1 Bonding and the Institutions of Bonding

Some of the institutions of the welfare state created after World War II in Europe can be seen as instruments able to change the internal dynamics of an economic system, as they were promoters of economic growth and higher levels of output in the long run. Schelling (1960) and Eichengreen (in Crafts and Toniolo, 1996) refer to these institutions as bonding institutions. There were institutions to bond capital such as subsidies for steel and aircraft industry in Germany, or regulations limiting the payments of dividends by public companies in Sweden. Other institutions targeted labor bonding: health insurance, child benefits and centralized pensions in Belgium, legislation at improving working conditions in Norway, policies of retraining, education and job placement services in Sweden. Besides these material incentives, bonding institutions also served to improve connections between government and various categories of economic agents. For example in order to monitor the compliance to commonly agreed on policies unions and employers' associations were encouraged to exchange information through government. There were also improved connections between various groups of economic agents. Employees were allowed to be represented in the executive board of a corporation. 'Solidarity' between agents of various ages, sex or skills was promoted by a system of centralized pensions, by social pacts which entailed narrowing earning differentials between men and women or intrasectorial income disparities.

In this way bonding institutions led to higher productivity and higher wages and output in equilibrium (Eichengreen, op.cit.). Bonding institutions should be therefore viewed as sharing of work facilities among different types of agents to provide a social safety net. They differ from simple public transfers in two aspects. They affect the way the agents work rather than directly increase their consumption. They also allow agents to commit to long term growth policies.

It is the goal of this paper to model bonding institutions as extensions of government spending targeted at changing the internal dynamics of an economic system in the long run. The economy will move from a stable equilibrium with low output to one with high GDP per capita. To account for the effect of bonding institutions the model used in the present paper is overlapping generations with population growth as in Farmer and Woodford (1997) and Farmer (1999). I extend their model by making the utility function take into account improvements in working conditions and labor productivity. That is translated in the model into a lower disutility from work. A similar extention and a similar utility function, with a non-monetary effort cost incurred by an individual when young, was considered by Aghion and Howitt (1998). In their model improvements in working conditions were replaced by increases in the productivity of the current technology.

Unlike in the above models, there is no uncertainty in this one. The dynamic system yields two steady states. The one with a higher output level is desirable but unstable and therefore unattainable. The other equilibrium is stable yet has an undesirably low production level. I model bonding as increments in public funding that reduce the disutility from work of young agents and induce in this way a movement from the equilibrium with low to the one with high output. Small perturbations, such as increased public expenditures for mere government consumption, are used to check the stability of the new equilibrium output.

In a similar model with two equilibria (one low, one high) McCallum (1997) uses the method of minimal state-variable to move to the equilibrium with a higher output. In his case there is no dynamics, the economic system simply chooses the higher equilibrium. There are no additional costs involved in the process. While the likelihood of such a fortunate case it is not zero, it is also not very high. Most countries had to voluntarily redirect some of their output to pursue growth oriented economic policies. My paper considers growth as a costly act in terms of public funds. Dynamical patterns change as a result of the new type of public expenditures.

In what follows I describe the model, the changing dynamical patterns induced by bonding, and then analyze the economic conditions under which a country will create bonding institutions.

2 OLG Model with Bonding

The economy consists of a monetary overlapping generations model in which each agent lives for two periods: agents work when young, and consume when old. Within each generation agents are identical and their preferences can be represented by the following utility function:

$$U_t(c_{t+1}, l_t) = c_{t+1} - \mu(b, \nu) g(l_t) \quad (1)$$

so that each agent gets utility from tomorrow's consumption (c_{t+1}) and disutility from today's work (a function of labor $g(l_t)$). This particular utility function is a theoretical abstraction to describe an agent that values consumption, as well as better working conditions (translated into a decrease in the disutility from work, measured by the factor $\mu(b, \nu) \in [0, 1]$ - any value of μ below 1 indicates a reduction in disutility). It assumes that a young agent is directly interested in working conditions and only indirectly in consumption. Therefore consumption is absent in the first period, replaced by the disutility from work. Consumption is relevant for the utility function only during the second period of life of the agent, when the agent retires from the labor market.

