Seesaw and Disciplining Effects of Central Bank Reform on Labor Taxes and Redistribution in the Presence of Labor Unions *

Alex Cukierman and Alberto Dalmazzo†

September 3, 2010

Abstract

This paper investigates the impact of central bank reform on labor taxation, redistribution and welfare in economies with a small number of wage setting labor unions and governments concerned with maximizing some combination of general welfare and redistribution. By raising central bank (CB) conservativeness such reforms directly reduce the premium of unions’ wages over the competitive wage inducing reductions in both inflation and unemployment, and an increase in aggregate welfare.

But such reforms also induce government to adjust the tax rate on labor. Depending on whether this rate goes down (a disciplining effect) or up (a seesaw effect) the direct beneficial effects of reform are either reinforced or moderated. On one hand, by raising

---

*This paper draws on the analytical structure of the paper "Fiscal Policy, Labor Unions and Monetary Institutions: Their Long Run Impact on Unemployment, Inflation and Welfare", CEPR Discussion Paper, No. 6429, August 2007 by the same authors.

†Alex Cukierman; Tel - Aviv University and CEPR. Alberto Dalmazzo; University of Siena. E-mails: Cukierman: <alexcuk@post.tau.ac.il>, Dalmazzo: <dalmazzo@unisi.it>
the positive marginal impact of a labor tax on the wage premium, central bank reform deters government from raising the tax. On the other hand, by raising the tax base, such a reform encourages government to raise it. A disciplining effect arises when the reform raises the marginal impact of the tax on the wage premium by a lot and a seesaw effect arises when this increase is moderate. In the first case the beneficial effect of CB reform is amplified and in the second it is moderated opening the door for the possibility that flexible inflation targeting is optimal even in the absence of stabilization policy. The paper also discusses the consequences of CB reform for redistribution and the size of government in each case.

Keywords and Phrases: Fiscal monetary policy interactions, seesaw and disciplining effects, labor unions, redistributive politics, central bank reform, social welfare

JEL Classification Codes: E5, H3, H5, H7, J5, E1

1 Introduction

This paper discusses the impact of central bank reform on government’s tax policy and on social welfare in the presence of unionized labor markets. Most existing discussions of fiscal-monetary policy interactions posit competitive labor markets.\(^1\) Frameworks with competitive labor markets may be reasonable for the US in which the fraction of the labor force covered by collective agreements is relatively small. But they clearly are counterfactual for European economies in most of which union membership is at least fifty percent.\(^2\) The literature of the last ten to fifteen years has established that, contrary to competitive labor markets, in the


\(^2\)Even in those countries in which membership is lower than fifty percent the fraction of the labor force actually \textit{covered} by collective bargaining is substantially higher. This is achieved through various legal and other institutionalized extensions of union wages to segments of the labor force that are not members of unions. According to OECD (1997) coverage rates ranged from 68\% in Spain to 92\% in France at the beginning of the nineties.
presence of a small number of wage setters, the level of central bank conservativeness affects real variables along with inflation. Consequently, the nature of interactions between fiscal and monetary policy in the presence of unionized labor differs substantially from their interaction under competitive labor markets.

By delivering price stability more conservative central banks are making it easier for government to use fiscal policy for the pursuit of other objectives. With price stability assured by another institution government can use taxation more effectively to maximize social welfare but also to finance redistribution in favor of general and special interests. Acemoglu et al. (2008) argue that sensible reforms do not always generate their anticipated benefits because, in the presence of strong political constituencies, the new constraints imposed by reform in one area are often offset by more intensive use of distortionary instruments in other areas in order to satisfy the same politically powerful constituencies. They provide empirical support for this argument by showing that only a subset of the countries that upgraded the independence of their central bank achieved the anticipated benefits. Thus, the upgrading of central bank independence in Argentina and Columbia in 1991 was followed by a significant fall in inflation, as well as by increases in government expenditures as a share of GDP.

The literature on monetary policy in unionized economies has shown that, in the presence of a small number of wage setters, effective central bank conservativeness (CBC) or independence affects the equilibrium levels of employment and output. Since they have a stronger concern for price stability more conservative central banks react to union’s wage increases with stronger contractions of monetary policy. This moderates union’s real wage demands – lowering the premium of unions wage demands over the competitive real wage. And the lower wage premium induces higher levels of employment and economic activity (see Soskice and Iversen (2000)).

---

3 A non exhaustive list includes Skott (1977), Cukierman and Lippi (1999) and Lippi (2003).

4 Ardagna (2007) considers the interactions between fiscal policy and wage-setting unions, abstracting from monetary policy.
Consequently, in unionized economies higher CBC is associated, in the long run, with both higher income and lower inflation implying that, in the absence of stabilization policy, strict inflation targeting is optimal (see Coricelli, Cukierman and Dalmazzo (2006)).

This paper revisits those results when tax rates chosen by partly redistribution minded governments are affected by the level of CBC. Such governments care about aggregate social welfare but also about the total volume of (general and targeted) redistribution. Since the level of CBC affects total income central bank reform raises government’s tax base, and with it the temptation to raise the tax and spend more on redistribution. On the other hand, since an increase in the tax rate reduces employment, income and social welfare, there is also a countervailing effect that induces government to reduce the tax rate in the aftermath of central bank reform. When the first effect dominates there is a seesaw reaction of fiscal policy as argued, more broadly, by Acemoglu et. al. (2008). When the second effect dominates the increase in CBC generates a disciplining effect on government’s tax policy. In general both types of outcomes are possible. A main objective of the paper is to identify circumstances under which either one of those two outcomes arises. The paper also revisits the long run optimality of strict inflation targeting in unionized economies in the presence of endogenous fiscal policy.

The paper is organized as follows. Section 2 presents an overview of the model economy and the main results for the case of an exogenously given fiscal policy. In the interest of brevity all proofs underlying the results of this section are relegated to a separate Annex that is available upon request. Using the results in section 2 as a benchmark, section 3 endogenizes the fiscal policy of a government that partially caters to special interests of particular constituencies. Section 4 contains the main results of the paper. It identifies structural parameters leading to either seesaw or disciplining effects on government’s tax rate and redistribution. It also examines

---

5For simplicity the paper abstracts from the existence of public goods so that all tax receipts are used for either general or targeted redistribution.

6As a matter of fact our paper can be viewed as contributing a precise mechanism through which seesaw effects might operate in unionized economies.
the robustness of the long run social optimality of strict inflation targeting to the endogenization of fiscal policy. Most proofs of results in sections 3 and 4 appear in the appendix to the paper. This is followed by concluding remarks.

2 Overview of the model

The economy is composed of individuals, firms, a central bank and a fiscal authority (the government). There is a continuum of mass one of monopolistically competitive firms. Each firm is owned by an entrepreneur who earns profits. There are $n$ labor unions that organize the entire labor force. Each union covers the labor force of a fraction $1/n$ of the firms. A quantity $L_0$ of workers is attached to each firm. Without loss of generality, all firms whose labor force is represented by union $i$ are assigned to the contiguous subinterval $(\frac{i}{n}, \frac{i+1}{n})$ of the unit interval, where $i = 0, 1, \ldots, n - 1$.

