Proposition

*A fiscal $\{\delta_t\}$-devaluation in a dynamic PCP or LCP economy with complete markets:*

$$\left.\begin{array}{ll}\text{(FDD}'\text{)} & \tau_t^m = \varsigma_t^x = \tau_t^d = \delta_t \\ \text{(FDD}''\text{)} & \tau_t^v = \varsigma_t^p = \frac{\delta_t}{1+\delta_t},\ \tau_t^d = 0\end{array}\right] \quad \textit{and} \quad \varsigma_t^c = \tau_t^n = \delta_t,$$

*and a suitable choice of $\{M_t'\}$.*

— analogous to static economy: terms of trade, RER

— interest-elastic money demand: no additional tax instruments

$$\chi C_t^\sigma \left(\frac{M_t(1+\varsigma_t^c)}{P_t}\right)^{-\nu} = \frac{i_{t+1}}{1+i_{t+1}}$$

# Results II
## Incomplete markets

1. Foreign-currency risk-free bond:
   - Home country budget constraint:

$$Q_t^* B_{t+1}^f - B_t^f = \left[ P_{Ht}^* C_{Ht}^* - P_{Ft} C_{Ft} \frac{1}{\mathcal{E}_t} \frac{1-\tau_t^v}{1+\tau_t^m} \right]$$

   - The optimal risk sharing condition

$$Q_t^* = \beta \mathbb{E}_t \left\{ \left( \frac{C_{t+1}^*}{C_t^*} \right)^{-\sigma} \frac{P_t^*}{P_{t+1}^*} \right\} = \beta \mathbb{E}_t \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \frac{(1+\varsigma_{t+1}^c)\mathcal{E}_{t+1}}{(1+\varsigma_t^c)\mathcal{E}_t} \right\}$$

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- Same proposition applies: (FDD′) and (FDD″)
  — dynamic savings decision

2. Same for international trade in equities ▸ show

3. Home-currency bond: additionally requires partial default

$$1 - d_t = (1+\delta_{t-1})/(1+\delta_t)$$

# Results III
## Unanticipated devaluation

### Proposition

*A one-time unanticipated fiscal $\delta$-devaluation in an incomplete markets economy:*

$$\left.\begin{array}{ll} \text{(FDR}'\text{)} & \tau_t^m = \varsigma_t^x = \tau_t^d = \delta \\ \text{(FDR}''\text{)} & \tau_t^v = \varsigma_t^p = \frac{\delta}{1+\delta}, \quad \tau_t^d = 0 \end{array}\right] \quad \textit{and} \quad M_t' \equiv M_t,$$

*together with a one-time partial default (haircut) $\tau^h = \delta/(1+\delta)$ on home-currency debt.*

- No consumption subsidy needed
- Applies to risk-free-bond and international-equity economies
- Generalization of revenue neutrality:

$$TR_t = -\frac{\delta_t}{1+\delta_t} NX_t + \frac{\delta_t}{1+\tau_t^d} \Pi_t$$

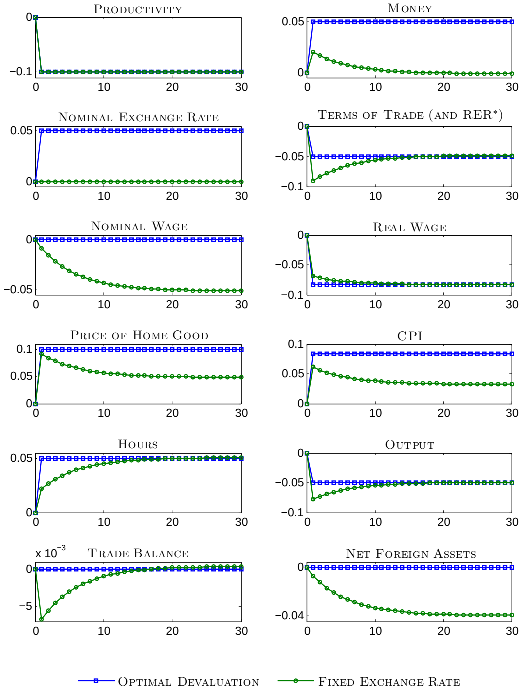
## Optimal Devaluation

### Setup

- Small open economy
- Flexible prices, sticky wages
- Permanent unexpected negative productivity shock
- Nominal devaluation is optimal
- Fiscal devaluation requires no consumption subsidy (VAT+payroll or tariff+subsidy)