A generation that lives in periods t and t+1 is referred to as generation t. In the first period of life, each agent of generation t supplies labor l_t. There is a single perishable consumption good each period, produced at constant returns to scale through the labor of the young agents in that period:

$$y_t = l_t \tag{2}$$

where y is output. Each generation t has population levels N_t. Population grows at rate ν and wages have the same level as the price:

$$N_{t+1} = (1 + \nu)N_t \qquad\qquad w_t = p_t \tag{3}$$

suggesting that any increase in prices has to be translated into an increase in wages. Since consumption is perishable, there is one other good in this economy used for saving. One can call that money, but shells or land (even though land could be used for production - and this is not the case here) might be better (see McCallum, 1997). 'Money' holdings at the beginning of the second period of life are spent on consumption during that period.

The main innovation brought to this generic model is that the disutility from work is no longer a constant. It remains a function of labor yet it is now affected by the public institution through the *bonding term* $\mu(b, \nu)$. This term depends on the level of public expenditures for bonding b and population growth ν.

In the rest of the paper I will consider the example from Farmer and Woodford (1997) and Farmer (1999) such that each agent solves the following optimization problem:

$$\max_{c_{t+1}, l_t} U_t = c_{t+1} - \frac{1}{2}\,\mu(b, \nu)\, l_t^2 \text{ s.t. } \left\{ \begin{array}{lcl} p_t y_t & = & M_t \\ p_{t+1} c_{t+1} & = & M_t \end{array} \right. \tag{4}$$

It is assumed the existence of a perennial institution called government whose role is to collect 'money', administer it and pursue the bonding policies. One such policy could be full employment. The collected funds are to be directed to programs such as social insurance, health care, and education that pay off in the long run, and gain the acceptance of labor suppliers for long run results by reducing their disutility from work. The government policy is to keep the level of public expenditures for bonding b constant and to collect enough 'money' every period to finance them. As derived in Farmer (1999) the funding of public expenditures reduces to solving:

$$b = m_t - \frac{1}{1+\nu}\frac{p_{t-1}}{p_t} m_{t-1} \tag{5}$$

where m_t is the real money balance at time t.

The market clearing condition is:

$$c_t = (1+\nu)\,(y_t\ -\ b) \tag{6}$$

where consumption c_t is consumption of an agent born at time *t-1* living at time *t*.

The result of the optimization problem is the following map, ϕ:

$$y_{t+1} = \phi(y_t) = \frac{1}{1+\nu}\mu(b\,,\,\nu)y_t^2 + b \tag{7}$$

There are two stationary equilibria where output is constant through time (the lower steady state is y_1):

$$y_{1,2} = \frac{1 \pm \Delta_1}{\frac{2\,\mu(b,\nu)}{1+\nu}}, \tag{8}$$

with $\Delta_1\ =\ 1\ -\ \frac{4b\mu(b,\nu)}{1+\nu}$.

There are also many non-stationary equilibria in which output and employment are changing over time. All sequences in the interval $(0,\, y_2)$ converge to the lower output steady state y_1, which is stable and attracts the economy to an undesirable poverty trap. In order to avoid this type of outcomes, the society creates bonding institutions to accomplish the higher employment and output at y_2.

To construct the function $\mu(b,\nu)$ a few restrictions need to be imposed. It should be a decreasing function of bonding expenditures, and when $b\ =\ 0$ it should be 1 so that it will have the same law of motion as in Farmer (1999). Consider now this particular case (the Farmer case) with $b\ =\ 0$ and disutility 1. These values make it easy to study the two possible stationary equilibria (see figure 1).

