Fiscal Devaluations

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Motivation

• **Currency devaluation**: response to loss of competitiveness
  — New relevance: crisis in the Euro Area

• **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*
  - 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

• Numerical example: approximate fiscal devaluations
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

• Numerical example: approximate fiscal devaluations

• Relate literature
  3. Quantitative studies of the VAT effects
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. Numerical 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:**
    \[ U(C, N), \quad C = C_H^{\gamma} C_F^{1-\gamma}, \quad \gamma \geq 1/2 \]
  - **Budget constraint**
    \[ \frac{PC}{1 + \zeta^c} + M + T \leq \frac{WN}{1 + \tau^n} + \frac{\Pi}{1 + \tau^d} + B \]
  - **Cash in advance:**
    \[ \frac{PC}{1 + \zeta^c} \leq M \]
Setup II

**Firms:** \( Y = AN \)

\[
\Pi = (1 - \tau^v) P_H C_H + (1 + \varsigma^x) \varepsilon P_H^* C_H^* - (1 - \varsigma^p) WN
\]

**Government:** balanced budget

\[
M + T + TR = 0,
\]

\[
TR = \left( \frac{\tau^n}{1 + \tau^n} WN + \frac{\tau^d}{1 + \tau^d} \Pi - \frac{\varsigma^c}{1 + \varsigma^c} PC \right)
\]

\[
+ (\tau^v P_H C_H - \varsigma^p WN) + \left( \frac{\tau^v + \tau^m}{1 + \tau^m} P_F C_F - \varsigma^x \varepsilon P_H^* C_H^* \right)
\]
Equilibrium relationships I

PCP case

1 International relative prices:

\[ P^*_H = P_H \frac{1}{\mathcal{E}} \frac{1 - \tau^v}{1 + \varsigma^x} \]

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

2 Wage and Price setting:

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

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

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)

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

- Perfect risk-sharing:

\[
\left( \frac{C}{C^*} \right)^\sigma = \frac{P^* \mathcal{E}}{P/(1 + \varsigma^c)} \equiv Q \implies \mathcal{E} = \frac{M}{M^* Q^{\sigma - 1} / \sigma}
\]
Results I

Proposition

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

1. under balanced trade or foreign-currency debt:

\[
\begin{align*}
(FD') \quad \tau^m &= \xi^x = \delta \\
(FD'') \quad \tau^v &= \xi^p = \frac{\delta}{1+\delta}
\end{align*}
\]

and $\zeta^c = \tau^n = \epsilon$, $\frac{\Delta M}{M} = \frac{\delta - \epsilon}{1 + \epsilon}$, $\forall \epsilon$

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

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

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

$\epsilon = \delta$ and $\frac{\Delta M}{M} = -\frac{\sigma - 1}{\sigma} \frac{\Delta Q}{Q}$
Local currency pricing

- Result: *Same as under PCP.*

- Law of one price does not hold

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

- Real effects differ under PCP and LCP
Revenue neutrality

- Result: \((\text{FD}')\) and \((\text{FD}'')\) are fiscal revenue-neutral.

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

\[
TR = \left[ \frac{\delta}{1 + \delta} - \frac{\epsilon}{1 + \epsilon} \right] \left( PC - WN \right) = -NX + \Pi
\]

- 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
- Endogenous savings and portfolio decisions
- Dynamic (interest-elastic) money demand
- More general preferences
Dynamic model

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

Definition: Consider an equilibrium path of the economy with
\[ \mathcal{E}_t = \mathcal{E}_0(1 + \delta_t), \]
given \( \{M_t\} \).

Fiscal \( \{\delta_t\}\)-devaluation is a sequence
\[ \{M_t', \tau_t^m, \zeta_t^x, \tau_t^v, \zeta_t^p, \zeta_t^c, \tau_t^n, \tau_t^d\} \]
that leads to the same real allocation, but with \( \mathcal{E}'_t \equiv \mathcal{E}_0 \).

