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slides

chapter 10

fixed exchange rates,

taxes, and capital controls

Motivating Fiscal Policy in Open Economies

• Chapter 9 shows that the combination of a currency peg and downward nominal wage rigidity creates downward real wage rigidity.

• The aforementioned real wage rigidity creates an externality, known as the *peg-induced externality*: during booms, the real wage increases, placing the economy in a vulnerable situation, because when the boom is over, the real wage is stuck at too high a level to clear the labor market, creating involuntary unemployment.

• The peg-induced externality opens the door to welfare increasing government policy. In chapter 9, we studied the most obvious one, namely, the optimal currency float. But some countries lack the ability to conduct exchange-rate policy. Examples are countries that belong to currency unions, like the eurozone, and countries that unilaterally adopted dollarization, like Ecuador and El Salvador.

• This motivates the analysis of fiscal policy to address the peg-induced externality. This chapter is devoted to this task.

Road Map of the Chapter

- It begins by recalling the equilibrium under a currency peg.

- It then characterizes a number of fiscal schemes that can achieve the first-best allocation: labor subsidies, sales subsidies, and consumption subsidies.

- Next, it studies the role of capital controls. It analyzes the question of whether optimal capital control policy is macroprudential in the cyclical sense.

- It then studies the welfare consequences of optimal capital control policy in the context of a quantitative model

- The analysis in this chapter provides a general framework for understanding the role of fiscal policy in open economies with nominal rigidity and suboptimal monetary/exchange-rate policy.

Equilibrium Under a Currency Peg, $\epsilon_t = 1$ (Chapter 9)

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t} \tag{9.9}$$

$$\lambda_t = U'(A(c_t^T, F(h_t)))A_1(c_t^T, F(h_t)) \tag{9.13}$$

$$\frac{\lambda_t}{1+r_t} = \beta \mathbb{E}_t \lambda_{t+1} \tag{9.14}$$

$$p_t = \frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))} \tag{9.15}$$

$$p_t = \frac{w_t}{F'(h_t)} \tag{9.16}$$

$$w_t \geq \gamma w_{t-1} \tag{9.20}$$

$$h_t \leq \bar{h} \tag{9.18}$$

$$(\bar{h} - h_t)\left(w_t - \gamma w_{t-1}\right) = 0 \tag{9.21}$$

10.1 First-Best Fiscal Policy Under Fixed Exchange Rates

References: Schmitt-Grohé and Uribe (AER-PP, 2012) and Farhi, Gopinath, and Itskhoki (RES, 2014).

Labor Subsidies

Government subsidizes employment at the firm level at the rate s_t^h

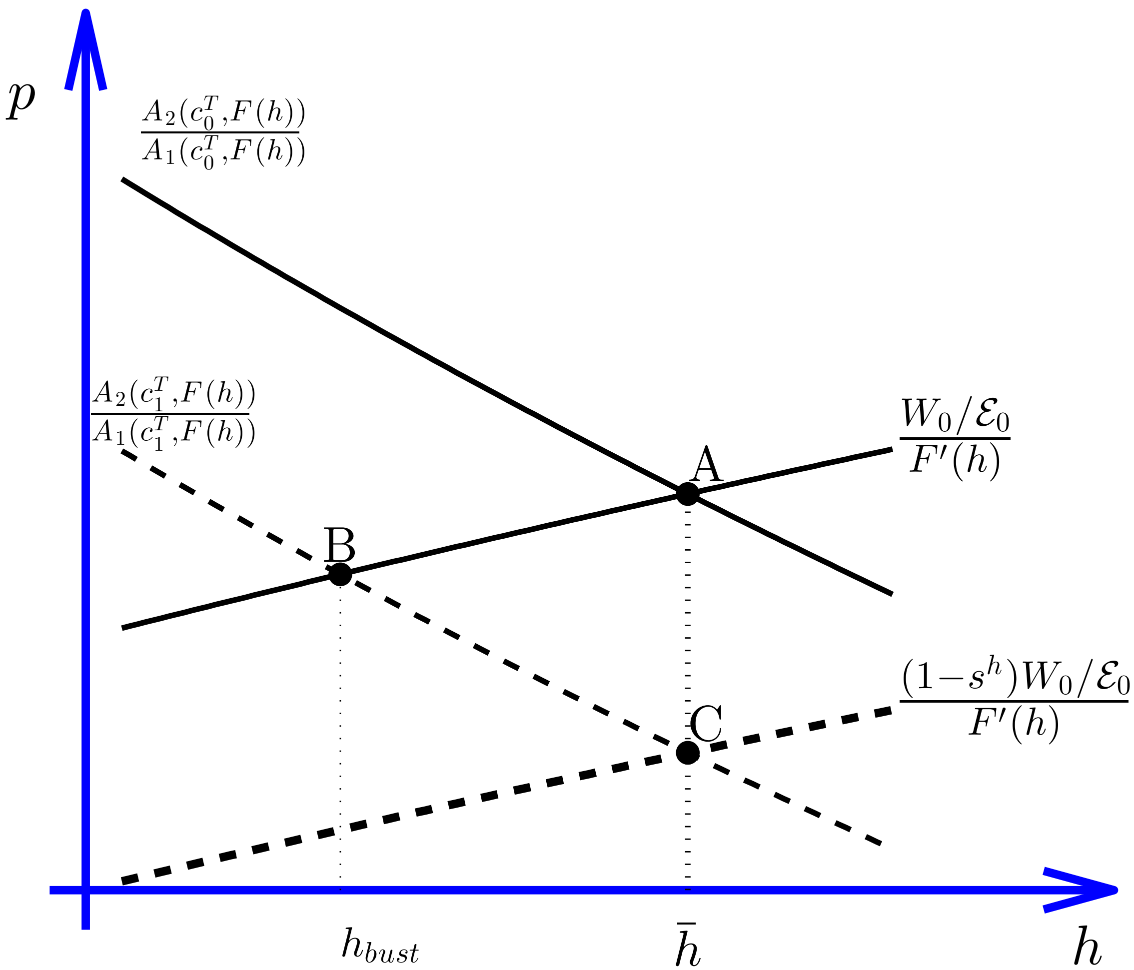
Profits:

$$\phi_t = p_t F(h_t) - (1 - s_t^h) w_t h_t$$

Optimality conditions:

$$p_t = (1 - s_t^h) \frac{w_t}{F'(h_t)}$$

Figure 10.1 Adjustment Under Optimal Labor Subsidy Policy



- economy starts at point A, there is full employment
- a negative external shock (an increase in the country premium, say) depresses demand, $c^T \downarrow$ from c_0^T to $c_1^T < c_0^T$.
- without government intervention, eqm is point B, $h_t = h_{bust}$ $\Rightarrow$ involuntary unemployment.
- optimal labor subsidy, $s^h > 0$, lowers labor costs for firms and returns economy to point C, full employment.

• Unlike what happens under the optimal exchange-rate policy, under the optimal labor subsidy, the real wage does not fall during the crisis. Specifically, the real wage received by the household remains constant at $w_0 = W_0/\mathcal{E}_0$.

• Once the negative external shock dissipates, i.e., once the interest rate falls back to its original level, the fiscal authority can safely remove the subsidy, without compromising its full employment objective.

A relevant question is how the government should finance this subsidy. It turns out that in the present model the government can tax any source of income in a nondistorting fashion. Suppose, for instance, that the government levies a proportional tax, τ_t, on all sources of household income, including wage income.

Government budget constraint: $s_t^h w_t h_t = \tau_t \left(y_t^T + w_t h_t + \phi_t \right)$

To see that the income tax, τ_t, is nondistorting, consider the household's budget constraint, which now takes the form

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

Let's inspect each source of household income separately. Because the endowment of tradable goods, y_t^T, is assumed to be exogenous, it is not affected by taxation. Similarly, profit income from the ownership of firms, ϕ_t, is taken as given by individual households. Consequently, the imposition of profit taxes at the household level is non-distorting. Finally, notice that households either supply $\bar{h}$ hours of work inelastically, in periods of full-employment, or are rationed in the labor market, in periods of unemployment. In any event, households take their employment status as given. As a result, taxes do not alter households' incentives to work. One can demonstrate that income taxes continue to be nondistorting even when the labor supply is endogenous.

It follows that the first-order conditions associated with the household's utility-maximization problem are the same as those given in Chapter 9 for an economy without taxation of household income.

An equilibrium under a currency peg ($\epsilon_t = 1$) with labor subsidies, denoted s_t^h, is a set of processes $\{c_t^T,\, h_t,\, w_t,\, d_{t+1},\, p_t,\, \lambda_t\}_{t=0}^{\infty}$ satisfying

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t} \tag{10.1}$$

$$\lambda_t = U'(A(c_t^T, F(h_t)))A_1(c_t^T, F(h_t)) \tag{10.5}$$

$$\frac{\lambda_t}{1+r_t} = \beta E_t \lambda_{t+1} \tag{10.6}$$

$$p_t = \frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))} \tag{10.7}$$

$$p_t = (1 - s_t^h)\frac{w_t}{F'(h_t)} \tag{10.8}$$

$$w_t \geq \gamma w_{t-1} \tag{10.9}$$

$$h_t \leq \bar{h} \tag{10.10}$$

$$(\bar{h} - h_t)\left(w_t - \gamma w_{t-1}\right) = 0 \tag{10.11}$$

given a labor-subsidy policy, $\{s_t^h\}$, initial conditions w_{-1} and d_0, and exogenous stochastic processes $\{r_t,\, y_t^T\}_{t=0}^{\infty}$.

The optimal labor subsidy solves the Ramsey problem:

$$\max E_0 \sum_{t=0}^{\infty} U(A(c_t^T, F(h_t)) \tag{10.12}$$

subject to the complete set of equilibrium conditions, that is (10.1) and (10.5)-(10.11).