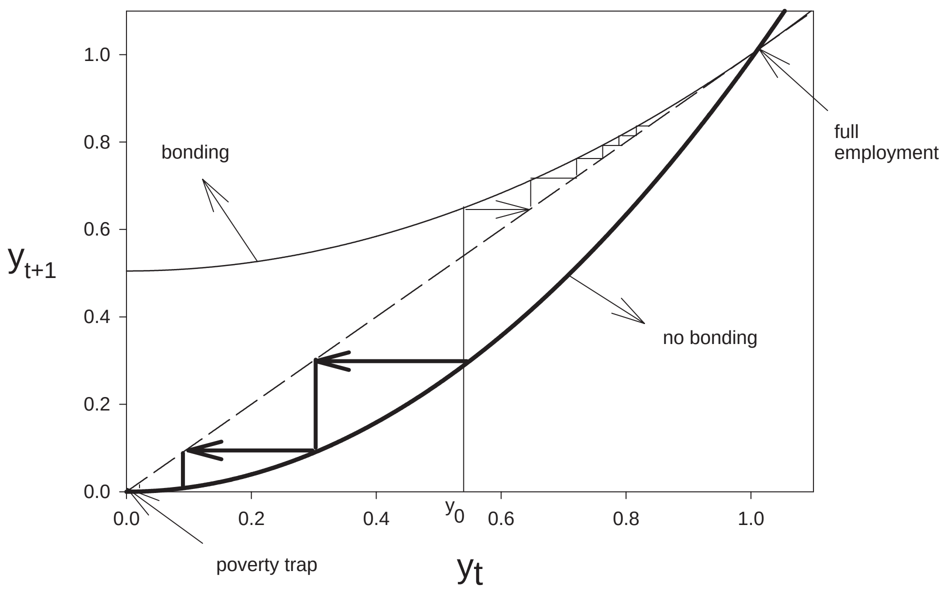

Figure 1: Bonding - Switching to Full Employment Output

With $b = 0$ and $\mu = 1$ the map ϕ becomes:

$$y_{t+1} = \phi(y_t) = \frac{1}{1+\nu} y_t^2 \tag{9}$$

with two obvious solutions, one of zero (or subsistence) output and high unemployment (a stable yet undesirable equilibrium - a poverty trap) and one of $y = 1 + \nu$ called from now on *full employment* because the entire work force is employed (a desirable yet unstable equilibrium; all sequences starting in the interval $(0, 1 + \nu)$ converge to the undesirable equilibrium of low output).

Full employment in (7) means that $y^* = 1 + \nu$ in equilibrium and gives a functional form:

$$\mu(b, \nu) = 1 - \frac{b}{1+\nu} \tag{10}$$

which is decreasing, as wanted, in bonding expenditures. The function turns out to be increasing in population growth - that could mean that public efforts need to be even more appreciable if population grows fast. Since this is a closed economy $b \in [0, 1 + \nu] \Rightarrow \mu \in [0, 1]$. Note that when bonding expenditures are zero, then $\mu(0, \nu) = 1$ as in Farmer's model with no bonding.

If one wants to find a way out, it is important to understand what causes the unwanted dynamical path in this economic system. The undesirable equilibrium is reached because the marginal utility from consumption is constant, while the marginal disutility from work is an increasing function of labor. The result is therefore determined by the particular form of the utility function. An utility optimizing young agent would want to work less and charge the old one a higher price for her products. That can be better seen by looking at the labor supply of an optimizing agent: $l_t = \frac{p_t}{p_{t+1}}$. Argumenting along the lines of McCallum (1997) labor supply is practically chosen in light of the expectation of p_{t+1}. Any expected increase in prices by the future young generations cuts incentives of the current young to supply more output. Any decrease in current output generates inflation. One solution to this vicious circle of low inputs and higher prices could be a mechanism to bind all generations to the goal of higher output, called here full employment. Agents receive a 'bond' - the guarantee of better working condition for example - that reduces their disutility from work today and promises full employment and higher output to future generations.

With bonding, the labor supply of the optimizing agent becomes $l_t = \frac{1}{\mu} \frac{p_t}{p_{t+1}}$. In this case, even with with increasing future prices (therefore future wages), if μ is made sufficiently smaller than 1 through additional public expenditures, output and employment increase. Economic growth occurs and it is accompanied by better working conditions, higher output and consumption, and higher prices (therefore higher wages).