Individuals. Utility of an individual (be him a worker or an entrepreneur) in the economy is given by:

$$U = \left( \frac{C}{\gamma} \right)^\gamma \left( \frac{M/P}{1-\gamma} \right)^{1-\gamma} + (1 - \lambda)R, \quad \gamma \in (0, 1)$$

(1)

where $C$ is the usual Dixit-Stiglitz (1977) consumption aggregator

$$C = \left( \int_0^1 C_j^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}}, \quad \theta > 1$$

(2)

of imperfectly substitutable consumption varieties, $C_j$, and $\theta$ is the elasticity of substitution between any pair of varieties. $M$ denotes the nominal money stock held by the individual, and

---

7The reader may recognize that the first part of this utility function is identical to the first part of equation (1) in chapter 8 of Blanchard and Fischer (1988). (See also Blanchard and Kiyotaki (1987)).
the price level, $P$, is given by:

$$P = \left( \int_{0}^{1} P_{j}^{1-\theta} \right)^{\frac{1}{1-\theta}}$$

where $P_{j}$ is the price of variety $j$. A worker can be either employed or unemployed. $R$ denotes utility from leisure when unemployed, so that $\lambda = 0$ when the worker is unemployed and $\lambda = 1$ when he is employed. Since all entrepreneurs must forego leisure to manage their firms, we take $\lambda = 1$ for each entrepreneur. Each individual, whether worker or entrepreneur, possesses the same initial endowment of money, $\bar{M}$.

Let $A_{cs}$ denote total nominal resources available to individual $s$ in class $c$ where $c = EW, UW, E$. Here $EW, UW, E$ stand for "employed worker", "unemployed worker", and "entrepreneur" respectively. The budget constraint of individual $s$ states that the nominal resources at his disposition are used to satisfy his consumption demands for the different varieties, $C_{csj}$, plus his demand for nominal money balances, $M_{cs}$:

$$A_{cs} = M_{cs} + \int_{0}^{1} P_{j} C_{csj} dj, \ c = EW, UW, E$$

where

$$A_{EWs} = W_{EWs} + \bar{M} + TR_{W}, \ A_{UWs} = B + \bar{M} + TR_{W}, \ A_{Es} = \Pi_{s} + \bar{M} + TR_{E}.$$  

Here $W_{EWs}$ is the net nominal wage earned by employed worker $s$, $B \geq 0$ is an unemployment benefit paid by government to each unemployed worker, $\Pi_{s}$ is the profit received by firm owner $s$, and $TR_{W}$ and $TR_{E}$ are governmental transfers to each worker (be him employed or unemployed) and employer respectively.\(^8\) For simplicity we focus on the case of zero unemployment benefits.

\(^8\)Due to the homotheticity of preferences, transfers across individuals do not affect the size or composition of demand for goods at given prices (Alesina and Perotti (1997, p.924)).
Each individual \( s \) in class \( c \) chooses the consumption \( C_{csj} \) of each variety \( j \), with \( j \in [0,1] \), and nominal money balances \( M_{cs} \), so as to maximize utility (1), subject to the budget constraint (4).

**Government.** Government raises taxes on labor and utilizes the proceeds to finance transfer payments. As in Alesina and Perotti (1997), there are two types of taxes. A social security tax paid by the employer (at rate \( \sigma \)), and an income tax (at rate \( \nu \)). Denoting by \( W_g \) the gross wage paid to an employee, a firm bears a per-worker cost of labor equal to \((1 + \sigma)W_g\), while the worker receives a net wage equal to \( W = (1 - \nu)W_g \). Thus, the ratio between the net wage and the cost of labor to the firm is given by \( \frac{W}{(1 + \sigma)} \equiv (1 - t) \), and the cost of labor to the firm can be written as \( \frac{W}{(1 - t)} \). Taking (natural) logarithms, the last equation can be reformulated as \( \log W - \log(1 - t) \equiv w + \tau \), where \( -\log(1 - t) \equiv \tau > 0 \). Government tax revenues are used to finance transfer payments (other than unemployment benefits, since here \( B = 0 \)), which are \( TR_W \) per worker and \( TR_E \) per employer. Since the mass of employers is one, the total outlays for those transfers are \( L_0 TR_W + TR_E \). Denoting by \( \chi \geq 0 \) the amount of such transfers as measured per-worker, the government pays out \( \chi L_0 \) where \( \chi \equiv TR_W + \frac{1}{L_0} TR_E \). Total tax revenues are given by \( \frac{tW}{1 - t} (1 - u) L_0 \). We assume the budget is balanced implying that:

\[
\frac{tW}{1 - t} (1 - u) = \chi
\]

where \( u \) is the rate of unemployment.

**Firms.** Given taxation, the real profits of firm \( j \), whose workforce belongs to union \( i \) are given by

\[
\frac{\Pi_{ij}}{P} = \frac{P_j}{P} C_j^a - \frac{W_i}{P(1 - t)} L_{ij}, \quad j \in [0, 1]
\]

\[\text{footnote}{^9}\text{However all the proof in the separate Annex are developed for the more general case } B \geq 0.\]
where \( \sum C_j^a \) denotes the aggregate demand for variety \( j \). Taking the nominal wage \( W_i \) and the general price level \( P \) as given, each firm chooses the price, \( P_j \), of the variety it sells so as to maximize profits subject to the production function

\[
Y_j = L_{ij}^\alpha, \quad \alpha < 1.
\]  

(8)

\( Y_j \) is the amount of this variety that is produced and \( L_{ij} \) is the number of workers employed by firm \( j \) and covered by union \( i \).

**Central Bank.** Monetary institutions are represented by a central bank (CB) that dislikes both inflation, \( \pi \), and unemployment, \( u \). As in Coricelli, Cukierman and Dalmazzo (2006), the CB chooses the money supply so to minimize the combined costs of inflation and of unemployment given by

\[
\Gamma = u^2 + I \cdot \pi^2, \quad I \in [0, \infty).
\]  

(9)

As in Rogoff (1985), the parameter \( I \) measures the relative importance that the CB assigns to the objective of low inflation versus low unemployment. This parameter is also known as the degree of CB conservativeness.

**Labor Unions.** The probability that a member of union \( i \) will be unemployed is identical and independent across the union’s members. Thus, the probability that any union member is unemployed is equal to the rate of unemployment among union members. Taking the nominal wages of other unions as given, each union, \( i \), sets the nominal wage \( W_i \) for its members so as to maximize the expected utility of a representative member. This expected utility is given by

\[
V_i = (1 - u_i) \cdot v_{EW} + u_i \cdot v_{UW}
\]  

(10)

where \( u_i \) is the unemployment rate among union \( i \)’s members and, \( v_{EW} \) and \( v_{UW} \) are the individually optimal values of utility of employed and unemployed workers respectively. We postulate
that the level of utility when employed is larger than utility when unemployed for all real wages higher than or equal to the competitive one. Thus

\[ v_{EW} \geq v_{UW}. \] (11)

This implies that all unemployment is involuntary. We refer to (11) as a "participation constraint".

### 2.1 Timing

We postulate the following sequence of events. In the first stage government sets fiscal policy parameters. Those parameters consist of labor taxes and of transfer payments that reflect government’s politically motivated redistributive objectives. In the second stage each union chooses its nominal wage so as to maximize its objective function (10). When doing this, the union takes the nominal wages set by other unions as given, and anticipates the reactions of both the CB and the firms to its wage choice. In the third stage the CB chooses the nominal stock of money so as to minimize its loss function (9), taking as given the preset nominal wages and anticipating the reaction of firms to its choice. In the last stage, each firm takes the wage and the general price level as given and sets its own price so as to maximize real profits.