- Anticipated and unanticipated devaluations
Two Key Dynamic Equations

- Flow budget constraint of a country:
  \[
  \sum_{j \in \Omega_t} \frac{Q^j_t}{P^*_t} B^j_{t+1} - \sum_{j \in \Omega_{t-1}} \frac{Q^j_t + D^j_t}{P^*_t} B^j = \frac{P^*_{Ht}}{P^*_t} \left[ C^*_t - C_{Ft} S_t \right],
  \]

- International risk sharing condition:
  \[
  \mathbb{E}_t \left\{ \frac{Q^j_{t+1} + D^j_{t+1}}{Q^j_t} \frac{P^*_t}{P^*_{t+1}} \left[ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{Q_{t+1}}{Q_t} - \left( \frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \right] \right\} = 0 \quad \forall j \in \Omega_t
  \]

- Terms of Trade and Real Exchange Rate:
  \[
  S_t = \frac{P_{Ft}}{P^*_{Ht}} \frac{1}{\mathcal{E}_t} \frac{1 - \tau^V_t}{1 + \tau^m_t} \quad \text{and} \quad Q_t = \frac{P^*_t \mathcal{E}_t}{P_t/(1 + \zeta^c_t)}
  \]
Result 1
Complete markets

Proposition

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

\[
\begin{align*}
(FDD') & \quad \tau^m_t = \zeta^x_t = \tau^d_t = \delta_t \\
(FDD'') & \quad \tau^v_t = \zeta^p_t = \frac{\delta_t}{1+\delta_t}, \quad \tau^d_t = 0
\end{align*}
\]

and a suitable choice of \( \{ M'_t \} \).

— analogous to static economy: terms of trade, RER
— interest-elastic money demand: no additional tax instruments

\[
\chi C^\sigma_t \left( \frac{M_t (1 + \zeta^c_t)}{P_t} \right)^{-\nu} = \frac{i_{t+1}}{1 + i_{t+1}}
\]
Results II
Incomplete markets

1. Foreign-currency risk-free bond:

   — Home country budget constraint:

   \[ Q^*_t B^f_{t+1} - B^f_t = \left[ P^*_H^C H^C_t - P^*_F^C F^C_t + \frac{1}{E^t} \left( 1 - \tau^v_t \right) \frac{1}{1 + \tau^m_t} \right] \]

   — The optimal risk sharing condition

   \[ Q^*_t = \beta E^t \left( \frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \frac{P^*_t}{P^*_t} = \beta E^t \left( \frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \frac{(1 + \varsigma^c_{t+1})E^t_{t+1}}{(1 + \varsigma^c_t)E^t_t} \]

Same proposition applies: \((FDD')\) and \((FDD'')\)

2. Same for international trade in equities

Home-currency bond: additionally requires partial default

\[ d_t = \frac{(1 + \delta_t - 1)}{(1 + \delta_t)} \]
Results II
Incomplete markets

1. Foreign-currency risk-free bond:
   - Home country budget constraint:
     \[ Q^*_t B^f_{t+1} - B^f_t = \left( P_{Ht}^* C_{Ht}^* - P_{Ft} C_{Ft} \right) \frac{1}{\mathcal{E}_t} \frac{1 - \tau^y_t}{1 + \tau^m_t} \]
     - The optimal risk sharing condition
     \[ Q^*_t = \beta \mathbb{E}_t \left\{ \left( \frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \frac{P^*_t}{P^*_{t+1}} \right\} = \beta \mathbb{E}_t \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \frac{(1 + \varsigma^c_{t+1}) \mathcal{E}_{t+1}}{(1 + \varsigma^c_t) \mathcal{E}_t} \right\} \]
   - Same proposition applies: (FDD') and (FDD'')
     - dynamic savings decision

2. Same for international trade in equities

3. Home-currency bond: additionally requires partial default
   \[ 1 - d_t = \frac{(1 + \delta_{t-1} / (1 + \delta_t)} \]

•
Results III
Unanticipated devaluation

Proposition

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

\[
\begin{align*}
(FDR') & \quad \tau_t^m = \zeta_t^x = \tau_t^d = \delta \\
(FDR'') & \quad \tau_t^v = \zeta_t^p = \frac{\delta}{1+\delta}, \quad \tau_t^d = 0
\end{align*}
\]

and $M'_t \equiv M_t$, 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:

\[
TR_t = -\frac{\delta_t}{1+\delta_t} NX_t + \frac{\delta_t}{1+\tau_t^d} \Pi_t
\]
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:  \( \tau^v_t = \frac{\bar{\tau}^v_0 + \delta_t}{1 + \delta_t} \)

5. Quantitative investigation
Implementation in a Monetary Union

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

  \[ \tilde{M}_t = M_t + M^*_t \]