2.1 Adding government consumption, g, to the model

We have been so far in an ideal environment where collected public expenditures are returned to the economic agent through the bond of lower disutility from work. Other costs such as the cost of communication between group members, the costs of educating, equipping and protecting a formal group organization in charge of the new policy should not be neglected. These administrative costs are called g. Their distinguishing note is that they do not affect the disutility from work of agents, yet without them the institution cannot properly run. They are often considered pure government consumption. This is to point out that they become a drain in resources of an economy, if improperly used. With these additional costs the dynamics is described by the following equation:

$$y_{t+1} = \phi(y_t) = \frac{1}{1+\nu}\mu(b\,,\,\nu)y_t^2 + b + g \tag{11}$$

while μ remains as in (10):

$$\mu(b\,,\,\nu) = 1 - \frac{b}{1+\nu}. \tag{12}$$

In equilibrium:

$$\begin{aligned} \Delta_2 &= (1+\nu)^2 - 4(1+\nu)\mu(b\,,\,\nu)(b+g) & (13) \\ &= (1+\nu)^2 - 4(1+\nu)(b+g)\left(1 - \frac{b}{1+\nu}\right) & (14) \end{aligned}$$

For real solutions one more condition has to hold:

$$\Delta_2 \geq 0 \Leftrightarrow g \geq \frac{(1+\nu-2b)^2}{4(1+\nu-b)} \tag{15}$$

It is obvious that with positive administrative expenditures the previous output level of full employment is not reached anymore. However, the output still stabilizes at a level higher than the one without bonding expenditures. *The smaller g, the closer is the new equilibrium to full employment.*

Public expenditures can not be higher than output (since this is a closed economy), in this case taken at full employment, i.e. $b + g < 1 + \nu$ which implies that $g \leq \frac{1+\nu}{4}$ and $\mu \in [0, 1]$. With the above mentioned restriction, one could prove that in fact public expenditures $b + g$ cannot exceed half of the GDP at full employment, a result tuned to the economic reality of most countries today.

3 Dynamics

3.1 Bifurcation Diagram

3.1.1 Ideal case of g = 0; full employment

Consider first the ideal case, without administrative expenditures. The effects of bonding expenditures on the dynamics of the system are revealed by drawing output against bonding expenditures. The result is a plot of various values of the two output equilibria for different levels of b. One equilibrium is stable but has a low level of output. The other one has a higher level of output but it is unstable. A particularity of this higher outcome is that it remains constant (at a level called here full employment), no matter the values for b. Only the lower equilibrium changes its values when b changes. This is the graph of a transcritical bifurcation. In this way, by moving the bifurcation parameter (bonding expenditures, b) these two steady-states get arbitrarily close, merge and split again after exchanging stability. The higher output becomes now stable. By choosing the level of bonding expenditures at the bifurcation point (mathematically: where the two steady-states merge and $\Delta_1 = 0$), the bonding institution could make full employment a reachable outcome of the economy.

3.1.2 $g > 0$; below full employment

Add now administrative expenditures g to the equation. The transcritical bifurcation breaks into two fold bifurcations. In a fold bifurcation there are still two steady-states like before, but they meet at a lower level of output and they do not split again, meaning that the full employment cannot be implemented anymore. Given a historically determined level of expenditure for public administration, one can choose the level of bonding expenditures such that equilibrium is at the bifurcation (meeting) point (mathematically: Δ_2 = zero). This is the highest level of output that can be reached with public bureaucracy and it is below full employment. Any reform in the public administration targeted at increasing the efficiency of the bureaucratic apparatus by reducing administrative expenditures (reducing g) frees public resources for bonding and moves the output in equilibrium closer to the ideal case of full employment. In the light of the above mentioned restrictions on b and g only the lower fold has economic meaning.

A full mathematical description of the changing dynamical patterns for different levels of b and g as well as graphs can be found in the Appendix.