This timing sequence is meant to capture, within a static model, the fact that nominal wages are stickier than prices and that they normally are set for a period that is longer than the period for which monetary policy is set.\(^\text{10}\) We view fiscal authorities as the first mover because tax rates and transfers are adjusted relatively infrequently.

---

\(^{10}\)Note that, since there are no shocks in the model the relative position of monetary policy and of price setting by firms within this timing sequence is immaterial for the nature of equilibrium. The reason is that, in the absence of shocks firms perfectly anticipate the subsequent choice of monetary policy by the CB. Hence they set the same prices as those they would have set when monetary policy precedes price setting - - leading to the same monetary policy and an identical equilibrium.
General equilibrium is characterized by backward induction. We start by solving the firms’ pricing problem, then the CB problem, and finally the unions’ nominal wage decisions. First, we briefly characterize equilibrium in the last three stages for *given* values of transfer payments and taxes. Then, we discuss the choice of fiscal policy parameters by a politically motivated government in stage 1. In particular, we discuss the impact on macroeconomic equilibrium of redistributive policies in favor of the general public and/or "special interests".

### 2.2 Equilibrium with exogenous taxation

We take the actions of the government in stage 1 as exogenously given, and solve the model by backward induction starting with the typical firm’s problem. Proofs of all results in the remainder of this section appear in the separate Annex.

**Firm j’s price-setting problem.** When individuals maximize utility (1) with respect to each consumption variety, $C_j$, $j \in [0,1]$ and money, $M$, subject to (4), the resulting aggregate demand for variety $j$ faced by producer $j$ is equal to

$$C_j^a = \left( \frac{\gamma(1 + L_0)}{1 - \gamma} \right) \left( \frac{P_j}{P} \right)^{-\theta} \left( \frac{M}{P} \right).$$

(12)

Firm $j$ maximizes profits (7), subject to technology (8) and demand (12). This yields the optimal pricing rule (in logs):

$$p_j - p = \psi + \frac{\alpha}{D} (w_i + \tau - p) + \frac{1 - \alpha}{D} (\bar{m} - p)$$

(13)

where $D \equiv \alpha + \theta(1 - \alpha)$ and $\psi$ are constants.

**The Central Bank’s money supply decision.** The CB recognizes that (as shown in the Annex) both the inflation rate, $\pi \equiv p - p_{-1}$, and the unemployment rate, $u$, are: (i) increasing functions of the tax wedge $\tau$, and (ii) increasing functions of nominal wages set in the economy.
Moreover, inflation rises and unemployment falls when $\bar{m}$, the logarithm of money supply $\bar{M}$, goes up. The CB choose the money supply $\bar{m}$ so as to minimize the objective function (9), where $I \in [0, \infty)$. The solution to the central bank’s problem yields the following reaction function:

$$
\bar{m} = \mu + \left[ \frac{1 - \alpha(1 - \alpha)I}{K} \right] \cdot \tau + \left[ \frac{(1 - \theta) - D(1 - \alpha)I}{(1 - \theta)K} \right] \cdot \ln \left( \frac{\bar{W}_1}{\frac{1}{K}} \right) - \ln \left( \frac{\bar{W}_2}{\frac{1}{K}} \right)
$$

(14)

where $K \equiv 1 + (1 - \alpha)^2I > 0$, $\mu$ is a combination of exogenous parameter, $\bar{W}_1 \equiv \int_0^1 W_j^{\alpha(1-\theta)} dj$ and $\bar{W}_2 \equiv \int_0^1 W_j^{\alpha} dj$ are aggregations of individual wages.

Equation (14) implies that the sign of the response of the money supply to an increase in the tax wedge, $\tau$, depends on the degree of Central Bank conservativeness (CBC), $I$. Depending on whether $I$ is larger or smaller than $\frac{1}{\alpha(1-\alpha)}$, the CB reacts to an increase in the tax wedge by reducing or raising the money supply. The intuitive reason is that an increase in the tax wedge raises both inflation and unemployment. Although the CB dislikes those changes it cannot fully offset both since it has only one instrument. But, if the CB is sufficiently conservative, it will partially offset the increase in inflation in spite of the fact that this aggravates unemployment.\textsuperscript{11}

Union $i$’s choice of nominal wage. Each monopolistic union $i$, $i \in \{1, 2, \ldots, n\}$, sets the same nominal wage $W_i$ for all its members so as to maximize a typical member’s expected utility, (10). Thus, all firms whose workforce is controlled by union $i$ pay the same nominal wage. In setting its wage, the union takes the demand for its workforce and the nominal wages set by other unions as given. The union also anticipates the impact of its action on subsequent monetary policy as summarized by the monetary policy reaction of the CB in equation (14). We define the wage premium $\phi$ as the logarithmic difference between the wage set by the union,

\textsuperscript{11}It can also be shown that an increase in nominal wages will induce a contraction in the money supply when the CB is sufficiently conservative, that is, if and only if $I > \frac{1}{\alpha(1-\alpha)}$. A related analysis that abstracts from the existence of taxes appears after equation (16) in Coricelli, Cukierman and Dalmazzo (2006).
$W/P$, and the competitive wage, $(W/P)_c$: thus, $\phi \equiv \log(W/P) - \log(W/P)_c$. In a symmetric equilibrium where all unions set the same wage $(W_i = W, \ i = 0,1,...,n)$ a first-order Taylor approximation for the wage premium is given by

$$\phi \approx \left[ \frac{Z_w}{Z_u} + \frac{R}{(1-t)W_x} - 1 \right] - \frac{(1-\gamma)}{\gamma} \frac{\alpha(1-\alpha)}{nKZ_u} \frac{J}{(1-t)}.$$  

(15)

Here $W^g_{rc} = \alpha L_a^{\alpha-1} \frac{(\theta - 1)}{\theta}$ is the level of the gross competitive real wage, $J$ is a constant, and $Z_w$ and $Z_u$ are given by:

$$Z_w \equiv 1 - \frac{1}{n \left[ 1 + (1-\alpha)^2 I \right]} > 0; \quad Z_u \equiv \frac{1}{n} \left[ \frac{\theta(n - 1)}{\alpha + \theta(1-\alpha)} + \frac{(1-\alpha)I}{1 + (1-\alpha)^2 I} \right] > 0.$$  

(16)

$Z_w$ measures the overall elasticity of the union’s net real wage with respect to a change in its nominal wage, and $Z_u$ measures the overall elasticity of the union’s unemployment rate with respect to a change in the union’s nominal wage. These overall elasticities take into consideration the subsequent reactions of the money supply and of the price level to a change in the union’s nominal wage policy. Since it is likely that the weight attached to utility from a unit of aggregate consumption is large in comparison to utility from a unit of real money balances, $\gamma$ is likely to be close to one, implying that the ratio $\frac{1-\gamma}{\gamma}$ is relatively small.