Strategy to Solve Ramsey problem

Solve the less restricted problem of maximizing (10.12) subject to (10.1) and (10.10), that is,

$$\max_{\{c_t^T, h_t, d_{t+1}\}} E_0 \sum_{t=0}^{\infty} U(A(c_t^T, F(h_t)) \text{ s.t.} \tag{10.12}$$

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t} \tag{10.1}$$

$$h_t \leq \bar{h} \tag{10.10}$$

If the solution of this problem also satisfies the remaining equilibrium conditions, then we have found the Ramsey optimal allocation. Furthermore, the less restricted optimization problem is the optimization problem of the Pareto planner and therefore its solution yields the Pareto optimal allocation.

By simple inspection it is clear that the solution of the less restrictive problem features full employment at all times, $h_t = \bar{h}$ for all t.

Does the solution to the less restricted problem satisfy the omitted equilibrium conditions?

Yes. To see this note that:
– Because $h_t = \bar{h}$, the slackness condition (10.11) holds.
– It's easy to verify that (10.5) and (10.6) are FOCs of the less restrictive problem, so they are satisfied.
– Set p_t to satisfy (10.7).
– Then, set w_t to satisfy (10.9) (for example, but not necessarily, with equality).
– Finally, set the labor subsidy s_t^h to satisfy equation (10.8).

We have therefore shown that the government can set labor subsidies applied at the firm level to support the first-best allocation as a competitive equilibrium.

Equivalence of Labor Subsidies and Devaluations

How does the optimal labor subsidy in the present economy compare to the optimal devaluation policy characterized in Chapter 9? Combine equilibrium conditions (10.7) and (10.8) and evaluate the result at the optimal allocation to obtain

$$w_t(1 - s_t^h) = \frac{A_2(c_t^T, F(\bar{h}))}{A_1(c_t^T, F(\bar{h}))} F'(\bar{h})$$

As in Chapter 9, define

$$\omega(c_t^T) \equiv \frac{A_2(c_t^T, F(\bar{h}))}{A_1(c_t^T, F(\bar{h}))} F'(\bar{h}).$$

Then we can write $w_t = \omega(c_t^T)/(1 - s_t^h)$. Finally, combine this expression with equilibrium condition (10.9) to obtain

$$\boxed{\frac{1}{1-s_t^h} \geq \frac{\gamma w_{t-1}}{\omega(c_t^T)}.} \tag{10.13}$$

Any subsidy policy satisfying this condition is Ramsey and Pareto optimal. As in the case of optimal exchange-rate policy, there is a whole family of labor subsidy policies that support the Pareto optimal allocation. Furthermore, comparing this expression with the full employment devaluation rule presented in Chapter 9, we obtain the following equivalence result:

If the process for the devaluation policy ϵ_t is optimal in the economy with no labor subsidies, then the process $s_t^h \equiv (\epsilon_t - 1)/\epsilon_t$ is optimal in the economy with a fixed exchange rate.

This relationship between the optimal exchange-rate policy and the optimal labor subsidy policy as alternative ways of achieving the first-best allocation is useful to gauge the magnitude of the labor subsidy necessary to preserve full employment during crises. In Chapter 9, we found that during a large crisis like the one observed in Argentina in 2001, the model predicts optimal devaluations of between 30 and 40 percent per year, or between 7 and 9 percent per quarter, for about two and a half years. Using the formula given above, the implied optimal labor subsidy required to prevent unemployment ranges form 6.5 to 8 percent. These are large numbers. Consider a labor share of 75 percent of GDP and a share of nontradables of 75 percent of GDP as well. Then, the budgetary impact of a labor subsidy of 6.5 to 8 percent is 3.5 to 4.5 percent of GDP.

Finally, we note that a property of the optimal labor subsidies characterized here is that there is a sense in which they are good for only one crisis. Specifically, suppose the fiscal authority grants a labor subsidy during a crisis and keeps it in place once the crisis is over. When the next crisis comes, the old subsidy does not help at all to avoid unemployment. The reason is that the recovery after the first crisis causes nominal wages to increase, placing the economy in a vulnerable situation to face the next downturn. The new crisis would then require another increase in labor subsidies. This logic leads to a process for labor subsidies converging to one hundred percent. To avoid this situation, the policymaker must remove the subsidy as soon as the crisis is over. In this way, the recoveries occur in the context of nominal wage stability, and the optimal subsidy policy is stationary. Formally, the stationary optimal labor-subsidy policy takes the form

$$\frac{1}{1-s_t^h} = \max\left\{1, \frac{\gamma w_{t-1}}{\omega(c_t^T)}\right\}$$

which belongs to the family of optimal labor-subsidy policies given in equation (10.13).

Sales Subsidies in the Nontraded Sector, s_t^{yN}

$$\phi_t = (1 + s_t^{yN}) p_t F(h_t) - \frac{W_t}{\mathcal{E}_t} h_t$$

Profit-maximization condition

$$p_t = \frac{1}{(1 + s_t^{yN})} \frac{W_t/\mathcal{E}_t}{F'(h_t)}$$

This expression is exactly like the firm's FOC under labor subsidies, excpt that $\frac{1}{(1+s_t^{yN})}$ takes the place of $1 - s_t^h$. We therefore have following equivalence result:

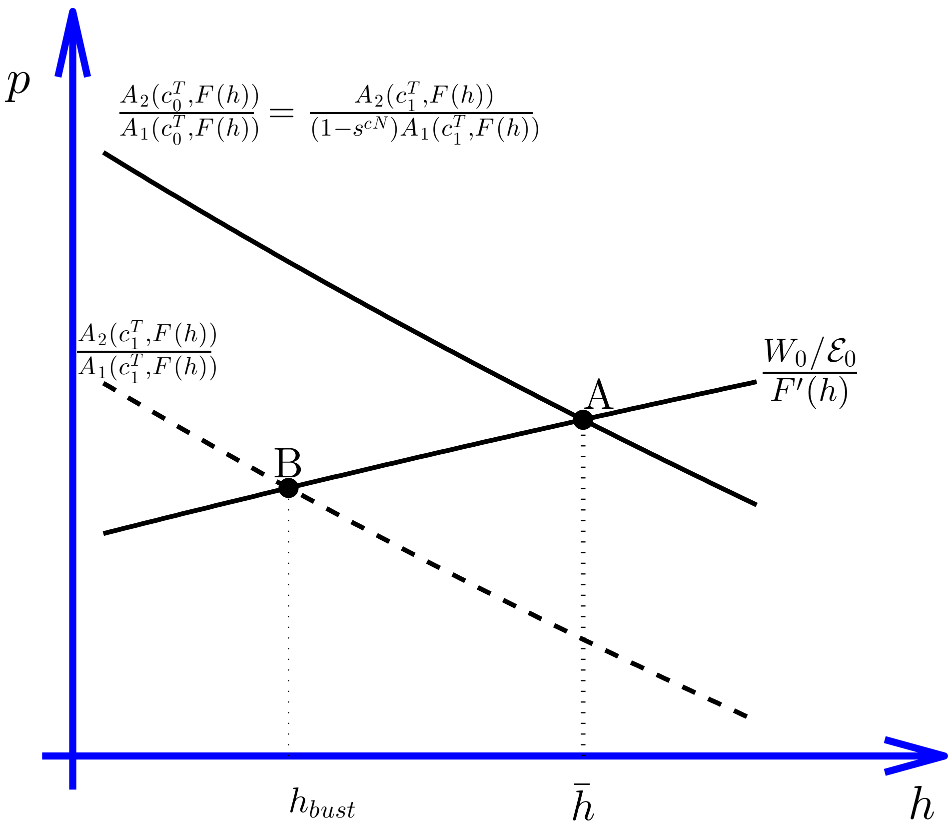
Equivalence of labor subsidies and sales subsidies: Suppose $\epsilon_t = 1$ (currency peg). Then the labor subsidy process s_t^{h*} with $s_t^{yN} = 0$ is Ramsey optimal if and only if the sales subsidy process

$$s_t^{yN*} \equiv \frac{s_t^{h*}}{1 - s_t^{h*}}$$

with $s_t^h = 0$ is Ramsey optimal, and both supposrt the Pareto optimal allocation.

Consumption Subsidies in the Nontraded Sector, s_t^{cN}

Figure 10.2 Adjustment Under Optimal Taxation of Nontradable Consumption



With the consumption subsidty the HH bc becomes:

$$c_t^T + (1 - s_t^{cN}) p_t c_t^N + d_t = y_t^T + \cdots$$

First-order condition becomes:

$$p_t = \frac{1}{(1 - s_t^{cN})} \frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))}$$

Intersection of demand and supply of NT goods:

$$\frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))} = (1 - s_t^{cN}) \frac{W_t/\mathcal{E}_t}{F'(h_t)}$$

$\Rightarrow$ Equivalence Result:

$$s_t^{cN} = s_t^h.$$

Summary of First Best Taxation

The distortions created by suboptimal monetary policy (here a currency peg) can be offset fully by each of the following 3 fiscal instruments set optimally:

- labor subsidy, s_t^h
- sales subsidy, $s_t^{y^N}$
- consumption subsidy, $s_t^{c^N}$