3.2 Factors Affecting Bonding

3.2.1 Public consumption and bonding, changes in g

Figure 2 draws a complete picture of the relationship between bonding (b) and administrative expenditure (g) as derived by imposing the condition that delta is zero in equation (14):

$$g = \frac{(1+\nu-2\,b)^2}{4(1+\nu-b)}. \tag{16}$$

From equation (16) one could find b as function of population growth and the historic government consumption level g:

$$\overline{b} = \Pi(g,\nu). \tag{17}$$

with $\frac{d\Pi}{dg} < 0$ and $\frac{d\Pi}{d\nu} > 0$, when $\overline{b} \in [0, \frac{1+\nu}{2}]$. This level of b is called the bifurcation bonding expenditures level. The higher the share of government consumption, the lower the share of output available for bonding. This suggests that for countries with historically high levels of government consumption there might not be enough resources left for bonding.

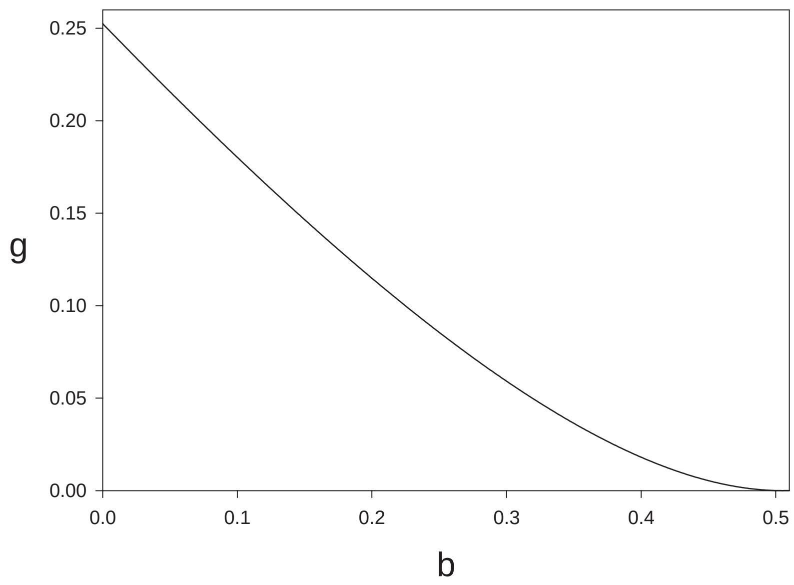

Figure 2: The Relationship between g and b

As shown in figure 2 the higher the level of administrative expenditure, g, the lower the level of available bonding expenditures, b. This is due to the scarcity of resources in a closed economy. Note that to any given level of g corresponds only one level of b; historically determined bureaucracy sizes determine the size of current bonding.

Redirecting part of the output for pure government consumption is not totally without results, as this also induces a movement from a subsistence economy to one with increased levels of output. The maximum level of output that can be obtained just by increasing government consumption is y $= \frac{1+\nu}{2}$, as given by (16). At the equilibrium point (y, g, b, μ)= ($\frac{1+\nu}{2}$, $\frac{1+\nu}{4}$, 0, 1) after a period of economic growth, the economy finds itself at a level of output above the subsistence level. The case is shown by the dotted line in figure 3. Increased levels of output in equilibrium can be generated by increased levels of government consumption. The same conclusion is derived by Farmer (1999).

However, this does not need to be the end of the story, as even higher levels of output can be obtained by redirecting a small amount of output from government consumption to long term growth policies. Coming back to figure 3 this is shown by the continuous line, whose levels of output are above those of the dotted line. Even a small amount of bonding is more effective than pure government consumption. On the other hand, bonding requires even more public resources than before, as seen again in the graph. This suggests that an economy must have a high enough level of output to be able to engage in bonding.