**Equilibrium Unemployment and Inflation rates.** The equilibrium values of the economy-wide unemployment rate, $u$, and of the inflation rate, $\pi$, can be expressed as increasing linear functions of the wage-premium $\phi$ as follows:

$$u = \frac{\phi}{1-\alpha}$$  

(17)

and

$$\pi = \frac{\phi}{(1-\alpha)^2 I}.$$  

(18)
It can be shown that the wage premium, $\phi$, is an increasing function of the tax wedge, $t \left( \frac{d\phi}{dt} > 0 \right)$, and a decreasing function of CBC, $I \left( \frac{d\phi}{dI} < 0 \right)$. Consequently both inflation and unemployment are increasing in $t$ and decreasing in $I$.\(^{12}\) Stated somewhat differently, an increase in the tax wedge reduces employment – a result supported by most empirical studies on unionized European economies like that of Nickell, Nunziata and Ochel (2005).\(^{13}\)

The results described so far hold for any arbitrarily given level of the tax wedge $t$ (or $\tau$). The following subsection contains a preliminary analysis of some welfare implications for such an exogenously given fiscal stance. This analysis provides a partial benchmark for the main analysis in sections 3 and 4 in which the tax wedge is determined endogenously along with other variables.

### 2.3 Social Welfare

This subsection presents the comparative statics effects of taxation and of Central Bank conservativeness (CBC) on welfare for a given fiscal policy stance. Average welfare per individual\(^ {14}\), denoted by $\hat{\psi}$, can be expressed as the following function of the wage premium:

$$
\hat{\psi}(\phi) = \Psi \cdot [1 - \phi]^{1-\alpha} + \frac{L_0}{1+L_0} \left[ 1 - \frac{\phi}{1-\alpha} \right]^{\alpha} + \frac{L_0}{1+L_0} \left[ \frac{\phi}{1-\alpha} \right] \cdot R
$$

\text{(19)}

where $\Psi > 0$ is a constant combination of parameters. An increase in the wage-premium, $\phi$, affects $\hat{\psi}(\phi)$ through three channels: (i) it reduces average utility by reducing income from production, (ii) it increases average utility from leisure by raising the number of unemployed.

---

\(^{12}\)Details and proofs appear in subsection 3.1 of the Annex. Those results provide robustness to similar results in Cukierman and Dalmazzo (2006).

\(^{13}\)See also OECD (1997), Alesina and Perotti (1997), Daveri and Tabellini (2000) and Belot and van Ours (2001).

\(^{14}\)Recall that the mass of individuals in the economy is given by $1 + L_0$ – that is; the mass of entrepreneurs (1) plus the mass of workers per firm ($L_0$).
and (iii) it reduces average utility by reducing aggregate real money balances. We assume that some positive employment is socially desirable which implies that

\[ \alpha [(1 - u) L_0]^\alpha - 1 > R. \]  

(20)

This condition states that the marginal contribution to output (and therefore to welfare from consumption) from an additional employee has to be greater than the value of leisure this worker foregoes when becoming employed. Under this condition an increase in the wage-premium, \( \phi \), unambiguously reduce welfare, i.e. \( \frac{d\bar{v}(\phi)}{d\phi} < 0 \) (A proof appears in Appendix 6.1). Furthermore, given that some employment is socially desirable and taking the tax wedge, \( t \), as exogenously given, it can be shown that:\(^15\)

**Lemma:** Given the participation constraint, (11), and the social desirability of some positive employment, (20), and provided \( (1 - \gamma) \) is sufficiently small, then:

(i) The higher the tax wedge, \( t \), the lower social welfare.

(ii) The higher central bank conservativeness, \( I \), the higher social welfare.

The Lemma states that higher taxation is detrimental to welfare.\(^16\) Given the tax wedge, \( t \), it also implies that an ultra-conservative central banker (with \( I \to +\infty \)) is socially optimal. This result which confirms, for unionized labor markets, Rogoff’s (1985) conclusion in the absence of shocks, is common to several other papers that analyze the strategic interaction between the central bank and labor unions.\(^17\) Roughly speaking it is a consequence of the fact that the more conservative is the central bank, the more it contracts the money supply in reaction to inflationary increases in nominal wages – leading to a more serious contraction

\(^{15}\)A proof appears in section 4 of the Annex.

\(^{16}\)As shown in the Annex, the results in the Lemma also hold when there exists a strictly positive (but smaller than \( \alpha \)) "replacement ratio".

\(^{17}\)See, e.g., Soskice and Iversen (2000) and Coricelli et al. (2006) among others.
in output and labor demand. Fearing the unemployment consequences of this stronger reaction, unions tone down their real (and nominal) wage demands—which leads to an equilibrium with a lower wage premium and higher employment. This disciplining effect on union’s wage demands is highest when the central bank is ultra-conservative. Essentially the deterring effect of central bank conservativeness on unions’ wage demands is maximal in this case.\footnote{During the seventies and the eighties the Bundesbank occasionally contracted the money supply in order to moderate unions’ wage demands.}

Maintaining the conditions postulated in the Lemma the next section reconsiders, inter alia, the issue of optimal central bank conservativeness when a government with some partisan leanings toward general or "special interests" redistribution sets the tax wedge, $t$, and, $\chi$, endogenously.

### 3 Fiscal policy and redistribution.

This section characterizes the first stage of the game in which a political authority picks fiscal instruments, anticipating the reactions of labor unions, the Central Bank and price setters in subsequent stages. Formally, the fiscal authority acts as a Stackelberg leader.

It is well known that the motives of political authorities and of social planners are not fully aligned. Although this does not necessarily mean that politicians do not care at all about social welfare, it usually implies that they also care about general redistribution, as well as about redistribution in favor of particular constituencies. We therefore endow fiscal authorities with an objective function that is a weighted average of social welfare and of total redistribution. In particular, government’s objective function is given by:

$$Y = \delta \cdot \left[ \frac{\chi}{P} L_0 \right] + (1 - \delta) \cdot \hat{v}$$

(21)
The term $\frac{\chi}{P}L_0$ on the right-hand side of (21) represents the total amount of real transfer payments. Thus, the parameter $\delta \in [0,1]$ represents the weight assigned by government to total redistribution and $1-\delta$ represents the weight assigned to $\hat{v}$, the indirect average utility of individuals in the economy in (19). The balanced-budget condition in (6) can be written as

$$\frac{\chi}{P}L_0 = \frac{W}{P}t(1-u)L_0 \equiv T(t).$$  \hspace{1cm} (22)$$

where the left hand side of (22) represents total real redistribution and the right hand side represents total real tax revenues.

The instrument of fiscal policy - the tax rate $t$ - is chosen to maximize (21) subject to (22). To develop some intuition about the mechanisms underlying government’s choice, it is convenient to start with two extreme particular cases: (i) a government that has no interest in redistribution ($\delta = 0$) and, (ii) a government that only cares about redistribution ($\delta = 1$).

**Case (i).** A government that only cares about social welfare gives no weight to redistribution ($\delta = 0$) and sets $t$ so as to maximize $\hat{v}$. Part (i) of the Lemma implies that welfare is maximized when $t = 0$. Hence, like a Benthamite social planner, a government with no redistributinal concerns will impose no taxes.$^{20}$

**Case (ii)** A fully partisan government that only cares about the special interests of its favored constituency ($\delta = 1$) chooses the tax wedge, $t$, so as to maximize $T$, the amount of funds available for redistribution in (22). Formally such a government sets the tax wedge, $t$, so that the condition $\frac{dT(t)}{dt} = 0$ is satisfied.$^{21}$

---

$^{19}$See also the discussion preceding equation (6). Since $\chi \equiv TR_W + \frac{1}{T_0}TR_E$ is the average transfer per worker in the economy, $\chi L_0$ represent total nominal transfers. Note that, although transfers are measured per worker, they can accommodate any pattern of transfers between workers and entrepeneurs.

