

Corporate Debt Dynamics, Capital Accumulation, and Macroeconomic Instability: A Post-Keynesian Analysis*

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This study presents a simple model of corporate debt dynamics within the framework of the post-Keynesian theory of growth and distribution. Our model introduces corporate debt dynamics into a modified version of Lavoie's Minsky–Steindl model, yielding long-run results different from those of Lavoie (1995) and Hein (2007) by showing that a stable long-run equilibrium exists in both puzzling and normal cases. On the basis of these results, this study shows that Minsky's financial instability as well as Steindl's paradox of debt as a phenomenon of macroeconomic instability can be formulated within the framework of a post-Keynesian debt dynamics system.

JEL Classification: E12

Keywords: Corporate Debt Dynamics, Post-Keynesian Theory of Growth and Distribution, Macroeconomic Instability, Paradox of Debt

I. Introduction

The post-Keynesian theory of growth and distribution was developed by the studies of Rowthorn (1981), Dutt (1984), Taylor (1985), and others. These studies presented the stagnationist thesis that deteriorating income distribution would obstruct economic growth. However, by formulating a modified post-Keynesian investment function, Bhaduri and Marglin (1990) argued that alternative growth regimes could coexist within the same theoretical space. They showed that when income distribution deteriorates, the growth rate is impeded in the wage-led growth regime but is accelerated in the profit-led growth regime.

Received: May 28, 2014. Revised: Nov. 21, 2014. Accepted: Dec. 2, 2014.

* This study was financially supported by Wonkwang University in 2013.

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Bhaduri and Marglin's (1990) argument inspired numerous discussions and motivated further theoretical and empirical studies of the relationship between income distribution and economic growth. Some post-Keynesian economists have argued that alternative growth regimes could occur without modification of the investment function if either workers saving were assumed or an open economy was considered (Mott and Slattery, 1994; Blecker, 1999). Blecker (2002) presented an excellent survey of the theoretical development of the post-Keynesian theory of growth and distribution. Bowles and Boyer (1995) presented the first empirical study of post-Keynesian growth and distribution theory, which found that the United Kingdom and United States both showed wage-led growth, while France, Germany, and Japan showed profit-led growth. After Bowles and Boyer (1995), empirical studies that adopted similar methods have been developed (e.g., Hein and Vogel, 2008; Stockhammer, Onaran, and Ederer, 2009).

Recently, there have been various theoretical attempts to integrate corporate debt dynamics and post-Keynesian growth and distribution theory. On the one hand, some studies have examined Minsky's financial instability hypothesis by analyzing corporate debt dynamics. Lima and Meirelles (2007) attempted to explain Minsky's hypothesis by integrating corporate debt dynamics with the banking system's interest rate markup policy. Charles (2008) introduced corporate debt dynamics and the retention rate of firms into the post-Keynesian growth and distribution model in order to examine financial instability. Taylor (2012) proposed the post-Keynesian financial theory of business cycles that considers corporate debt dynamics and asset prices.

On the other hand, certain studies have examined the existence and characteristics of alternative finance growth regimes, such as debt-led and debt-burdened growth regimes. Explicitly considering corporate debt dynamics, Lee and Ko (2010) illustrated the existence of alternative finance growth regimes. However, they made peculiar and unreasonable assumptions about firms' financial constraints. They assumed that firms finance their investment only by borrowing and have to pay interest on those borrowed funds in the current period. The assumption that firms finance all of their investment by borrowing is unrealistic. Under this assumption, internal reserves cannot play a role in investment financing, which contradicts conventional wisdom in economics. The assumption that firms have to pay interest on the borrowed funds in the current period is also difficult to justify from the perspective of a stock-flow consistent model, in which the interest on loans made in t will only be received in $t+1$ (Dos Santos, 2004, p. 11). In this study, we construct a more robust post-Keynesian debt dynamic model by introducing a financial constraint for normal firms that is acceptable in a stock-flow consistent model framework and by presenting a more realistic saving function that includes shareholders' savings from dividend earnings and bondholders' savings from interest earnings.

Sasaki and Fujita (2012) introduced corporate debt dynamics into Lavoie's (1995) Minsky–Steindl model and insisted that Hein's (2007) long-run results were unacceptable. On the basis of Lavoie's Minsky–Steindl model, Hein (2007) argued that a higher interest rate would result in both a higher rate of capital accumulation (the puzzling case) and a lower rate of capital accumulation (the normal case). Without explicit analysis of debt dynamics, he insisted that a stable long-run equilibrium exists only in the puzzling case, whereas the normal case shows an unstable long-run equilibrium. Sasaki and Fujita (2012) demonstrated that stable long-run equilibria would exist in both the normal and puzzling cases. However, they made the restrictive assumption that firms issue shares when they begin operations and do not issue new shares in the course of capital accumulation, which is only financed by retained earnings and credit obtained from rentier capitalists. In this study, we construct a more general post-Keynesian debt dynamics system that considers issuing new shares as a source of firms' investment financing.