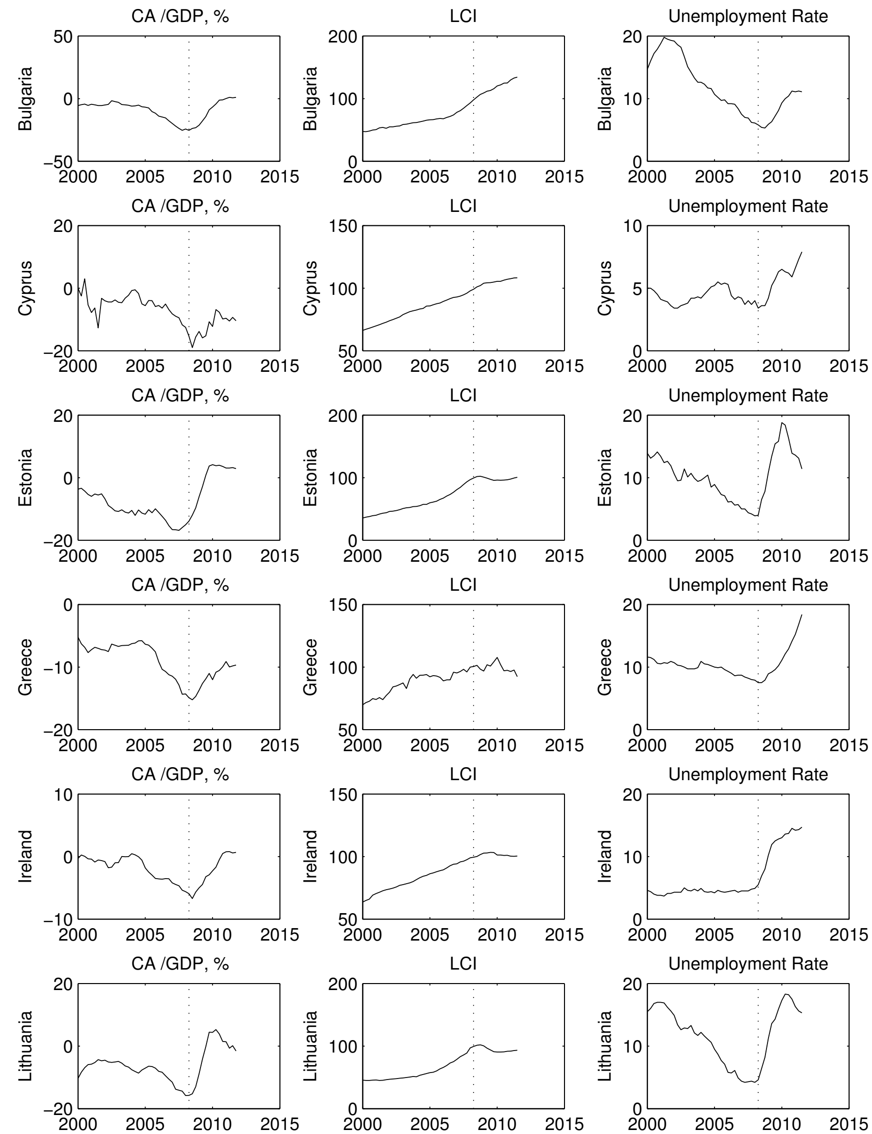
Potential drawbacks of using fiscal instruments in this context: (1) optimal subsidy rates inherit stochastic properties of underlying shocks. This requires subsidy rates to change at business cycle frequency, which might be impractical as tax code changes require legislative approval. (2) optimal subsidy rates become ineffective over time unless during good times they are taken back. This might be impractical politically. Example: Portugal discussed a proposal to shift part of the employers' social security contributions to the employees' social security contribution in 2011. In the face of widespread protests, this proposal was quickly discarded.

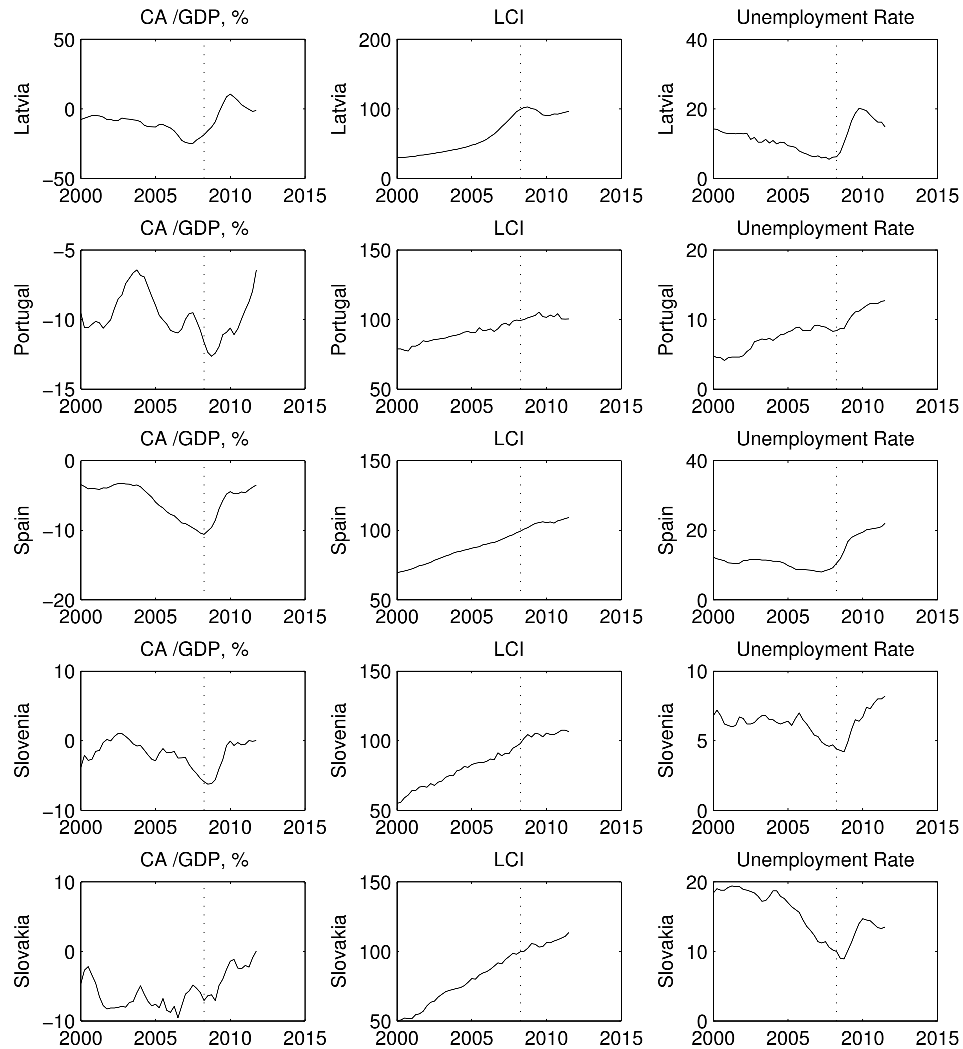
Chapter 10.2 Second Best Tax Policy: Optimal Capital Controls

First-best fiscal instruments may not be available, perhaps for the reasons given above or for other political reasons. This motivates studying other, second best, instruments. We will focus on capital controls, which are of interest because they represent a policy tool often advocated and implemented under the umbrella of financial stability regulations.

Capital Controls and Currency Pegs: Fixed-exchange rate arrangements are often part of broader economic reform programs that include liberalization of international capital flows. For small emerging economies, such a policy combination has been a mixed blessing. A case in point is the periphery of the European Union during the Great Recession of 2008.

Figure 10.3 Boom-Bust Cycle in Peripheral Europe, 2000-2011





Notes. CA/GDP= Current account to GDP ratio in percent, LCI= Nominal Labor Cost Index, 2008=100. The vertical dotted line indicates 2008:Q2, the onset of the Great Contraction in Europe. The sample period is 2000Q4 to 2011Q3. All data is from Eurostat `http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database`.

Should the large capital inflows been avoided?

Four Questions

(Q1) Are capital controls desirable (i.e., Ramsey optimal)?

(Q2) Is the optimal capital control policy prudential (i.e., positive on average and countercyclical)?

(Q3) How large are the welfare gains associated with the optimal capital control policy?

(Q4) What are the cyclical and long-run effects of optimal capital controls on the economy?

Related Literature On Optimal Capital Controls

Models with Nominal Rigidities (this section): Schmitt-Grohé and Uribe (JPE 2016); Farhi and Werning (Econometrica 2016).

Real Models with Financial Frictions (Chapter 12): Auernheimer and García-Saltos, 2000; Uribe, 2006, 2007; Lorenzoni, 2008; Korinek, 2010; Benigno et al., 2011; Bianchi, 2011; Jeanne and Korinek, 2012;

Trade Theory: Obstfeld and Rogoff, 1996; Costinot, Lorenzoni, and Werning, 2011;

Preview of Answers to the Four Questions

(Q1) Are capital controls desirable (i.e., Ramsey optimal)?
A: Yes.

(Q2) Is the optimal capital control policy cyclically prudential?
A: Yes.

(Q3) How large are the welfare gains associated with the optimal capital control policy?
A: > 2 percent of C_t.

(Q4) What are the cyclical and long-run effects of optimal capital controls?
A: Capital inflows are taxed on average, foreign debt is lower, and so is unemployment.

The Policy Tradeoff

Benefit of Capital Controls: They alleviate the externality created by the combination of nominal rigidity and suboptimal exchange-rate policy (the *peg-induced externality*).

Costs of Capital Controls: They distort the intertemporal allocation of consumption.

Introducing Capital Controls Capital controls are modeled as a tax on external borrowing. The household budget constraint becomes

$$c_t^T + p_t c_t^N + d_t = (1 - \tau_t)(y_t^T + w_t h_t + \phi_t) + \frac{(1 - \tau_t^d) d_{t+1}}{1 + r_t}.$$

where τ_t^d denotes the capital control tax, and τ_t denotes a proportional income tax used to rebate the capital controls. Note that the income tax is non-distorting, because y_t^T, $w_t h_t$, and ϕ_t are all taken as given by the household.

The government follows a balanced-budget rule. Its budget constraint is:

$$\tau_t^d \frac{d_{t+1}}{1 + r_t} + \tau_t(y_t^T + w_t h_t + \phi_t) = 0$$

Equilibrium Conditions Under a Currency Peg and Capital Controls

All equilibrium conditions are as in the peg economy without capital controls (Chapter 9), excpt for the Euler equation. Formally, a competitive equilibrium under a fixed exchange-rate regime with capital controls is a set of processes $\{c_t^T, d_{t+1}, h_t, w_t, \lambda_t\}_{t=0}^{\infty}$ satisfying

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t} \tag{10.14}$$

$$\frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))} F'(h_t) = w_t \tag{10.15}$$

$$h_t \leq \bar{h} \tag{10.16}$$

$$w_t \geq \gamma w_{t-1} \tag{10.17}$$

$$U'(A(c_t^T, F(h_t)))A_1(c_t^T, F(h_t)) = \lambda_t \tag{10.19}$$

$$\frac{\lambda_t(1-\tau_t^d)}{1+r_t} = \beta E_t \lambda_{t+1} \tag{10.20}$$

$$(\bar{h} - h_t)(w_t - \gamma w_{t-1}) = 0 \tag{10.23}$$

given exogenous stochastic processes $\{y_t^T, r_t\}_{t=0}^{\infty}$, initial conditions d_0 and w_{-1}, and a capital-control policy $\{\tau_t^d\}_{t=0}^{\infty}$.