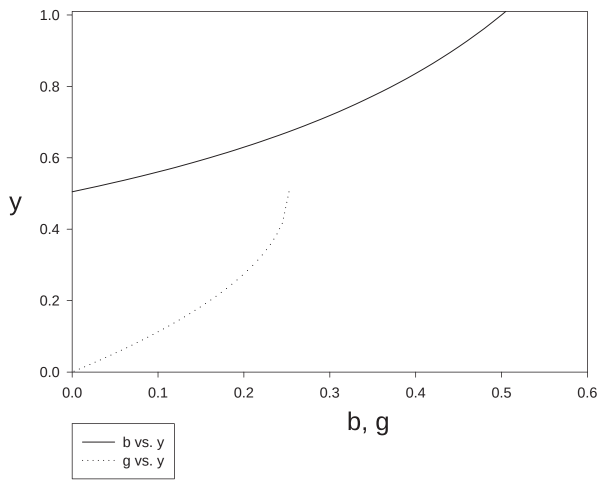

Figure 3: Output, g and b

The lower the level of public administration expenditures and the higher the bonding expenditures, the higher the output. The more developed the economy, the higher the share of output routed to public institutions.

3.2.2 Population and bonding; changes in ν

Higher rates of population growth imply a bigger effort in terms of both administrative and bonding expenditure. This is showed in figure 4, where the fine line indicates the combinations of g and b for higher population growth. The curve with higher population growth is always above the curve of the initial ν. On the other hand, the long-run equilibrium output will be bigger than before, if the economy is able to commit to these higher efforts.

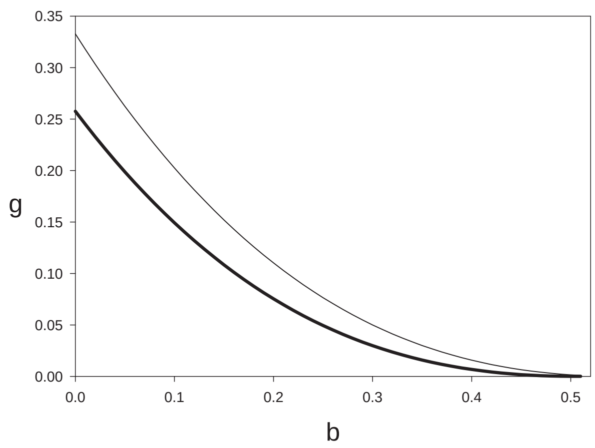

Figure 4: Various Levels of Population Growth

In introducing bonding one has take into account the extend of bureaucracy in the economy, the amount of resources needed to support it, and how fast the population grows. Large bureaucracies, as well as high birth rates could hinder the further growth of the economy, especially if the starting output is low. It could be, in a closed economy, that the existent resources are not able to support an extension of public expenditures to pursue growth policies. Resources could be created, for example, by redirecting output from the pure consumption of bureaucracy to growth policies - a process not always easy to accomplish.

4 Conclusion

In a complex economic world it has become important that governments increase their ability to undertake and efficiently promote collective actions through the design of new and better public institutions as well as the dismantling of obsolete ones. Wherever fundamental factors such as good laws, property rights, education and health care were not provided, economic crises have deepened.

In the overlapping model considered by Farmer and Woodford (1997) and Farmer (1999) by relaxing the assumption that disutility of labor is constant over time I introduced bonding expenditures to fund economic growth policies. The government is a partner in the implementation of bonding policies (as perennial institution). Different generations commit to the new economic path through bonding institutions.

Bonding is complex and difficult to implement: it demands significant public resources and sufficiently high levels of output. It needs efficient, professional governments. Bonding is also dependent on demographic factors: countries with high population growth rates need more resources to bond than those with lower rates. Younger populations are on the other hand more willing to accept and undertake change. Last, it requires a change in the mentalities of agents about growth policies. An increased willingness to accept the idea that not only technological progress is required for growth, but also the need to adopt and fund a social insurance system whose positive results on output materialize only in the long run.

Once introduced, bonding institutions need not be permanent. Developed countries with heavy reliance on bonding institutions could take the path of reform and eventually dismantle some extensions of their social welfare state. On the other hand, one could see the idea of dismantling more in the sense of a transformation of current central social institutions. It could be that some public services will be turned into private organizations, while others will no longer be needed due to the higher levels of wealth and longer life expectancy accomplished in these countries.