  — \( M_t/M^*_t \) is endogenous

  ○ Division of seigniorage between members:

  \[ \Delta \tilde{M}_t = \Omega_t + \Omega^*_t \]

• Special cases: unilateral fiscal adjustment suffices
  
  — seigniorage is small (\( \Delta \tilde{M}_t \rightarrow 0 \))
  
  — devaluing country is small (\( \Delta \tilde{M}_t/\tilde{M}_t \rightarrow 0 \))
Numerical example

Setup

- Small open economy calibrated to Spain
- With nominal friction: wage stickiness
- With capital and adjustment cost
- Initial distortionary taxes (as in Spain)
- Money-in-the-utility to match M1 or M2-to-GDP ratio
- Initial debt-to-GDP of 87%
- Shock to country risk premium to generate the 2008 recession:
  \[ i_{t+1} = i^* + \psi(e^{B^* - B_{t+1}} - 1) + \varepsilon_t, \quad \varepsilon_t \sim AR(1) \]

- Scenarios:
  - Flexible wages
  - Sticky wages, no policy intervention
  - 10% fiscal devaluation (one-time unanticipated)
  - Various incomplete fiscal devaluations
Figure 1: Impulse response to an interest rate shock

In the short run, as opposed to decreasing as in the flexible price case, the combined effect is a 4.5% drop in labor, a 4% decline in output and an increase in the employment of labor relative to capital. The direction of movement of labor and output differs both qualitatively and quantitatively from the flexible price case.

It is useful to compare the sticky wage outcome to papers that have used interest rate shocks but with flexible prices. For instance, Neumeyer and Perri (2005) highlight the importance of attenuating wealth effects on labor supply to generate a negative comovement between interest rates and output. Further,
## Incomplete fiscal devaluations

<table>
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<tr>
<th>Loss relative to no shock</th>
<th>Permanent</th>
<th>10 quarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sticky wages, no intervention</td>
<td>−0.64%</td>
<td>−3.65%</td>
</tr>
<tr>
<td>Flexible wages</td>
<td>−0.47%</td>
<td>−2.66%</td>
</tr>
<tr>
<td>10% one-time devaluation</td>
<td>−0.45%</td>
<td>−2.55%</td>
</tr>
</tbody>
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<thead>
<tr>
<th>Of this gap</th>
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</thead>
<tbody>
<tr>
<td>10% fiscal devaluation</td>
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<tr>
<td>5% fiscal devaluation</td>
</tr>
<tr>
<td>Fiscal devaluation w/out capital subsidy</td>
</tr>
<tr>
<td>Anticipated fiscal devaluation</td>
</tr>
<tr>
<td>No seigniorage transfer</td>
</tr>
</tbody>
</table>
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
• 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.
## Related Literature

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

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<tr>
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<th>ACT (2009)</th>
<th>FGI (2011)</th>
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<td><strong>Allocation</strong></td>
<td>Flexible-price (first best)</td>
<td>Nominal devaluation</td>
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<tr>
<td><strong>Implementation</strong></td>
<td>General non-constructive fiscal implementation principle</td>
<td>Specific implementation:</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Sticky prices (PCP or LCP)</td>
<td>Sticky prices (PCP and LCP) and sticky wages</td>
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<tr>
<td></td>
<td>Risk-free nominal bonds</td>
<td></td>
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<tr>
<td><strong>Instruments</strong></td>
<td>Separate consumption taxes by origin of the good and income and additional instruments in other cases</td>
<td>VAT, payroll, consumption and income tax in one country</td>
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<tr>
<td><strong>Implementability</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>No, unilateral policy</td>
</tr>
<tr>
<td></td>
<td>In general, yes</td>
<td>In general, complex dynamic path</td>
</tr>
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<td></td>
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Local currency pricing

- Law of one price does not hold

- Price setting in consumer currency

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

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

- Terms of trade appreciates

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

- Foreign firm profit margins decline

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

\[ \hat{P}_{Ht}(i) = \frac{E_t \sum_{s \geq t} (\beta \theta_p)^{s-t} C_s^{-\sigma} P_s^{-1} \rho P_{Hs} Y_s \frac{\rho}{1+\tau_d^s} \frac{(1+\zeta_s^c)(1-\zeta_s^p)}{1+\zeta_s^c} W_s/A_s(i)}{E_t \sum_{s \geq t} (\beta \theta_p)^{s-t} C_s^{-\sigma} P_s^{-1} \frac{(1+\zeta_s^c)(1-\tau_s^d)}{1+\tau_d^s}}, \]

- Under (FDD''), \((1 + \zeta_s^c)(1 - \tau_s^d) = (1 + \zeta_s^c)(1 - \zeta_s^p) = 1\), therefore the reset price \(\hat{P}_{Ht}\) stays the same, and hence so does \(P_{Ht}\).