Ramsey Optimal Capital Controls

The Ramsey optimal capital control policy maximizes lifetime welfare subject to the complete set of competitive quilibirum conditions ((10.14)-(10.17), (10.19), (10.20), and (10.23)).

Follow the same strategy as in the case of first-best taxes, that is, start by considering a less constrained Ramsey problem and then show that the solution toless constrained problem also satisfies the constraints of the full problem.

The Less Restricted Ramsey Planner's Problem

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(A(c_t^T, F(h_t)))$$

subject to

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t} \tag{10.14}$$

$$\frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))} F'(h_t) = w_t \tag{10.15}$$

$$h_t \leq \bar{h} \tag{10.16}$$

$$w_t \geq \gamma w_{t-1} \tag{10.17}$$

Two Observations: (1) This problem has more restrictions than its counterpart under labor subsidies (eqns. (9.15) and (9.17)). This means that capital capital controls are weakly dominated by labor subsidies (second best). (2) It is readily seen that the solution features either (9.15) or (9.17) holding with equality.

Make Sure Ramsey Solution Satisfies Missing (Boxed)Eq

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

$$\boxed{\tfrac{1-\tau_t^d}{1+r_t}\lambda_t = \beta \mathbb{E}_t \lambda_{t+1}} \text{ with } \boxed{\lambda_t = U'(A(c_t^T, F(h_t))A_1(c_t^T, F(h_t))}$$

$$\frac{A_2(c_t^T, F(h_t))}{A_1(c_t^T, F(h_t))} F'(h_t) = w_t; \quad h_t \leq \bar{h}; \quad w_t \geq \gamma w_{t-1}$$

$$\boxed{(\bar{h} - h_t)(w_t - \gamma w_{t-1}) = 0}$$

Proceed as follows: Given processes c_t^T, h_t, d_{t+1}, and w_t that solve the less restricted problem, pick λ_t to satisfy the second box and τ_t^d to satisfy the first box the Euler equation). By observation (2) on the previous slide, the third box (the slackness condition) is satisfied.

What is the capital control tax rate associated with the Ramsey optimal allocation?

Use: $1 - \tau_t^d = \beta(1 + r_t)\mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t}$

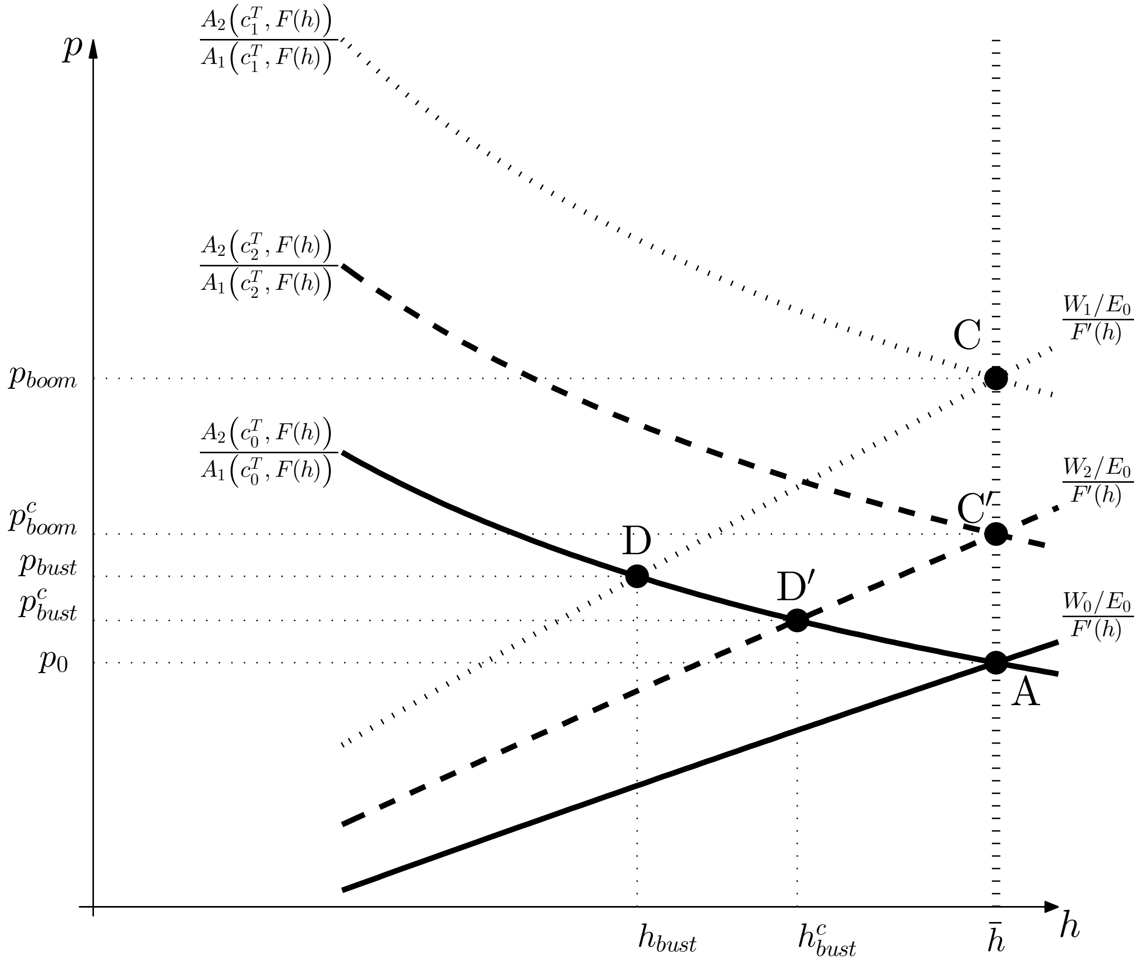
In the case that $\sigma = 1/\xi$, we have: $1 - \tau_t^d = \beta(1 + r_t)\mathbb{E}_t \left(\frac{c_{t+1}^T}{c_t^T}\right)^{-1/\xi}$

Can we tell from this expression whether Ramsey optimal capital control taxes are countercyclical? Not really, because the RHS features one exogenous variable, r_t, and the expectation of one endogenous variable, $\mathbb{E}_t \left(\frac{c_{t+1}^T}{c_t^T}\right)^{-1/\xi}$.

To establish whether they are we will:
1.) Perform an intuitive graphical analysis.
2.) Consider an analytical example.
3.) Perform a quantitative analysis in a richer environment.

We will show that in this model Ramsey optimal capital control taxes are indeed cyclically prudential in the sense of being countercyclical.

Prudential Capital Control Policy: Intuition



Note. The figure is drawn under the assumption that $\gamma = 1$.

The figure is explained in the next slide.

Explanation of the Figure

The economy is initially at point A. A positive external shock (a fall in r, say) shifts the demand schedule up and to the right. Wages begin to raise, shifting the marginal cost schedule up and to the left. Without capital controls, the equilibrium is at point C, with nominal wages increasing from W_0 to W_1.This boom in wages begets high unemployment when the the demand schedule goes back to its initial level (perhaps because the period of low r is over). In the absence of capital controls, the equilibrium is at point D with high unemployment equal to $\bar{h} - h_{busrt}$. Suppose now that during the boom, the government applies a capital control tax τ^d, that discourages tradable consumption. The demand schedule now shifts up and to the rate but by less. The boom equilibrium is at point C', with wages increasing to W_2 a lower level than in the absence of capital controls. This puts the economy in a stronger position when the boom is over. When the demand schedule shifts back to its original position, the equilibrium is point D', and unemployment is only $h_b^c ust$. Note that in this graphical example, the government applies the capital controls when the economy is booming (capital control policy is prudential).

The Prudential Nature of Optimal Capital Controls Under Fixed Exchange Rates: An Analytical Example

Consider the following functional forms and endowments:
$U(c_t^T, c_t^N) = \ln(c_t^T) + \ln(c_t^N)$; $F(h_t) = h_t^{\alpha}$; $d_0 = 0$, $y_t^T = y^T$.
and the initial conditions $w_{-1} = \alpha y^T$.
Suppose the economy experiences a purely temporary fall in the interest rate: $r_t = r$ for all $t \neq 0$, and $r_0 = \underline{r} < r$.
Finally, assume that $\beta(1+r) = 1$, $\gamma = 1$, $\bar{h} = 1$, and $w_{-1} = \alpha y^T$.

Chapter 9 established that under free capital mobility ($\tau_t^d = 0\ \forall t$) this economy borrows and is in full employment in period 0 and reaches a steady state in period 1 in which the wage lower bound holds with equality.

We conjecture that a similar situation (possibly of a different magnitude) occurs under optimal capital controls. Formally, we conjecture that $h_0 = \bar{h}$ and $d_1 \geq 0$ in period 0, and $c_t^T = c_1^T$, $d_{t+1} = d_1$, $h_t = h_1$, for all $t \geq 1$, with $h_1 = c_1^T / c_0^T$ and $d_1 \geq 0$. Shortly, we will verify that this conjecture is correct.

Under the conjecture, the Ramsey-optimal capital control problem simplifies to

$$\max_{\{c_0^T, c_1^T, d_1\}} \left[\ln c_0^T + \frac{\beta}{1-\beta} \ln c_1^T + \frac{\alpha\beta}{1-\beta}\left(\ln c_1^T - \ln c_0^T\right)\right]$$

subject to $d_1 \geq 0$, $c_0^T = y^T + \frac{d_1}{1+\underline{r}}$, and $c_1^T = y^T - \frac{r d_1}{1+r}$.