A Bifurcations

A.1 Case 1: $g > 0$

Solve for

$$y_{t+1} = \phi(y_t) = \frac{1+\nu-b}{1+\nu} y_t^2 + b + g \tag{18}$$

with g historically fixed and $b \in [0\,,\,1+\nu]$. Fixed points are when $y_{t+1} = y_t = y$, i.e.

$$y^2 - \frac{(1+\nu)^2}{1+\nu-b} y + \frac{(1+\nu)^2}{1+\nu-b}(g+b) = 0 \tag{19}$$

and

$$\Delta_2 = \frac{(1+\nu)^2}{1+\nu-b}\left[\frac{(1+\nu)^2}{1+\nu-b} - 4(g+b)\right]. \tag{20}$$

If $\Delta_2 < 0 \Leftrightarrow g > \frac{(1+\nu-2b)^2}{4(1+\nu-b)}$ no fixed points,

if $\Delta_2 = 0 \Leftrightarrow g = \frac{(1+\nu-2b)^2}{4(1+\nu-b)}$ one fixed point,

if $\Delta_2 > 0 \Leftrightarrow g < \frac{(1+\nu-2b)^2}{4(1+\nu-b)}$ two fixed points, whose equations are

$$y_1 = \frac{(1+\nu)[1+\nu+\sqrt{(1+\nu-2b)^2 - 4g(1+\nu-b)}]}{2(1+\nu-b)} \tag{21}$$

$$y_2 = \frac{(1+\nu)[1+\nu-\sqrt{(1+\nu-2b)^2 - 4g(1+\nu-b)}]}{2(1+\nu-b)} \tag{22}$$

and with the above mentioned restrictions on b they are positive.

What does it mean $g = \frac{(1+\nu-2b)^2}{4(1+\nu-b)}$? This is the bifurcation point at which the system moves from one equilibrium to two equilibria when b varies.

If $\Delta_2 = 0$ one has a quadratic equation in b.

The two solutions for b are in this case:

$$b_1 = \frac{1+\nu-g+\sqrt{g^2+2g(1+\nu)}}{2}, \tag{23}$$

$$b_2 = \frac{1+\nu-g-\sqrt{g^2+2g(1+\nu)}}{2} \tag{24}$$

Notice that $b_1 \in (0,\, 1+\nu)$ and $b_2 < b_1 < 1+\nu$. By imposing the additional constraint that the sum of all public expenditures should not exceed the output at full employment, i.e. $b_1 + g$, it can be shown that public administration expenditures cannot be bigger than one fourth of total output, $g \leq \frac{1+\nu}{4}$. In this case b_2 is positive. As total public expenditures should not consume the whole output, then one could be even more severe and impose that $b + g \leq \frac{1+\nu}{2}$. In that case only b_2 remains a valid solution for the system. Therefore $b \in [0,\, b_2]$ and $g \in [0,\, \frac{1+\nu}{4}]$.

Study now the bifurcation type at b_2:

$b^* = b_2 = \frac{1+\nu-g-\sqrt{g^2+2g(1+\nu)}}{2}$ and $g = \frac{(1+\nu-2b)^2}{4(1+\nu-b)}$.

From (22) $y_1 = y_2 = y^* = \frac{(1+\nu)^2}{2(1+\nu-b^*)}$.

Therefore:

$$\phi(y^*) = y^*. \tag{25}$$

It is easy to prove that:

$$\frac{\delta\, \phi}{\delta\, y}\,(y^*, b^*) = 1. \tag{26}$$

As long as $b < \frac{1+\nu}{2}$, a third requirement is satisfied:

$$\frac{\delta\, \phi}{\delta\, b}\,(y^*, b^*) > 0. \tag{27}$$

The last condition is:

$$\frac{\delta\, \phi^2}{\delta\, b^2}\,(y^*, b^*) > 0. \tag{28}$$

From (25,26,27,28) the bifurcation at b_2 is identified to be a fold (see figure 5). The line of stable levels of output is described mathematically by y_1 (equation 21) and graphically by the full line. The line of unstable output is given by y_2 (equation 22) and graphically by the dotted line. The equation 22 and the diagram show that output in the stable steady state is lower than full employment, $y = 1 + \nu$.