$^{20}$Obviously, this extreme conclusion is a consequence of the implicit assumption that utility from public goods is zero. In the presence of utility from public goods there will be, in this case, some taxation but only to finance the public good.

$^{21}$Such a political equilibrium arises in Meltzer and Richard (1981) when the median voter in their model does not work.
3.1 Characterization of \( t \) and of the size of government in the general case

To characterize the equilibrium values of \( t \) and of total redistribution in the intermediate case, in which \( 0 < \delta < 1 \), we need to express all the components of \( T \) in (22) as a function of \( t \). Since both the real wage and unemployment depend on \( t \) via the wage premium, we start by expressing \( T \) in terms of the wage premium \( \phi(t) \), which itself is a function of the tax wedge. By exploiting the approximation \( \frac{W}{P} \approx \frac{W^g_{re} \cdot (1-t)}{1-\phi(t)} \) in (22), expression (21) - the objective function of the fiscal authority - can be expressed as a function of \( t \):

\[
\Upsilon(t) = \delta \cdot T + (1 - \delta) \cdot \hat{v} \cong \delta \left( \frac{W^g_{re} \cdot t \cdot L_0}{1 - \phi(t)} \right) \left[ 1 - \frac{\phi(t)}{1 - \alpha} \right] + (1 - \delta) \cdot \hat{v}(t) \tag{23}
\]

where the function \( \hat{v}(t) \) is given by (19). At an internal solution, the tax rate \( t* \) that maximizes government’s objective (23) satisfies the first-order condition

\[
\frac{d\Upsilon(t^*)}{dt} = \delta \frac{dT(t^*)}{dt} + (1 - \delta) \frac{d\hat{v}(\phi(t^*))}{d\phi} \frac{d\phi}{dt} = 0 \tag{24}
\]

By the Lemma \( \frac{d\hat{v}(\phi(t^*))}{d\phi} < 0 \), and provided \( 1 - \gamma \) is sufficiently small, \( \frac{d\phi}{dt} > 0 \). Hence the second term on the right hand side of (24) is negative. Consequently, \( \frac{dT(t^*)}{dt} > 0 \) for all \( \delta < 1 \) establishing that government operates on the efficient side of the Laffer curve. Thus, in equilibrium, the size of redistribution (and therefore the "size of government") is increasing in the tax wedge.

Application of the implicit function theorem to (24) yields

\[
\frac{dt^*}{d\delta} = - \frac{\frac{dT(t^*)}{dt} - \frac{d\hat{v}(\phi(t^*))}{d\phi} \frac{d\phi}{dt}}{SOC(t^*)}
\]

where \( SOC(t^*) < 0 \) is the second order condition for government’s decision problem. Condition (24) implies that \( \frac{dT(t^*)}{dt} - \frac{d\hat{v}(\phi(t^*))}{d\phi} \frac{d\phi}{dt} > 0 \). This leads to the following proposition.
Proposition 1: Governments with stronger redistributive concerns (higher $\delta$) set higher tax wedges.

Thus, governments with stronger redistributive motives set a higher tax wedge in order to raise general as well as "special interests" redistribution.

4 Seesaw and disciplining effects of central bank conservativeness on taxation, redistribution and social welfare

The impact of an increase in CBC on government’s tax policy is generally ambiguous, since it triggers two opposing effects. On one hand, by raising the tax base for a given tax, an increase in $I$ tends to increase the marginal impact of $t$ on tax revenues. This effect encourages the government to raise the tax wedge due to its concern for redistribution. On the other hand, higher CBC, by magnifying the adverse effect of $t$ on the wage premium and unemployment, encourages government to reduce the tax wedge. This effect operates via government’s concern about general social welfare as well as through the reduction this causes in the tax base. Depending on which of those two effects dominates, central bank reform triggers either a seesaw or a disciplining effect on government’s choice of tax policy. The following discussion identifies conditions for the existence of either effect.\(^{22}\)

\(^{22}\)As in the earlier discussion this discussion relies on the assumption that utility from real money balances is small in comparison to utility from the total consumption basket ($\gamma$ in equation (1) is close to one).
4.1 Seesaw and disciplining effects

Applying the implicit function theorem to (24)

$$\frac{dt^*}{dI} = \delta \frac{d^2T}{dtdI} + (1 - \delta) \left[ \frac{d^2\tilde{v}}{d\delta dI} \frac{d\phi}{dt} + \frac{d\tilde{v}}{d\delta} \frac{d^2\phi}{d\delta dI} \right] - SOC(t^*). \tag{25}$$

where $SOC(t^*) < 0$ is the second order condition for government’s optimization. It is shown in Appendix 6.1 that $\frac{d\tilde{v}}{d\phi} < 0$ and in Appendix 6.2 that $\frac{d^2\phi}{d\delta dI} > 0$ and $\frac{d^2\tilde{v}}{d\delta dI} > 0$. Those inequalities imply that $\frac{d\tilde{v}}{d\phi} \frac{d^2\phi}{d\delta dI} < 0$ and, since $\frac{d\phi}{dt} > 0$, that $\frac{d^2\tilde{v}}{d\delta dI} \frac{d\phi}{dt} > 0$. Hence, the sign of the second term in the numerator on the right hand side (RHS) of (25) is generally ambiguous. Although the sign of $\frac{d^2T}{dtdI}$ is also ambiguous in general it can be shown that, when $\frac{d^2\phi}{d\delta dI}$ is not too large, $\frac{d^2T}{dtdI}$ is positive. Since in this case the second term in brackets in the numerator is also positive, $\frac{dt^*}{dI} > 0$.

Those considerations underlie the following proposition.\(^{23}\)

**Proposition 2:** *If the (non-negative) cross-derivative $\frac{d^2\phi}{d\delta dI}$ is not too large the tax wedge, $t^*$, set by fiscal authorities is increasing in the level of Central Bank conservativeness, $I$.*

Thus, under certain circumstances, higher CBC generates a "seesaw" effect on government’s behavior, inducing it to raise the tax wedge. Acemoglu et al. (2008) argue that sensible reforms do not always generate the benefits that they promise because, in the presence of strong political demands, the new constraints imposed by reform in a particular area are often offset by more intensive use of other distortionary instruments to satisfy the same politically powerful constituencies. Taking the success of central bank independence in reducing inflation as an example they show empirically that this offsetting or seesaw effect is weaker in countries with intermediate quality levels of political institutions.

Proposition 2 provides a sufficient condition for the operation of a seesaw effect between

\(^{23}\)Further details appear in Appendix 6.2
central bank reform and fiscal policy in countries with highly unionized labor markets. Broadly speaking the political economy content of this condition is that such an effect is more likely to appear when the (non-negative) impact of an increase in CBC on $\frac{d\phi}{dt}$ is sufficiently small. This condition implies that the increase in CBC induces only a moderate increase in the adverse marginal impact of the tax rate on the wage premium. As a consequence, the increase in the adverse direct effect of $t$ on marginal tax collections as well as on marginal social welfare are small in comparison to the increase in the indirect positive effect of $t$ on marginal tax collections due to the increase in the tax base. As a result the second effect dominates, creating a seesaw effect.