The optimality conditions associated with this problem are the above three constraints,

$$\frac{1}{1+\underline{r}} \frac{1}{c_0^T} - \beta \frac{1}{c_1^T} - \alpha\beta \left[\frac{1}{c_1^T} + \frac{1+r}{r(1+\underline{r})} \frac{1}{c_0^T}\right] \leq 0, \tag{1}$$

and the slackness condition

$$\left[\frac{1}{1+\underline{r}} \frac{1}{c_0^T} - \beta \frac{1}{c_1^T} - \alpha\beta \left[\frac{1}{c_1^T} + \frac{1+r}{r(1+\underline{r})} \frac{1}{c_0^T}\right]\right] d_1 = 0.$$

The first two terms of optimality condition (1) represent the trade-off that the representative household would face in an unregulated economy in deciding whether to take on an additional unit of debt in period 0. An additional unit of debt allows the household to consume $1/(1+\underline{r})$ units of goods in period 0. In period 1, the household must repay 1 unit of consumption to cancel the debt assumed in period 0. We refer to the first two terms as the private marginal utility of debt.

$$P(d_1) \equiv \frac{1}{1+\underline{r}} \frac{1}{c_0^T} - \beta \frac{1}{c_1^T}$$

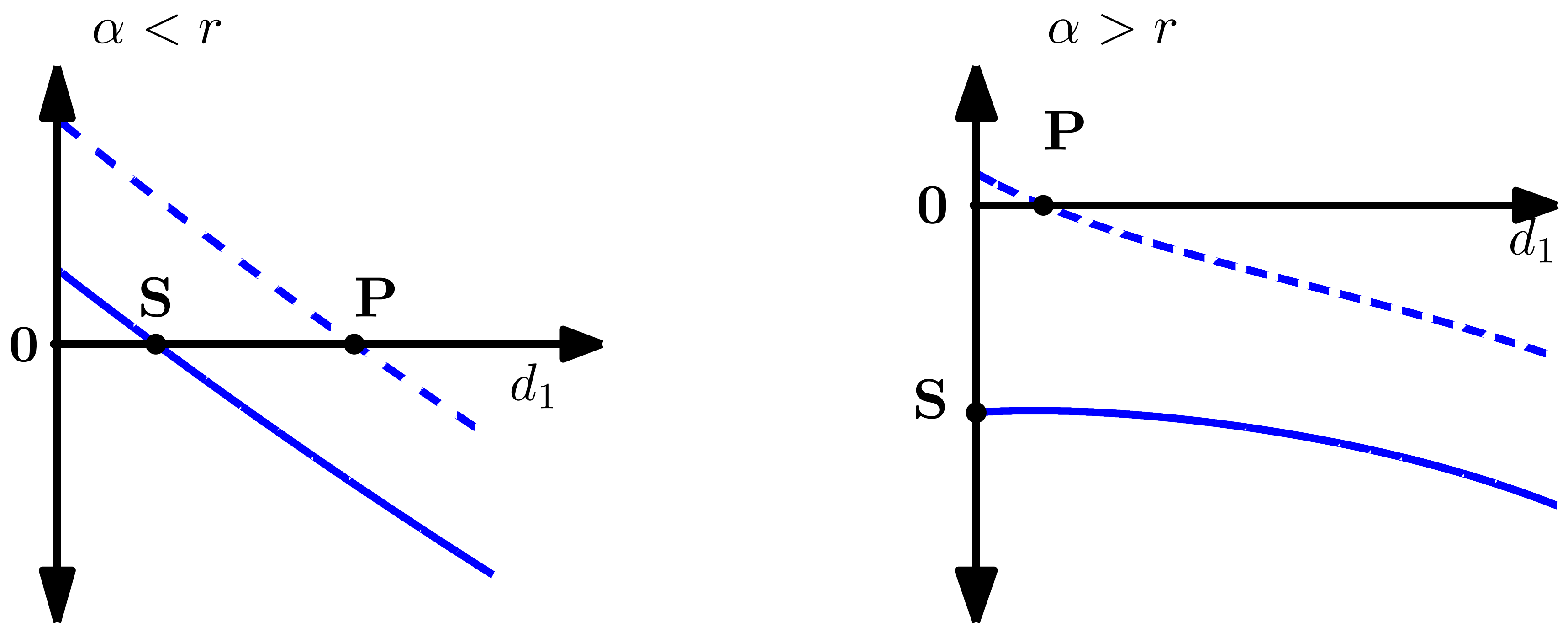
The third term in (1) captures the externality created by the combination of downward nominal wage rigidity and a currency peg. It reflects the Ramsey planner's internalization of the fact that changes in consumption affect unemployment (recall that $h_t = c_1^T/c_0^T$ for all $t \geq 1$). This is an equilibrium effect that is not taken into account by individual consumers.

We refer to the sum of the three terms as the social marginal utility of debt.

$$
\begin{aligned}
S(d_1) &\equiv \frac{1}{1+\underline{r}}\frac{1}{c_0^T} - \beta\frac{1}{c_1^T} - \alpha\beta\left[\frac{1}{c_1^T} + \frac{1+r}{r(1+\underline{r})}\frac{1}{c_0^T}\right] \\
&= P(d_1) - \alpha\beta\left[\frac{1}{c_1^T} + \frac{1+r}{r(1+\underline{r})}\frac{1}{c_0^T}\right]
\end{aligned}
$$

Since the third term is negative, we have that the social marginal utility of debt is always lower than its private counterpart. (This suggests that in general debt should be lower under Ramsey optimal capital control policy than under free capital mobility, that is, the unregulated economy should display overborrowing. We will show below that this is indeed the case in a calibrated richer version of this model.)

Private and Social Marginal Utility of Debt, $\mathrm{P}(\mathrm{d}_1)$ and $\mathrm{S}(\mathrm{d}_1)$



The figure plots the social marginal utility of debt, $S(d_1)$, as a function of debt with a solid line and the private marginal utility of debt, $P(d_1)$, with a broken line. The figure distinguishes two cases, $\alpha < r$ shown in the left panel, and $\alpha > r$ shown in the right panel. It can be shown that when $\alpha < r$, the private and social marginal utilities of debt are both downward sloping. The intercept of the private marginal utility of debt is always positive, whereas the intercept of the social marginal utility of debt may be positive or negative. Recalling that the social marginal utility of debt is always below its private counterpart, the socially optimal level of debt (point S in the figure) is always lower than the privately optimal level of debt (point P in the figure).

The Ramsey planner induces this outcome by applying capital controls in period 0. From the Euler equation in the regulated economy in period 0 we have that

$$(1 - \tau_0) = \beta(1 + \underline{r})\frac{c_0^T}{c_1^T}$$

Solving for τ_0 yields

$$\tau_0 = 1 - \beta(1+\underline{\mathrm{r}})\frac{c_0^T}{c_1^T} = c_0^T(1+\underline{r})P(d_1) > 0$$

The last inequality follows from the fact that at the Ramsey optimal choice of d_1, the private marginal utility of debt is strictly positive, $P(d_1) > 0$. This intervention is **prudential** in nature because it takes place when the economy is booming. By raising capital control taxes, the planner ensures that the level of involuntary unemployment that emerges in period 1 (when the boom is over) is lower in the Ramsey optimal equilibrium than in the private equilibrium.

Consider now the case $\alpha > r$ shown in the right panel of the figure. In this case the social marginal utility of debt is negative for all nonnegative values of debt. Thus, the socially optimal response to the decline in the interest rate is a corner solution featuring $d_1 = 0$ (point S in the figure). The Ramsey planner imposes positive capital control taxes such that the privately perceived (after tax) interest rate $(1+\underline{\mathrm{r}})/(1-\tau_0^d)$ equals $1+r$.

$$\tau_0^d = \frac{r - \underline{\mathrm{r}}}{1+r} > 0.$$

This strong distortion of the intertemporal allocation of tradable absorption leads households not to alter the level of consumption in period 0. This is inefficient, for the household is not taking advantage of the fact that borrowing costs are low. The benefit of the large increase in capital control taxes is that from period 1 onwards full employment will be preserved.

The intuition for why $\alpha > r$ is a sufficient condition for the corner solution of no increase in debt in response to a decline in the interest rate is as follows. An increase in debt implies a fall in employment of at least $(1/c_0^T)$ for all $t \geq 1$ (recall that $h_t = c_1^T/c_0^T$). This is equivalent to a decline in nontradable output of α/c_0^T for all $t \geq 1$. The value of this amount of nontradables in terms of tradables is α, since the relative price of nontradables in terms of tradables is c_0^T. The present discounted value of a stream of α units of tradables is approximately α/r. Thus, if this value is larger than unity (the increase in tradable consumption afforded by a unit increase in debt in period 0), the planner will never choose to increase debt in period 0.

In the case that $\alpha > r$, the optimal capital-control policy resolves the tradeoff between intertemporal distortions and static distortions entirely in favor of eliminating all static distortions, i.e., full employment at all times. In the case that $\alpha < r$, the tradeoff is resolved in a more balanced fashion. The optimal capital-control policy consists in reducing (but not eliminating) inefficient unemployment and distorts (although less strongly) the intertemporal allocation of consumption.