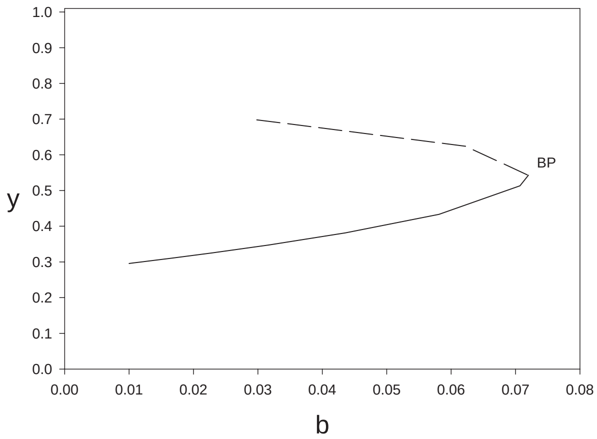

Figure 5: Bifurcation Diagram when g = 0.2

A.2 Case 2: $\mathbf{g = 0}$

If $b \neq \frac{1+\nu}{2}$, by making g equal zero in (21) and (22) one gets the new solutions $y_1 = (1+\nu)$ and $y_2 = \frac{b(1+\nu)}{1+\nu-b}$.

If $b^* = \frac{1+\nu}{2}$, there is only one fixed point $y^* = 1+\nu$ and at this point all requirements for a transcritical bifurcation (see figure 6) are fulfilled:

$$\frac{\delta\,\phi}{\delta\,y}\,(y^*, b^*) = 1 \tag{29}$$

and obviously $\phi(y^*, b^*) = y^*$,

$$\frac{\delta\,\phi}{\delta\,b}\,(y^*, b^*) = 0, \tag{30}$$

$$\frac{\delta\,\phi^2}{\delta\,y\delta\,b}\,(y^*, b^*) < 0, \tag{31}$$

$$\frac{\delta \phi^2}{\delta y^2}(y^*, b^*) > 0. \tag{32}$$

Full employment is represented by the horizontal line. For any $b < b^*$, we have $\frac{\delta \phi}{\delta y}(y_1, b) > 1$, which makes full employment an unstable outcome. Graphically, this is represented by the dotted part of the horizontal line.

As soon as b reaches the value of b^* a bifurcation occurs: the dotted line of full employment meets the full curve of stable, yet lower outcomes. At this point (called BP on the graph) the two lines change their dynamic properties.

From now on, for any $b > b^*$, we have $\frac{\delta \phi}{\delta y}(y_1, b) < 1$, and full employment becomes the stable solution. In this case full employment is represented graphically by a continuous horizontal line. The curve of higher outcomes becomes unstable. This suggests that any level of bonding expenditures above the optimal b^* is a waste of public resources, as no matter how much additional public money is spend the only stable equilibrium remains full employment.

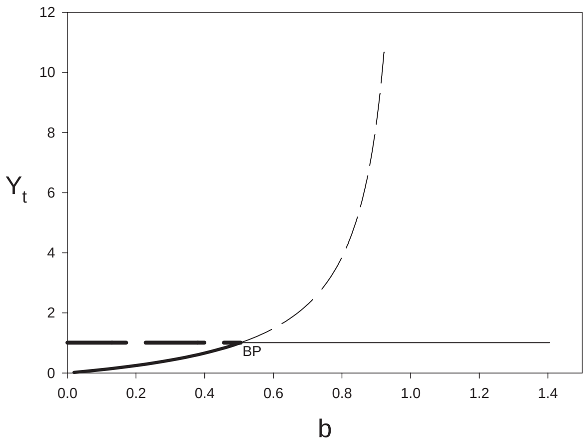

Figure 6: Bifurcation Diagram when $g = 0$

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