- Parameters:

$$\beta = 0.99, \quad \theta_w = 0.75, \quad \gamma = 2/3, \quad \sigma = 4, \quad \varphi = \kappa = 1, \quad \eta = 3$$


Productivity
Money
Nominal Exchange Rate
Terms of Trade (and RER*)
Nominal Wage
Real Wage
Price of Home Good
CPI
Hours
Output
Trade Balance
x 10⁻³
Net Foreign Assets
Optimal Devaluation
Fixed Exchange Rate

# Implementation

1. Non-uniform VAT (e.g., non-tradables)
   - match payroll subsidy
2. Multiple variable inputs (e.g., capital)
   - uniform subsidy
   - Model w/capital
3. Tax pass-through assumptions: equivalence of
   - VAT and exchange rate pass-through into foreign prices
   - VAT and payroll tax pass-through into domestic prices
   - Generalization
4. Non-zero initial tax: $\tau_t^v = \dfrac{\bar{\tau}_0^v + \delta_t}{1 + \delta_t}$
5. Quantitative investigation show

# Implementation in a Monetary Union

- Coordination with union central bank:
  - Union-wide money supply:

$$\bar{M}_t = M_t + M_t^*$$

    — $M_t / M_t^*$ is endogenous

  - Division of seigniorage between members:

$$\Delta \bar{M}_t = \Omega_t + \Omega_t^*$$

- Special cases: unilateral fiscal adjustment suffices
  — seigniorage is small ($\Delta \bar{M}_t \to 0$)
  — devaluing country is small ($\Delta \bar{M}_t / \bar{M}_t \to 0$)

# Summary

- Two robust FD policies:
  - — uniform import tariff and export subsidy, OR
  - — uniform increase in VAT and reduction in payroll tax

- Unanticipated devaluation: no additional instruments.
  Overall, *small* set of *conventional* fiscal instruments

- Require minimal information: size of desired devaluation $\delta$

- Robust in particular to:
  - — price and wage setting
  - — asset market structure

- Revenue-neutrality

- Sidesteps the trilemma in international macro

# Quotes

- Popular arguments for abandoning Euro and devaluation:
  - Feldstein (FT 02/2010):

    *If Greece still had its own currency, it could, in parallel, devalue the drachma to reduce imports and raise exports... The rest of the eurozone could allow Greece to take a temporary leave of absence with the right and the obligation to return at a more competitive exchange rate.*

  - Krugman (NYT): *Why devalue? The Euro Trap, Pain in Spain*

    *Now, if Greece had its own currency, it could try to offset this contraction with an expansionary monetary policy – including a devaluation to gain export competitiveness. As long as its in the euro, however, Greece can do nothing to limit the macroeconomic costs of fiscal contraction.*

  - Roubini (FT 06/2011): *The Eurozone Heads for Break Up*

    *...there is really only one other way to restore competitiveness and growth on the periphery: leave the euro, go back to national currencies and achieve a massive nominal and real depreciation.*

- Keynes (1931) in the context of Gold standard

  *Precisely the same effects as those produced by a devaluation of sterling by a given percentage could be brought about by a tariff of the same percentage on all imports together with an equal subsidy on all exports, except that this measure would leave sterling international obligations unchanged in terms of gold.*

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# Related Literature

## Comparison to ACT (Adao, Correia and Teles, JET, 2009)

| | ACT (2009) | FGI (2011) | |
|---|---|---|---|
| **Allocation** | Flexible-price (first best) | Nominal devaluation | — one-time unexpected |
| **Implementation** | General non-constructive fiscal implementation principle | Specific implementation: — simplicity, robustness, feasibility | |
| **Environment** | | | |
| – Nominal frictions | Sticky prices (PCP or LCP) | Sticky prices (PCP and LCP) and sticky wages | |
| – Int'l asset markets | Risk-free nominal bonds | Arbitrary degree of completeness | Arbitrary incomplete markets |
| **Instruments** | Separate consumption taxes by origin of the good and income taxes in both countries; additional instruments in other cases | VAT, payroll, consumption and income tax in one country | VAT and payroll tax only in one country |
| **Implementability** | | | |
| – Analytical characterization of taxes | No | Yes, simple characterization and expressions | |
| – Int'l coordination of taxes | Yes | No, unilateral policy | |
| – Tax dependence on microenvironment | In general, yes | No, robust to any changes in environment | |
| – Tax dynamics | In general, complex dynamic path | Path of taxes follows the path of devaluation | Only one-time tax change |