Summary of results from analytical example

(see also figure on next slide)

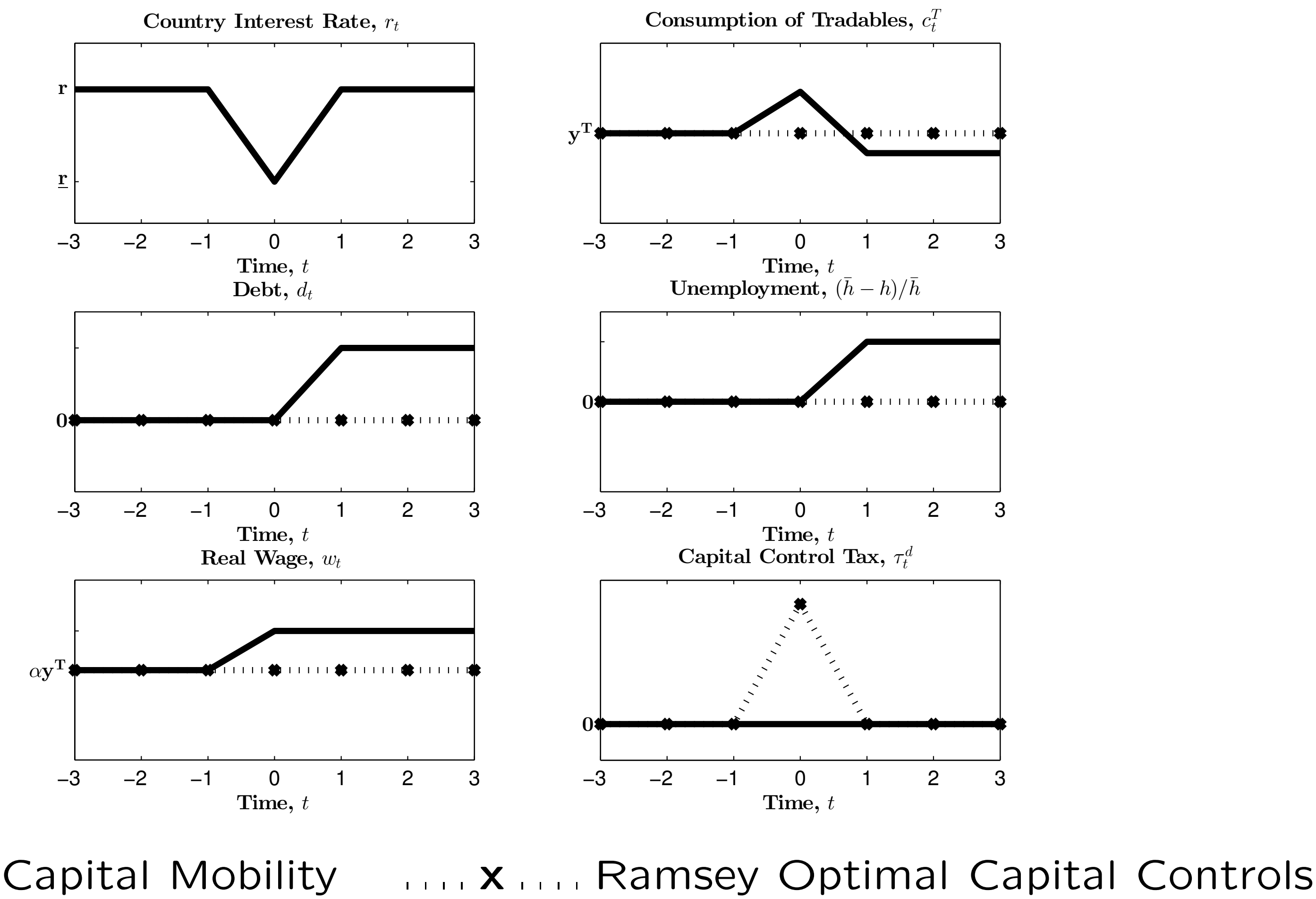
• Ramsey optimal capital controls are **prudential** in the sense that they rise during booms and fall once the boom is over.

• The increase in debt during the boom is smaller under optimal capital controls than under free capital mobility, that is, there is **overborrowing**.

• The tradeoff between employment and a suboptimal intertemporal allocation of consumption is resolved in favor of employment. (This is the case as long as the labor share in the nontraded sector exceeds the interest rate, which is the case of greatest relevance.)

As we will see shortly, the thrust of these findings carries over to richer economic environments.

Adjustment Under Ramsey Optimal Capital Control Policy To a Temporary Interest Rate Decline



Quantitative Analysis

To facilitate the computation, exploit the fact that the less restricted Ramsey problem can be expressed as the solution to a Bellman equation

$$v(y_t^T, r_t, d_t, w_{t-1}) = \max \left[U(A(c_t^T, F(h_t))) + \beta \mathbb{E}_t v(y_{t+1}^T, r_{t+1}, d_{t+1}, w_t) \right] \tag{10.24}$$

subject to (10.14)-(10.17).

This is a harder computational problem than a pure peg with $\sigma = 1/\xi$, because now w_t is a relevant state variable for the choice of c_t^T and d_{t+1}.

How to back out the value of the optimal capital control tax?

$$\tau_t^d = 1 - \beta(1+r_t) \frac{E_t U'(A(c_{t+1}^T, F(h_{t+1}))) A_1(c_{t+1}^T, F(h_{t+1}))}{U'(A(c_t^T, F(h_t))) A_1(c_t^T, F(h_t))} \tag{10.25}$$

Calibration and Functional Forms

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

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

$$F(h) = h^\alpha$$

For the calibration of γ see the empirical evidence on downward nominal wage rigidity in the slides for Chapter 9. Calibration strategy for other structural parameters is also discussed there. Here we give a summary:

Parameter	Value	Description
γ	0.99	Degree of downward nominal wage rigidity
σ^{-1}	2	Intertemp. elast. subst. (Reinhart and Végh, 1995)
a	0.26	Share of tradables
ξ	0.5	Intratemp. elast. subst. (González-Rozada et al., 2004)
α	0.75	Labor share in nontraded sector
$\bar{h}$	1	Labor endowment
β	0.9635	Quarterly subjective discount factor

The Driving Process:

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

Sample: Argentina, 1983:Q1—2001:Q3

(for details see the slides for Chapter 9: Nominal Rigidity, Exchange Rates, And Unemployment)

Solution Algorithms

- **Optimal Capital Control Policy:** Value function iteration on (10.24).

- **Free Capital Mobility:** See discussion in Chapter 9.

- **Discretization of state space** $\{d_t, w_{t-1}, y_t^T, r_t\}$: 57,865,500 grid points.
  - **External Debt,** d_t**:** 501 points.
  - **Real Wage,** w_{t-1}**:** 500 points.
  - **Traded Output,** y_t^T**:** 21 points.
  - **Interest Rate,** r_t**:** 11 points.

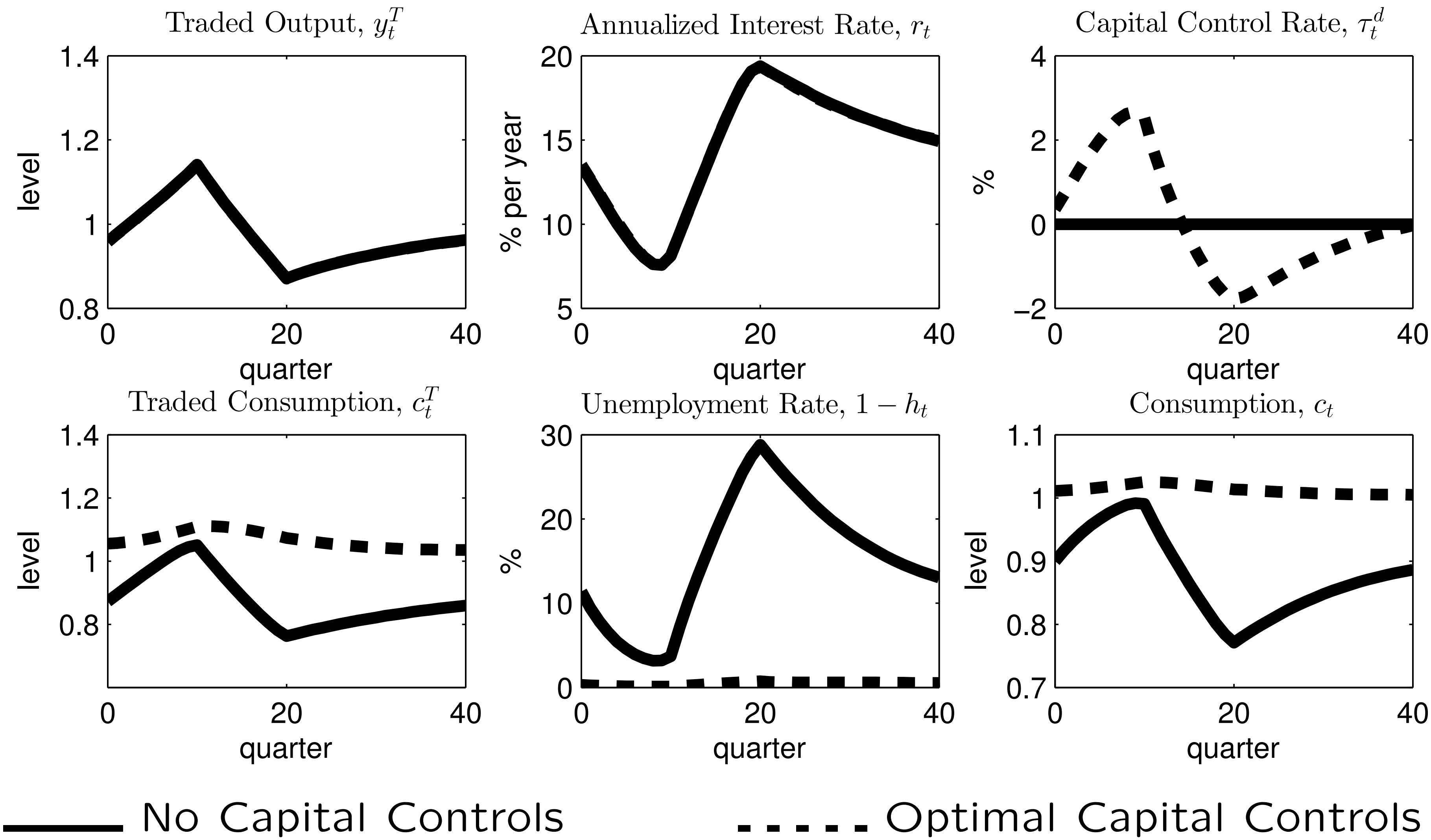
A Boom-Bust Episode

Definition: boom-bust episode as a situation in which tradable output, y_t^T, is at or below trend in period 0, at least one standard deviation above trend in period 10, and at least one standard deviation below trend in period 20. The time unit is one quarter, so tradable output falls from 1 standard deviation above trend to 1 standard deviation below trend over a period of 2.5 years.

This definition is motivated by the contraction in aggregate activity observed in Argentina in 2001.