- (FDD') additionally requires compensating with \(\tau_s^d = \delta_t\), unless devaluation is unanticipated.
International trade in equities

• Budget constraint

\[
\frac{P_t C_t}{1 + \varsigma_t} + M_t + (\omega_{t+1} - \omega_t) \mathbb{E}_t \{\Theta_{t+1} V_{t+1}\} - (\omega_{t+1}^* - \omega_t^*) \mathbb{E}_t \{\Theta_{t+1} \epsilon_{t+1} V_{t+1}^*\} \\
\leq \frac{W_t N_t}{1 + \tau_t} + \omega_t \frac{\Pi_t}{1 + \tau_t^d} + (1 - \omega_t^*) \epsilon_t \Pi_t^* + M_{t-1} - T_t,
\]

• Value of the firm:

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

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

• Risk-sharing conditions

\[
\mathbb{E}_t \sum_{s=t}^{\infty} \left(\Theta_{t,s} - \Theta_{t,s}^* \frac{\epsilon_t}{\epsilon_s}\right) \frac{\Pi_s}{1 + \tau_s^d} = 0 \quad \text{and} \quad \mathbb{E}_t \sum_{s=t}^{\infty} \left(\Theta_{t,s} \frac{\epsilon_s}{\epsilon_t} - \Theta_{t,s}^*\right) \Pi_s^* = 0.
\]
Home-currency Bond

- Partial defaults on home-currency bonds: contingent sequence \( \{d_t\} \)

- The international risk sharing condition becomes

\[
Q_t = \beta \mathbb{E}_t \left\{ \left( \frac{C_{t+1}}{C^*_t} \right)^{-\sigma} \frac{P_t^* \mathcal{E}_t}{P_{t+1}^* \mathcal{E}_{t+1}} \left(1 - d_{t+1}\right) \right\}
\]

\[
= \beta \mathbb{E}_t \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \frac{1 + \varsigma^{c}_{t+1}}{1 + \varsigma^{c}_{t}} \left(1 - d_{t+1}\right) \right\},
\]

- Country budget constraint can now be written as

\[
Q_t \frac{1}{\mathcal{E}_t} B^h_{t+1} - (1 - d_t) \frac{\mathcal{E}_{t-1}}{\mathcal{E}_t} \frac{1}{\mathcal{E}_{t-1}} B^h_t = (1 - \gamma) \left[ P_t^* C^*_t - P_t C_t \frac{1}{\mathcal{E}_t} \frac{1 - \tau_t^{\gamma}}{1 + \tau_t^{m}} \right]
\]
Model with capital

• Choice of capital input by firms:

\[
\frac{N_t}{K_t} = \frac{\alpha}{1 - \alpha} \left( 1 - \xi_t^R \right) \frac{R_t}{1 - \xi_t^p} \frac{W_t}{1 - \xi_t^W}
\]

• Choice of capital investment by households:

\[
U_{c,t} \left( 1 + \xi_{c,t+1} \right) = \beta \mathbb{E}_{t} U_{c,t+1} \left[ \frac{R_{t+1}}{P_{t+1}} \left( 1 + \xi_{c,t+1} \right) \left( 1 + \tau_{t+1}^K \right) + (1 - \delta) \left( 1 + \xi_{c,t+1} \right) \left( 1 + \tau_{t+1}^l \right) \right]
\]

• Results:

1 When consumption subsidy \( \xi_{c,t} \) is not used, only capital expenditure subsidy to firms \( \xi_t^R \) 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:

\[
\xi_t^l = \tau_t^K = \xi_t^c = \delta_t
\]
Pass-through of VAT and payroll tax

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

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

Proposition

_Fiscal devaluation is as characterized in Results I-III, but with payroll subsidy given by_

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

- 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 $\delta/(1 + \delta)$
Quantitative investigation
Source: Gopinath and Wang (2011)

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

- 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