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# Local currency pricing

- Law of one price does not hold
- Price setting in consumer currency

$$P_H^* = \bar{P}_H^{*\theta_p} \left[ \mu_p \frac{1-\varsigma^p}{1+\varsigma^x} \frac{1}{\mathcal{E}} \frac{W}{A} \right]^{1-\theta_p},$$

$$P_F = \bar{P}_F^{\theta_p} \left[ \mu_p \frac{1+\tau^m}{1-\tau^v} \mathcal{E} \frac{W^*}{A^*} \right]^{1-\theta_p}$$

- Terms of trade appreciates

$$\mathcal{S} = \frac{P_F}{P_H^*} \frac{1}{\mathcal{E}} \frac{1-\tau^v}{1+\tau^m}$$

- Foreign firm profit margins decline

$$\Pi^* = P_F^* C_F^* + P_F C_F \frac{1}{\mathcal{E}} \frac{1-\tau^v}{1+\tau^m} - W^* N^*$$

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# Price setting

$$\bar{P}_{Ht}(i) = \frac{\mathbb{E}_t \sum_{s\geq t} (\beta\theta_p)^{s-t} C_s^{-\sigma} P_s^{-1} P_{Hs}^{\rho} Y_s \frac{\rho}{\rho-1} \frac{(1+\varsigma_s^c)(1-\varsigma_s^p)}{1+\tau_s^d} W_s/A_s(i)}{\mathbb{E}_t \sum_{s\geq t} (\beta\theta_p)^{s-t} C_s^{-\sigma} P_s^{-1} \frac{(1+\varsigma_s^c)(1-\tau_s^v)}{1+\tau_s^d}},$$

- Under (FDD″), $(1+\varsigma_s^c)(1-\tau_s^v) = (1+\varsigma_s^c)(1-\varsigma_s^p) = 1$, therefore the reset price $\bar{P}_{Ht}$ stays the same, and hence so does $P_{Ht}$
- (FDD′) additionally requires compensating with $\tau_s^d = \delta_t$, unless devaluation is unanticipated

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# International trade in equities

- Budget constraint

$$\frac{P_t C_t}{1+\varsigma_t^c} + M_t + (\omega_{t+1} - \omega_t)\,\mathbb{E}_t\left\{\Theta_{t+1} V_{t+1}\right\} - (\omega_{t+1}^* - \omega_t^*)\,\mathbb{E}_t\left\{\Theta_{t+1}\mathcal{E}_{t+1} V_{t+1}^*\right\}$$
$$\leq \frac{W_t N_t}{1+\tau_t^n} + \omega_t \frac{\Pi_t}{1+\tau_t^d} + (1-\omega_t^*)\mathcal{E}_t \Pi_t^* + M_{t-1} - T_t,$$

- Value of the firm:

$$V_t = \mathbb{E}_t \sum_{s=t}^{\infty} \Theta_{t,s} \frac{\Pi_s}{1+\tau_s^d}, \qquad \Theta_{t,s} = \prod_{\ell=t+1}^{s} \Theta_\ell,\ \Theta_\ell = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\sigma} \frac{P_t}{P_{t+1}} \frac{1+\varsigma_{t+1}^c}{1+\varsigma_t^c},$$

$$V_t^* = \mathbb{E}_t \sum_{s=t}^{\infty} \Theta_{t,s}^* \Pi_s^*$$

- Risk-sharing conditions

$$\mathbb{E}_t \sum_{s=t}^{\infty} \left(\Theta_{t,s} - \Theta_{t,s}^* \frac{\mathcal{E}_t}{\mathcal{E}_s}\right) \frac{\Pi_s}{1+\tau_s^d} = 0 \quad \text{and} \quad \mathbb{E}_t \sum_{s=t}^{\infty} \left(\Theta_{t,s} \frac{\mathcal{E}_s}{\mathcal{E}_t} - \Theta_{t,s}^*\right) \Pi_s^* = 0.$$

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# Home-currency Bond

- Partial defaults on home-currency bonds: contingent sequence $\{d_t\}$
- The international risk sharing condition becomes

$$
\begin{aligned}
Q_t &= \beta \mathbb{E}_t \left\{ \left( \frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \frac{P^*_t \mathcal{E}_t}{P^*_{t+1} \mathcal{E}_{t+1}} (1 - d_{t+1}) \right\} \\
&= \beta \mathbb{E}_t \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \frac{1 + \varsigma^c_{t+1}}{1 + \varsigma^c_t} (1 - d_{t+1}) \right\},
\end{aligned}
$$