Simulate the model economy for 20 million periods and select all subperiods that satisfy the definition of a boom-bust episode. We then average across these episodes.

Figure 10.5 Prudential Policy for Peggers: Boom-Bust Dynamics With and Without Optimal Capital Controls



Notes. Replication file plot_bb_level.m in usg_capital_controls.zip.

Observations on the figure:

• optimal capital control policy is **cyclically prudential**. Capital controls increase significantly during the expansionary phase of the cycle, from about 2 percent at the beginning of the episode to 6 percent at the peak of the cycle. During the contractionary phase of the cycle, capital controls are drastically relaxed. Indeed at the bottom of the crisis, capital inflows are actually subsidized at a rate of about 2 percent.

Why is this optimal? The sharp increase in capital controls during the expansionary phase of the cycle puts sand in the wheels of capital inflows, thereby restraining the boom in tradable consumption. Under a peg with free capital mobility, during the boom, tradable consumption increases significantly more than under the optimal capital control policy. In the contractionary phase, the fiscal authority incentivates spending in tradables by subsidizing capital inflows. As a result consumption falls by much less in the regulated economy than it does in the unregulated one. During the recession, the optimal capital control policy, far from calling for austerity in the form of severe cuts in tradable consumption, supports this type of expenditure. That is, the capital control policy stabilizes the absorption of tradable goods over the cycle.

• The fact that the Ramsey optimal capital control policy fosters tradable consumption during contractions implies that optimal capital control policy does not belong to the family of beggar-thy-neighbor policies, for it does not seek to foster trade surpluses during crises.

• Because unemployment depends directly upon variations in the level of tradable absorption through the latter's role as a shifter of the demand schedule for nontradables, and because optimal capital controls stabilize the absorption of tradables, unemployment is also stable over the boom-bust cycle. In the peg economy without capital controls, unemployment increases sharply by over 20 percentage points during the recession. By contrast, under optimal capital controls the rate of unemployment rises relatively modestly by about 3 percentage points.

• The Ramsey planner's tradeoff between distorting the intertemporal allocation of tradable consumption and reducing unemployment is overwhelmingly resolved in favor of the latter. This conclusion echoes the one obtained earlier in the context of an analytical example.

• The rate of unemployment in the peg economy with optimal capital controls is much closer to the unemployment rate under the optimal exchange rate policy (equal to zero at all times) than to the unemployment rate in the peg economy with free capital mobility. However, the means by which the policymaker achieves low unemployment in the peg economy with optimal capital controls and in the optimal exchange-rate-policy economy are quite different. In the optimal-capital control economy lower unemployment is the consequence of stabilizing traded absorption (i.e., stabilizing the demand schedule in the earlier graphical analysis). By contrast under the optimal exchange rate policy, low unemployment is achieved through a series of large currency devaluations that lower the labor cost in the nontraded sector during crises (i.e., by shifts in the supply schedule).

10.6 Level and Volatility Effects of Optimal Capital Controls

Table 10.1 Optimal Capital Controls And Currency Pegs: Level and Volatility Effects

	Capital Control Tax Rate $100 \times \tau_t^d$	Country Interest Rate $400 \times r_t$	Effective Interest Rate $400 \times \left(\frac{1+r_t}{1-\tau_t^d} - 1\right)$	Unemployment Rate $100 \times \left(\frac{\bar{h}-h_t}{\bar{h}}\right)$	Growth in Traded Consumption $400 \times \ln(c_t^T/c_{t-1}^T)$
Mean					
FCM	0	12.7	12.7	11.8	0.0
OCC	0.6	12.6	15.1	0.4	0.0
Standard Deviation					
FCM	0	7.1	7.1	10.4	23.2
OCC	2.4	7.1	5.0	1.5	4.9
Correlation with y_t^T					
FCM	–	-0.8	-0.8	-0.6	0.1
OCC	0.7	-0.8	0.3	-0.2	0.2
Correlation with r_t					
FCM	–	1.0	1.0	0.7	-0.2
OCC	-0.9	1.0	-0.3	0.2	-0.3
Correlation with GDP					
FCM	–	-0.8	-0.8	-1.0	0.3
OCC	0.7	-0.8	0.2	-0.5	0.3

Notes. FCM stands for currency peg with free capital mobility ($\epsilon_t = 1, \tau_t^d = 0$ for all t), and OCC stands for currency peg with optimal capital controls. GDP stands for gross domestic product and is expressed in terms of units of the composite good. Replication file table_mean_std.m in usg_capital_controls.zip.

Comments on the Table

Optimal capital-control policy is cyclically prudential not only during large boom-bust cycles but also during regular business cycles. Here are some key unconditional first and second moments from the table that highlight this property:

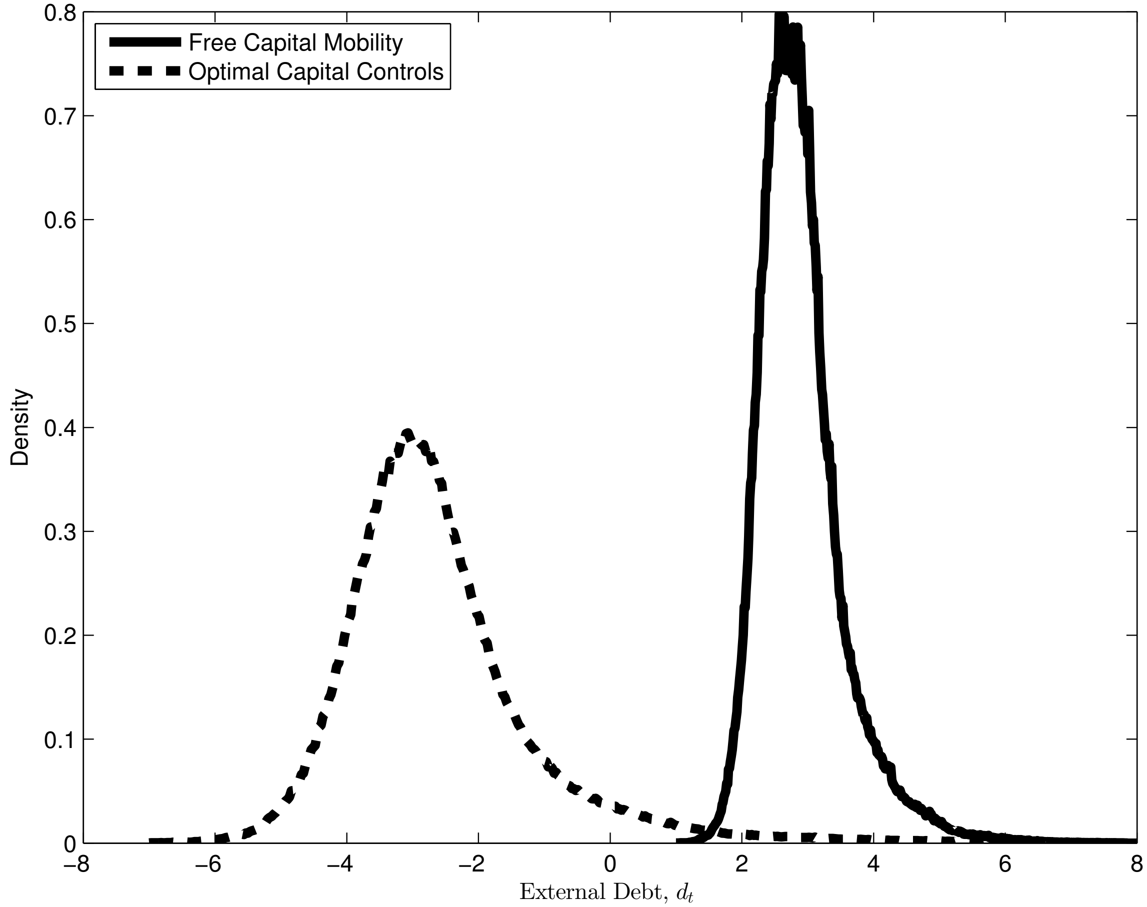
• Corr(τ_t^d,y_t^T) $= 0.7 > 0$. This reduces the volatility of tradable absorption (c_t^T) and the average level of unemployment. (In the model with financial frictions studied in Chapter 12 this correlation is negative (-0.84), suggesting that in that model capital controls are not cyclically prudential.

• The country interest rate, r_t is negatively correlated with y_t^T, -0.8, (when it rains it pours). This is a property of the data. However, the *effective interest rate,* $(1 + r_t)/(1 - \tau_t^D)$ is positively correlated with y_t^T, (0.3). This is the main channel through which capital controls stabilize movements in c_t^T, preventing both large increases in nominal wages during booms, and large unemployment during contractions.

• Mean unemployment is 11.7% under free capital mobility, but only 0.4% under optimal capital controls.

10.7 Peg-Induced Overborrowing

Figure 10.6 The Distribution of External Debt under FCM and OCC



- Currency Pegs Cum Free Capital Mobility ⇒ Overborrowing

Note. Replication file debt_distrib.m in usg_capital_controls.zip.

Observations on the Figure

$\mathbb{E}d_t = -2.6$ and 2.9 in the OCC and FCM economies, respectively.

• Mean capital control tax is positive, $E(\tau_t^D) = 0.6\%$. This means that the effective annual interest rate is on average 2.5% higher under OCC than under FCM.

• Mean debt is 22% of annual output under free capital mobility but -14% under optimal capital controls, a difference of 36 percent of output. By comparision in the the model with financial frictions (collateral constraints) of Chapter 12 the pecuniary externality induces either underborrowing or overborrowing. And in the standard calibration in which it produces overborrowing, the amount of overborrowing is only 1 percentage point of output.

Why does the Ramsey planner find it optimal to have less debt, indeed to have assets? Because here debt plays the role of a shock absorber.

Key objective of the Ramsey planner is to smooth c_t^T to avoid large increases in nominal wages during booms and high involuntary unemployment during contractions.