The first part of the next proposition identifies conditions leading to a negative impact of central bank reform on government’s choice of tax policy and the second identifies conditions under which this policy is independent of CBC. 24

**Proposition 3:**

(i) When the fiscal authority is concerned mainly with social welfare ($\delta$ close to zero), and $\frac{d^2\phi}{dt\cdot di}$ is relatively large, the tax wedge $t^*$ set by fiscal authorities is decreasing in the level of Central Bank conservativeness, $I$.

(ii) For sufficiently high levels of $I$ and for all $n > 3$ the tax wedge, $t^*$, is independent of $I$.

The first part of Proposition 3 suggests that, if $\frac{d^2\phi}{dt\cdot di}$ is sufficiently large and government has only moderate redistributive objectives, an increase in CBC disciplines government by inducing it to decrease the tax wedge. Thus, in the presence of unionized labor markets, an increase in CBC generates a seesaw effect under some circumstances and a disciplining effect.

24 The proof appears in Appendix 6.3.
on government under other circumstances. The second part of Proposition 3 provides a sufficient condition for the borderline case in which both effects are absent.

We turn next to the impact of CBC on total government tax collection, $T(t)$, and redistribution. Holding the tax wedge, $t$, constant an increase in CBC raises tax collections by increasing the tax base. This effect operates through the moderating impact that higher CBC has on the wage premium. In the presence of a seesaw effect on $t$ there is a further increase in tax collections and redistribution making the increase in redistribution even larger. But in the presence of a disciplining effect on $t$ there is a moderating effect on tax collections and redistribution. This is summarized in the following proposition.\textsuperscript{25}

**Proposition 4:**

(i) In the presence of a seesaw effect of $I$ on $t^*$ the total impact of an increase in CBC on tax collections, $T(t)$, and redistribution is positive.

(ii) In the presence of a disciplining effect of $I$ on $t^*$ the total impact of an increase in CBC on tax collections and redistribution is ambiguous.

The recent economic history of Argentina, in which union coverage is non negligible, is consistent with the first part of the proposition. In particular, the 1991 upgrading of central bank independence in this country was followed by both a fall in inflation and an increase in government expenditures as a percent of GDP. Note, however, that this fact alone does not discriminate between the seesaw and the disciplining effects of CBC. The reason is that, by the second part of the proposition, government expenditures can go up even in the presence of a disciplining effect provided this effect is sufficiently small in comparison to the direct positive effect of higher CBC on the tax base.

\textsuperscript{25}The proof appears in Appendix 6.4.
4.2 Central Bank conservativeness and social welfare

To this point we have been concerned with the impact of CBC on government’s tax policy. A related important question is what is the impact of Central Bank reform on social welfare when fiscal policy is endogenous. The analysis in section 2 has shown that, given fiscal policy, such a reform – by raising CBC – always raises welfare. However, proposition 2 implies that, when fiscal instruments are allowed to react to the change in $I$, this may no longer be the case in line with the seesaw argument.

To explore this issue we focus on the following specific question: Under what conditions will a potential seesaw effect between CBC and the tax wedge reduce welfare to an extent that more than offsets the direct beneficial effect of an increase in CBC on welfare? To answer this question we first note that a change in $I$ affects welfare only through the wage premium and that (by Appendix 6.1) welfare is a decreasing function of the wage premium. Hence in order to establish the overall impact of an increase in CBC on welfare in the presence of reactive fiscal policy it suffices to investigate the impact of $I$ on the wage premium, $\phi$. For a sufficiently small value of $(1 - \gamma)$ in (15), the total derivative of $\phi$ with respect to $I$ (which also accounts for the effect of $I$ on the equilibrium tax wedge $t^*$) is:

$$\frac{d\phi(t^*)}{dI} = \frac{\hat{K}}{1 - \alpha} \left[ 1 - \alpha \frac{R}{(1-t)W_{pc}^{\gamma}} \frac{d\left(\frac{Z_w}{Z_u}\right)}{dI} + \frac{R}{(1-t)^2W_{pc}^{\gamma}} \left(1 - \alpha \right) + \alpha \frac{Z_w}{Z_u} \left(1 - \alpha \right) \frac{dt^*(I)}{dI} \right]$$

(26)

where $\hat{K}$ is a positive constant, and $\left[1 - \alpha \frac{R}{(1-t)W_{pc}^{\gamma}}\right] > 0$ by the participation constraint. Using equation (16)

$$\frac{d\left(\frac{Z_w}{Z_u}\right)}{dI} = -\frac{(1 - \alpha)(n - 1)}{\left\{ \theta(n - 1) \frac{1 + (1 - \alpha)^2 I}{\alpha + \theta(1 - \alpha)} + (1 - \alpha)I \right\}^2 \left( \alpha + \theta(1 - \alpha) \right)} \left\{ \alpha + (1 - \alpha)^2 D I \right\}$$

(27)
which is negative for all \( n > 1 \). Together with (26) this confirms that (excluding the case \( n = 1 \)), when the tax wedge does not change or goes down, welfare is monotonically increasing in CBC as was the case when fiscal policy was exogenous. But in the presence of a seesaw effect \( \frac{d\pi^*(f)}{df} > 0 \) implying that the second term on the right hand side of (26) is positive. For a given value of the first term this raises the wage premium and reduces welfare. Thus, in the presence of a seesaw effect the overall impact of higher CBC on welfare depends on the relative magnitudes of the (negative) effect of the seesaw and of the direct (positive) effect of higher CBC on aggregate welfare.

5 Concluding remarks

Since the end of the eighties and mainly through the nineties there has been a worldwide trend of central bank reform. In practically all cases central banks were granted higher independence. A major feature of this process was the high priority assigned by law to the price stability objective in the central bank charter making central banks more effectively conservative. Acemoglu et. al. (2008) argue that, although the reforms reduced inflation, they triggered (mainly in countries with low government quality) offsetting adjustment in other areas of governmental activity. Thus, following the introduction of central bank independence in Columbia and Argentina in 1991, inflation went down and government expenditures went up.

This paper identifies political-economy channels through which an increase in central bank conservativeness (CBC) induces fiscal authorities to raise labor taxes in economies with unionized labor markets – creating a seesaw effect between central bank reform on one hand and tax cum redistribution policy on the other. A central message of the paper is that seesaw effects are neither the rule, nor the exception. Although such effects arise under some structural

\(^{26}\)Cukierman (2008) provides a survey of this process.
configurations, central bank reform triggers a decrease in labor taxes under other structural configurations – creating a disciplining effect of reform on taxation and redistribution. An important factor that determines whether, following reform, the tax rate will go up or down is the magnitude of the impact of higher CBC on the marginal effect of a higher tax rate on the wage premium.27

The paper shows that, invariably, an increase in conservativeness raises the impact of the tax rate on the wage premium. A seesaw or a disciplining effect arises depending on whether this increase is small or large. The intuition underlying this result follows from the observation that, by reducing income and the tax base, a higher marginal impact of labor taxes on the wage premium, has a stronger deterrent impact on government’s tendency to raise the tax rate.28 But at sufficiently high levels of CBC seesaw, as well as disciplining effects, become negligible. In these cases the size of government still goes up due to the direct upward impact of central bank reform on the tax base. As a matter of fact the size of government may go up even in the presence of moderate disciplining effects. But, in the presence of seesaw effects the size of government always goes up following central bank reform.