- Country budget constraint can now be written as

$$
Q_t \frac{1}{\mathcal{E}_t} B^h_{t+1} - (1 - d_t) \frac{\mathcal{E}_{t-1}}{\mathcal{E}_t} \frac{1}{\mathcal{E}_{t-1}} B^h_t = (1-\gamma) \left[ P^*_t C^*_t - P_t C_t \frac{1}{\mathcal{E}_t} \frac{1 - \tau^v_t}{1 + \tau^m_t} \right]
$$

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# Model with capital

- Choice of capital input by firms:

$$\frac{N_t}{K_t} = \frac{\alpha}{1-\alpha}\frac{(1-\varsigma_t^R)}{(1-\varsigma_t^p)}\frac{R_t}{W_t}$$

- Choice of capital investment by households:

$$U_{c,t}\frac{(1+\varsigma_t^c)}{(1+\varsigma_t^I)} = \beta\mathbb{E}_t U_{c,t+1}\left[\frac{R_{t+1}}{P_{t+1}}\frac{(1+\varsigma_{t+1}^c)}{(1+\tau_{t+1}^K)} + (1-\delta)\frac{(1+\varsigma_{t+1}^c)}{(1+\varsigma_{t+1}^I)}\right]$$

- Results:
  1. When consumption subsidy $\varsigma_t^c$ is not used, only capital expenditure subsidy to firms $\varsigma_t^R$ is required (parallel to payroll subsidy). All variable inputs should be subsidized uniformly
  2. Otherwise, investment subsidy and capital income tax need to be used in addition:

$$\varsigma_t^I = \tau_t^K = \varsigma_t^c = \delta_t$$

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# Pass-through of VAT and payroll tax

- Static model with differential pass-through $\xi_p > \xi_\tau$:

$$P_H = \left[\bar{P}_H \cdot \frac{(1-\varsigma^p)^{\xi_p}}{(1-\tau^v)^{\xi_\tau}}\right]^{\theta_p} \left[\mu_p \frac{1-\varsigma^p}{1-\tau^v} \frac{W}{A}\right]^{1-\theta_p}$$

## Proposition

*Fiscal devaluation is as characterized in Results I-III, but with payroll subsidy given by*

$$\varsigma^p = 1 - \left(\frac{1}{1+\delta}\right)^{\frac{\xi_v \theta_p + 1 - \theta_p}{\xi_p \theta_p + 1 - \theta_p}}.$$

— still $\tau^v = \delta/(1+\delta)$, to mimic international relative prices

— $\xi_v > \xi_p$ implies $\varsigma^p > \tau^v = \delta/(1+\delta)$

— as $\theta_p$ decreases towards 0, $\varsigma^p$ decreases towards $\delta/(1+\delta)$

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# Quantitative investigation

## Source: Gopinath and Wang (2011)

| | Germany | Spain | Portugal | Italy | Greece |
|---|---|---|---|---|---|
| Taxes | | | | | |
| — VAT | 13% | 7% | 11% | 9% | 8% |
| — payroll contributions | 14% | 18% | 9% | 24% | 12% |
| — including employee's SSC | 27% | 22% | 16% | 29% | 22% |
| % change, 1995-2010 | | | | | |
| – wages | 25% | 61% | 64% | 39% | 127% |
| – productivity | 17% | 19% | 28% | 3% | 42% |
| Required devaluation* | | 34% | 28% | 28% | 77% |
| Maximal fiscal devaluation** | | 23% | 11% | 32% | 14% |
| — with German fiscal revaluation | | 38% | 26% | 47% | 29% |
| — additionally reducing employee's SSC | | 43% | 34% | 56% | 43% |

- Required devaluation brings unit labor cost $(W_t/A_t)$ relative to Germany to its 1995 ratio
- Maximal fiscal devaluation is constrained by zero lower bound on payroll contributions and 45% maximal VAT rate (which is never binding). A reduction of $x$ in payroll tax and similar increase in VAT is equivalent to a $x/(1-x)$ devaluation
- Maximal German revaluation is an additional decrease in German VAT of 13% and a similar increase in German payroll tax, equivalent to an additional 15% devaluation against Germany

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