Variations in debt make it possible to stabilize c_t^T. But this requires large variations in the stock of debt:
Variance under OCC $= 1.6^2$, variance under FCM $= 0.65^2$
In turn, the higher variacne of debt requires that its distribution be centered more to the left, since otherwise the risk of hitting the debt limit would increase, which is highly welfare decreasing.

Does imposing optimal capital controls mean that the capital account is closed? On the contrary, we just saw that the OCC economy makes much more heavy use of changes in debt (il.e., the current account) than the FCM economy: var(CA_t) is 50% larger under OCC than under FCC.

10.8 Welfare Costs of Free Capital Mobility For Peggers

Question: What is the compensation demanded by a household living in the economy with a currency peg and free capital mobility to be as well off as a household living in the economy with a currency peg and optimal capital controls? Formally, find the random variable Λ_t such that

$$\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j U\left(c_{t+j}^{FCM}(1+\Lambda_t)\right) = \mathbb{E}_t \sum_{t=j}^{\infty} \beta^j U\left(c_{t+j}^{OCC}\right)$$

$FCM=$ currency peg and free capital mobility, and $OCC=$ currency peg and Optimal capital controls. Note that Λ_t is a conditional welfare cost that depends on the state of the economy, $(y_0^T, r_0, d_0, w_{-1})$. Consider the mean conditional cost of free capital mobility for peggers, given by the unconditional expectation of Λ_t, denoted λ. Note that this is different from the unconditional welfare cost of FCM (see the next slide).

Result. $\lambda = 3.65$. As welfare costs of business cycles go, this is a large number. It says that the typical consumer living in currency-peg economy with free capital mobility must receive a compensation of 3.65% of his consumption each quarter to feel as well off as living in a peg economy with optimal capital controls.

Unconditional Welfare Cost of Free Capital Mobility for Peggers

Transitional dynamics have a significant effect on welfare. Look again at the distribution of debt under FCM and OCC. The transition from FCM to OCC entails reducing significantly the average level of external debt. This 'deleveraging' can be quite costly, as it requires an initial sacrifice of consumption. To see how big this effect is, consider the following alternative measure of the welfare cost: Suppose the compensation to the consumer living in the peg economy with FCM is determined *before* knowledge of the initial state of the economy (i.e., before the vector $(y_t^T, r_t, d_t, w_{t-1})$ is revealed. Formally, the welfare cost is now the scalar $\tilde{\lambda}$ that solves

$$\mathbb{E} \sum_{j=0}^{\infty} \beta^j U\left(c_{t+j}^{FCM}(1+\tilde{\lambda})\right) = \mathbb{E} \sum_{j=0}^{\infty} \beta^j U(c_{t+j}^{OCC}).$$

The compensation that solves this equation is $\tilde{\lambda} = 13.0\%$. The consumer living in the peg economy with FCM requires an unconditional compensation of 13% of consumption per quarter to be as well off as living in a currency peg with OCC. This is a pretty big number.

10.9 Are Observed Capital Controls Prudential?

Based on Fernández, Andrés, Alessandro Rebucci, and Martín Uribe, "Are Capital Controls Countercyclical?" Journal of Monetary Economics, 76, 2015, 1-14.

Capital Controls: From Villain To Hero

• Early 1990s: large capital inflows to emerging countries. Capital controls were viewed, with few exceptions, as distortions that hindered the efficient allocation of capital across countries and thus impeded economic growth. To a large extent, policymakers allowed capital to flow unfettered.

• Many of the booms of the early 1990s ended in sudden stops and financial and/or exchange-rate crises (Southeast Asia and Russia in the late 1990s, South America in the early 200s, and peripheral Europe in the late 2000s). Since then policymakers view capital controls with more benign eyes.

• The strongest indication of this change of sentiment: The IMF now sees capital controls as an appropriate tool for macroeconomic stabilization. (IMF, 2011)

We say that capital controls are **prudential** or **countercyclical** when they are imposed during booms and relaxed during contractions.

Data on Capital Controls

• Fernandez, Klein, Rebucci, Schindler, and Uribe, "Capital Control Measures: A New Dataset," IMF Economic Review, 2016.

• Index of capital controls, from 1995 to 2015, covers 91 countries (22 developed, 45 emerging, and 24 low-income).

• Source of raw data: IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).

• Type of Index: De jure. Takes on 13 equally spaced values from 0 (no restrictions) to 1 (restrictions in all asset categories).

• Disaggregation: distinguishes inflows and outflows and 6 asset categories (equity, bonds, money market instruments, mutual funds, financial credit, and foreign direct investment.)

• All series filtered with a linear trend.

Result 1:

Virtually No Movement of Capital Controls Over the Business Cycle

Standard Deviations of Capital Controls

	All Countries	Developed Countries	Emerging Countries	Low-Income Countries
Inflows	0.07	0.03	0.08	0.08
Outflows	0.06	0.04	0.07	0.06

Recall that the index ranges from 0 to 1 with stepsize of 1/12.

Result 2:

Virtually No Correlation of Capital Controls With Output

Correlations of Capital Controls with Output

	All Countries	Developed Countries	Emerging Countries	Low-Income Countries
Inflows	-0.01	-0.01	0.05	-0.12
Outflows	-0.03	-0.10	0.03	-0.06

Sharp contrast to the results just presented in the quantitative analysis, Table 10.1: under optimal capital control policy there is a large positive correlation between capital controls and output, $corr(\tau_t^D, GDP_t) = 0.7$

What if policymakers only make the effort to change capital controls when there are large deviations of aggregate activity from trend, but not in response to the regular cyclical ups and downs?

Look at the Behavior of Capital Controls Around Booms and Busts

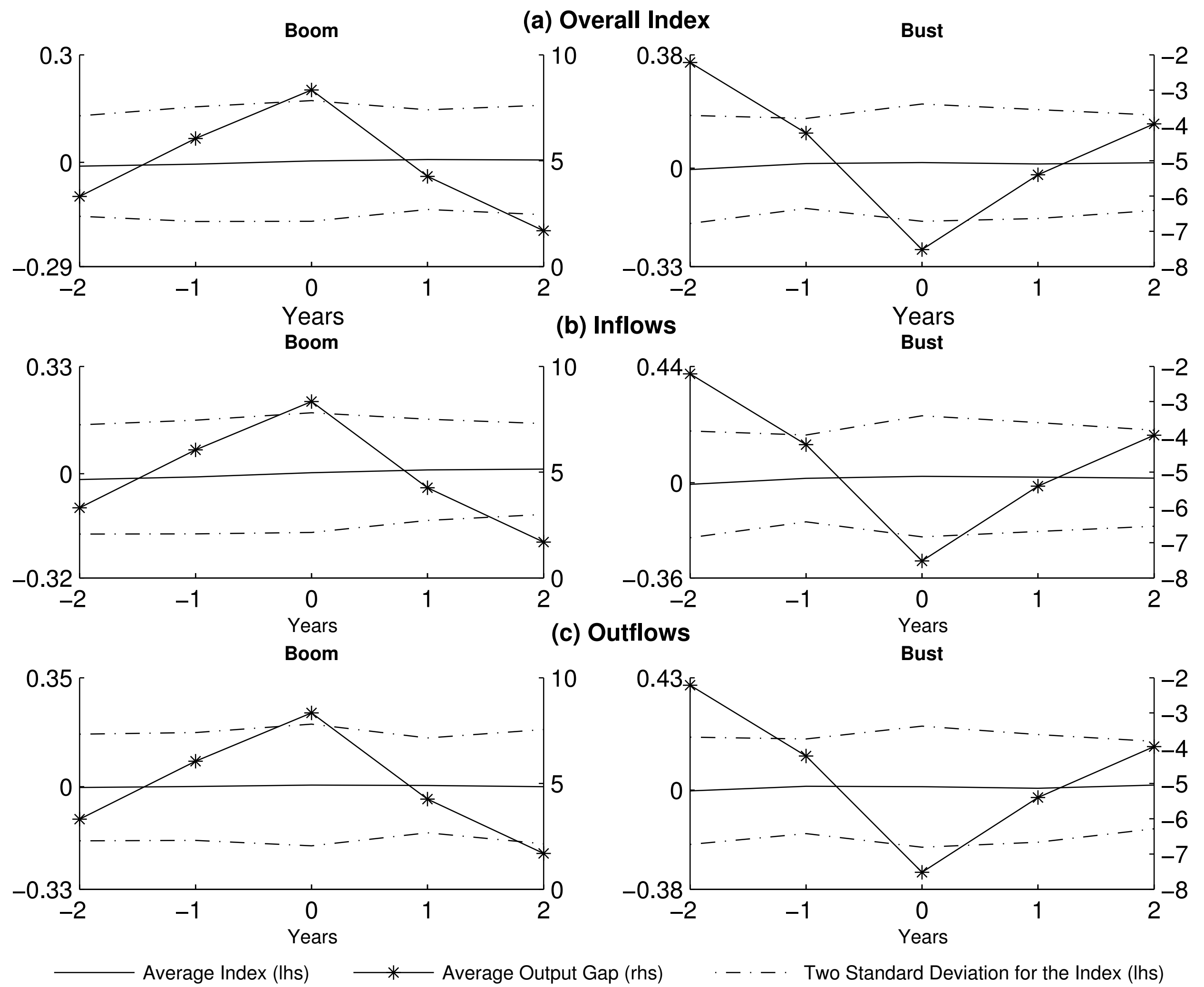
Definition of a Boom (Bust): At least 3 consecutive years of output above (below) trend.

Implied Features of the so identified Booms (Busts):

- Average magnitude of peaks (troughs), +(-)8%.

- Average duration of booms (busts), 7 years.

Result 3: Capital controls are virtually unchanged during economic booms or busts



Summary of the empirical findings of Fernandez, Rebucci, and Uribe:

on average capital controls are remarkably acyclical.

- **Two Interpretations of Results:**

(1) We are in the presence of a case of theory running ahead of policymaking. Under this view, observed movements in capital controls (or lack thereof) are suboptimal. As time goes by and theories percolate policy circles, we should observe changes in the cyclical behavior of capital controls.

(2) Policymakers know more than theorists. Under this view, actual capital control policy may be optimal, and more feedback from policy to theory is needed.