Previous literature on the strategic interaction between monetary policymaking institution has shown that, in the absence of stabilization policy, strict inflation targeting is socially optimal (Soskice and Iversen (2000), Coricelli, Cukierman and Dalmazzo (2006).29 But in those frameworks fiscal policy is given exogenously. When, government’s reaction to central bank reform takes the form of a seesaw effect, the optimality of strict inflation targeting may no longer obtain. As with exogenous fiscal policy, central bank reform still directly increases welfare by

27 In unionized economies the wage premium over the competitive wage is positive and is increasing in the labor tax rate.
28 This deterrence effect operates through both government’s concern about social welfare as well as about the volume of redistribution.
29 In the absence of stabilization policy this result already arises in Rogoff (1985) classic paper. But in Rogoff’s paper the sole reason for this result is lower inflation whereas, in the presence of strategic interactions the optimality of strict inflation targeting arises because of both lower inflation and higher employment.
lowering the wage premium and through it inflation and unemployment. However, the presence of a seesaw effect operates in the opposite direction opening the door for the possibility that flexible inflation targeting is optimal even in the absence of stabilization policy.

6 Appendix.

6.1 The impact of $\phi$ on $\hat{\nu}(\phi)$

Differentiating $\hat{\nu}(\phi)$ in (19) with respect to $\phi$ and rearranging

$$
\frac{d\hat{\nu}(\phi)}{d\phi} = -\Psi \left( \frac{\alpha}{1 - \alpha} \right) [1 - \phi]^{\frac{2\alpha - 1}{1 - \alpha}} - \frac{L_0}{(1 + L_0)(1 - \alpha)} \left[ \alpha (L_0(1 - u))^{\alpha - 1} - R \right] \tag{28}
$$

Since $\Psi \equiv \left( \frac{1 - \gamma}{\gamma} \right) \left( \frac{L_0}{1 + L_0} \right) \left[ \frac{\theta \exp(\alpha)}{\alpha(\theta - 1)} \right] > 0$ and $\gamma$ is close to zero the first term vanishes. Condition (20) implies that the second term is negative implying that $\frac{d\hat{\nu}(\phi)}{d\phi} < 0$.

6.2 Government’s choice of the tax wedge and proof of Proposition 2

The proof starts with two intermediate claims.

Claim 1: It holds that $\frac{d^2\phi}{dt\,dI} > 0$.

Proof: For $(1 - \gamma)$ sufficiently small,

$$
\frac{d\phi}{dI} = \frac{1}{D(1 - \alpha)} \left\{ 1 - \alpha \left( \frac{R}{(1 - t)W^g_e} \right) \right\} \frac{d\left( \frac{Z_w}{Z_a} \right)}{dI} < 0
$$

25
which, from (27), is negative. Differentiating \( \frac{d\phi}{dt} \) with respect to \( I \) and rearranging:

\[
\frac{d^2 \phi}{dIdt} = -Q_1 \left\{ \frac{\alpha}{1 - \alpha} \frac{Z_w}{Z_u} + \left[ 4 - \frac{\alpha R}{(1-t)W_{rc}} \right] \right\} \frac{d\left( \frac{Z_w}{Z_u} \right)}{dI}
\]

(29)

where \( Q_1 \) is a positive constant. The participation constraint (11) implies that \( \frac{R}{(1-t)W_{rc}} \leq 1 \) and, thus, that \( \frac{\alpha R}{(1-t)W_{rc}} < 1 \). The proof of Claim 1 is completed by noting that \( \frac{d^2 \phi}{dIdt} > 0 \), as claimed.

Claim 2: If \( \frac{d^2 \phi}{dt \cdot dI} \) is not too large, then it holds that \( \frac{d^2 T}{dt \cdot dI} > 0 \).

Proof: Differentiating \( T \) in (22) with respect to \( t \), one obtains that:

\[
\frac{dT}{dt} = \frac{W_g \cdot L_0}{1 - \alpha} \left[ \frac{1 - \alpha - \phi}{(1 - \phi)} - \frac{\alpha \cdot t}{(1 - \phi)^2} \left( \frac{d\phi}{dt} \right) \right]
\]

(30)

where \( 1 - \alpha - \phi > 0 \). Differentiating (30) with respect to \( I \),

\[
\frac{d^2 T}{dt \cdot dI} \equiv H_1 = \frac{\alpha \cdot W_{rc} \cdot L_0}{(1 - \alpha)(1 - \phi)^2} \left\{ \left( -\frac{d\phi}{dI} \right) \left[ 1 + \frac{2t}{(1 - \phi)} \frac{d\phi}{dt} \right] - t \left( \frac{d^2 \phi}{dt \cdot dI} \right) \right\}.
\]

(31)

We saw (at the end of section 2.2) that \( \frac{d\phi}{dt} > 0 \). Hence the first term in curly parentheses in (31) is positive. However, since \( \frac{d^2 \phi}{dt \cdot dI} > 0 \), the second term in curly parentheses is negative. It follows that the sign of (31) is positive whenever \( \frac{d^2 \phi}{dt \cdot dI} \) is not too large. This establishes Claim 2. Hence the first term in the numerator on the right hand side (RHS) of (25) is positive.

For \( (1 - \gamma) \) sufficiently small, and using equations (15) and (19),

\[
\frac{\bar{v}}{dt} = \frac{\bar{v}}{d\phi} \times \frac{d\phi}{dt} = -L_0 \left[ \alpha \frac{L_0(1 - u)^{\gamma - 1} - R}{(1 + L_0)(1 - \alpha)} \right] \times \frac{d\phi}{dt}.
\]

(32)

\(^{30}\) is a positive combination of parameters whose explicit form is irrelevant for the argument.
Differentiating the expression for \( \frac{db_v}{d\phi} \) in (32) with respect to \( I \) yields:

\[
\frac{d^2 \hat{v}}{dId\phi} = \frac{d}{dI} \left[ -L_0 \left[ \alpha \left[ L_0(1-u)\right]^{\alpha-1} - R \right] \right] = \left[ -\alpha L_0^\alpha (1-u)^{\alpha-2} \right] \times \frac{d\phi}{dI} > 0. \tag{33}
\]

Recall that \( \frac{d\phi}{dt} > 0 \) and \( \frac{d\phi}{d\phi} < 0 \) (see end of subsection 2.2). Equation (33) along with the second inequality implies \( \frac{d^2 \hat{v}}{d\phi dI} > 0 \). Along with \( \frac{d\phi}{dt} > 0 \) the last inequality implies that \( \frac{d^2 \hat{v}}{d\phi dI} \frac{d\phi}{dt} > 0 \). Thus, the second term in the numerator on the right hand side (RHS) of (25) is also positive.

However, from Claim 1, \( \frac{d^2 \phi}{d\phi dt} > 0 \) and from Appendix 6.1, \( \frac{d\phi}{d\phi} < 0 \). Hence, it holds that \( \frac{db_v}{d\phi \frac{d^2 \phi}{d\phi dt}} < 0 \): the third term in the numerator on the right hand side (RHS) of (25) is negative.

Consequently, the sign of the last expression in brackets on the RHS of (25) is generally ambiguous. However, when \( \frac{d^2 \phi}{d\phi dt} \) is sufficiently small, the positive terms in the numerator dominate establishing that \( \frac{dt^*}{dt} > 0 \).

### 6.3 Proof of proposition 3

(i) When the fiscal authority is concerned mainly with social welfare the first term in the numerator on the RHS of (25) is dominated by the second term. Since the cross derivative \( \frac{d^2 \phi}{d\phi dt} \) is relatively large this second term is dominated by the product \( \frac{db_v}{d\phi \frac{d^2 \phi}{d\phi dt}} \) which is negative. Hence \( \frac{dt^*}{dt} < 0 \).

(ii) Following a substantial amount of messy algebra it can be shown that equation (25)
may be rewritten

\[- SOC(t^*) \frac{dt^*}{dI} = -\delta \frac{\alpha \cdot W'_{rc} \cdot L_0}{(1 - \alpha) (1 - \phi)^2} \left[ 1 + \frac{2t}{(1 - \phi)} \frac{d\phi}{dt} \right] \frac{1}{D_1^2(1 - \alpha)} \left\{ 1 - \alpha \left( \frac{R}{(1 - t) W'_{rc}} \right) \right\} \frac{d \left( \frac{Z_w}{Z_u} \right)}{dI} \]

\[-(1 - \delta) \frac{d\phi}{dt} \left[ \frac{\alpha L_0^\alpha (1 - u)^{\alpha - 2}}{(1 + L_0)(1 - \alpha)} \right] \times \frac{1}{D_1^2(1 - \alpha)} \left\{ 1 - \alpha \left( \frac{R}{(1 - t) W'_{rc}} \right) \right\} \frac{d \left( \frac{Z_w}{Z_u} \right)}{dI} \]

\[+ \{Q_2 - Q_3\} \frac{d^2\phi}{dt^2} \cdot dI \]

(34)

where

\[
\begin{align*}
Q_2 &\equiv \delta \frac{d\phi}{dt} \frac{\alpha \cdot W'_{rc} \cdot L_0}{(1 - \alpha) (1 - \phi)^2} \\
Q_3 &\equiv (1 - \delta) \left\{ \frac{\alpha L_0^\alpha (1 - u)^{\alpha - 2}}{(1 + L_0)(1 - \alpha)} \left[ \frac{1}{n - 1} \frac{\partial}{\partial t} (n - 1) \right] + \frac{L_0}{(1 - \alpha)} \left[ \alpha (1 - u) \right] \right\} \\
d^2\phi \frac{d^2\phi}{dt^2} &= -Q_1 \left\{ \frac{\alpha Z_w}{1 - \alpha Z_u} + \left[ 4 - \alpha \frac{R}{(1 - t) W'_{rc}} \right] \right\} \frac{d \left( \frac{Z_w}{Z_u} \right)}{dI} 
\end{align*}
\]

(35)

and where \(Q_1\) and \(D_1\) are bounded combinations of parameters that do not depend on \(\frac{d \left( \frac{Z_w}{Z_u} \right)}{dI}\).

Equations (34) and (35) imply that \(\frac{dt^*}{dI}\) may be rewritten as

\[
\frac{dt^*}{dI} = \frac{CTI \frac{d \left( \frac{Z_w}{Z_u} \right)}{dI}}{-SOC(t^*) \frac{d \left( \frac{Z_w}{Z_u} \right)}{dI}}
\]

(36)

where \(CTI\) is a bounded combination of parameters that does not depend on \(\frac{d \left( \frac{Z_w}{Z_u} \right)}{dI}\). Differentiating (15) with respect to \(I\)

\[
\frac{d \left( \frac{Z_w}{Z_u} \right)}{dI} = -\frac{(1 - \alpha)(n - 1)}{D} \left\{ \frac{1}{I} + (1 - \alpha)^2 D \right\} < 0
\]

(37)

where \(D \equiv \alpha + \theta(1 - \alpha)\). It is easy to see from (37) that, when \(I \to \infty\), \(\frac{d \left( \frac{Z_w}{Z_u} \right)}{dI}\) vanishes.
Differentiating $\frac{d(Z_w)}{dI}$ again with respect to $I$ and applying some further algebra it can be shown that for $n > 3$

$$\frac{d^2 \left( \frac{Z_w}{Z_u} \right)}{dI^2} > 0$$

implying that the absolute value of $\frac{d(Z_w)}{dI}$ converges monotonically to zero as $I$ increases. Hence
for $n > 3$ and $I$ sufficiently large $\frac{dt^*}{dI}$ in equation (36) becomes negligible implying that, at sufficiently large levels of CBC, seesaw and/or disciplining effects become negligible.

### 6.4 Proof of proposition 4

Let $W_{rc}^g$ be the gross real competitive wage rate. The definition of the wage premium implies.

$$\frac{1}{1-t} \cdot \frac{W}{P} = \frac{W_{rc}^g}{(1-\phi)}.$$

Using this relation and (17) in (22) total tax revenues can be expressed as

$$T(t) = \frac{t \cdot W_{rc}^g \cdot L_0}{(1-\phi)} \left[ 1 - \frac{\phi(t(I),I)}{1-\alpha} \right]$$

where the arguments of the wage premium are written explicitly to highlight the fact that the premium depends on $I$ directly trough the tax base as well as because CBC generally affects the choice of tax wedge. Differentiating totally with respect to $I$

$$\frac{dT}{dI} = W_{rc}^g \cdot L_0 \left\{ - \frac{1}{1-\phi} \cdot \left[ \frac{1}{1-\phi} \left( 1 - \frac{\phi}{1-\alpha} \right) \frac{dt}{dI} + \frac{t}{(1-\phi)(1-\alpha)} \left[ \frac{\partial \phi}{\partial I} + \frac{\partial \phi}{\partial t} \cdot \frac{dt}{dI} \right] \right] \right\}.$$
Rearranging:

\[
\frac{dT}{dI} = \frac{W_{tc} \cdot L_0}{(1 - \phi) (1 - \alpha)} \left\{ - \frac{\alpha t}{1 - \phi} \left( \frac{\partial \phi}{\partial I} \right) + \left[ (1 - \alpha - \phi) - \frac{\alpha t}{1 - \phi} \left( \frac{\partial \phi}{\partial t} \right) \right] \right\} \frac{dt}{dI} \tag{39}
\]

The sign of (39) is the same as the one of the sum of terms in curly brackets. The first-term in curly brackets is positive, since \( \frac{\partial \phi}{\partial I} < 0 \). Note that the second term in curly brackets, 
\[
\left[ (1 - \alpha - \phi) - \frac{\alpha t}{1 - \phi} \left( \frac{\partial \phi}{\partial t} \right) \right],
\]
captures both the direct and the indirect effect (working through \( \phi \)) of the tax-rate \( t \) on tax revenues, \( T \). Since, from equation (22) government operates on the efficient side of the Laffer curve, this expression is positive. Hence, in the presence of a seesaw effect (i.e., \( \frac{dt}{dI} > 0 \)) and \( \frac{dT}{dI} \) must be positive. In the presence of a disciplining effect (i.e., \( \frac{dt}{dI} < 0 \)) the second term in the curly brackets is negative implying that the sign of \( \frac{dT}{dI} \) is generally ambiguous.

7 References


Rogoff K. (1985), ”The Optimal Degree of Commitment to a Monetary Target”, Quarterly Journal of Economics, 100, 1169-1190.