In contrast to Lee and Ko (2010) and Sasaki and Fujita (2012), who both went no further than concluding that alternative finance growth regimes could exist, this study examines Minsky's financial instability hypothesis and Steindl's paradox of debt as a phenomenon of macroeconomic instability by making use of alternative finance growth regimes. We follow Vercelli's (2001) conceptual distinction between structural and dynamic instability. He proposed that the essential property of Minsky's hypothesis exists not in dynamic instability but in structural instability. In our model, structural instability comes from structural changes in parameters that reflect the changes in firms' investment decisions when faced with insolvency risks. We argue that Steindl's paradox of debt can be explained as a phenomenon of dynamic instability, while Minsky's financial instability can be examined as a phenomenon of structural instability.

The remainder of the paper is organized as follows. In the next section, we present a monetary post-Keynesian model of growth and distribution that is a modified version of Lavoie's (1995) Minsky–Steindl model. Section 3 introduces a simple model of corporate debt dynamics. We show that the standard post-Keynesian model could explain the existence of alternative growth regimes when debt services are introduced. Section 4 discusses how our dynamic model can examine macroeconomic instability and proposes some policy measures to deal with such a scenario. The final section summarizes our arguments.

II. The Basic Model and Short-Run Equilibrium

Consider, for simplicity, a one-good economy with households and firms. Households consist of workers and Kaldorian rentier capitalists. Workers supply labor services to firms and earn wage incomes only. Firms employ workers, produce

output, make investments, and accumulate productive capacity. We follow Kaldor (1966) to distinguish between firms of production units and rentier capitalists in terms of their financial sources. Rentier capitalists earn dividends as owners of firms' productive capacity and earn interest as suppliers of firms' external finances. They generate savings from these sources of income and lend them to firms to satisfy firms' demands for external finance.

Following Kalecki (1954), we assume that firms determine prices (p) by markups (m) over average variable costs (wl) while markup ratios are set to reflect the degree of price competition in the goods market.

$$p = (1+m)wl, \quad m > 0 \quad (1)$$

We simply assume that the markup is constant, and the price level remains constant for a given money wage rate (w) and a constant labor-output ratio (l). This leads to equation (2), the relation between the profit share (h), that is, the proportion of profits (Π) in nominal income (pY), and the markup.

$$h = \frac{\Pi}{pY} = \frac{m}{1+m} \quad (2)$$

We follow Taylor (1985) to define capacity utilization (u) as the ratio of real income over capital stock (Y/K).¹ Equation (3) expresses the relation between capacity utilization, profit share, and profit rate (r).

$$u = \frac{Y}{K} = \frac{pY}{\Pi} \frac{\Pi}{pK} = \frac{1}{h}r \quad (3)$$

According to equation (3), for a given profit share, a higher level of capacity utilization corresponds to a higher profit rate.

We assume that workers do not save and rentier capitalists adopt the same propensity to save (s_r) out of dividend and interest earnings.² Aggregate savings (S) of the economy consist of firms' reserves of current profits and rentier capitalists' savings:

¹ The rate of capacity utilization is originally defined as the ratio of actual output over potential output (Y/\bar{Y}). Since $Y/\bar{Y} = \frac{1}{v} \frac{Y}{K}$ holds, $Y/\bar{Y} = Y/K$ is valid if the capital coefficient (v), for the sake of simplicity, is assumed to be one.

² Lavoie (1995) assumed that shareholders and bondholders follow different propensities to save out of dividend and interest earnings. For the sake of simplicity, we assume that they follow the same propensity to save out of dividend and interest earnings.

$$S = s_f(\Pi - iD) + s_r(1 - s_f)(\Pi - iD) + s_r iD \quad (4)$$

where s_f is firms' retention ratios out of net profits. Net profits are defined as gross profits minus interest payments, which, in turn, are determined by the interest rate (i) and firms' debts (D). Equation (4) indicates that aggregate savings consist of firms' internal retention from net profits, shareholders' savings from dividend earnings, and bondholders' savings from interest earnings.

Normalizing equation (4) by the nominal capital stock (pK) and rearranging it, we derive the following equation:

$$g^s = \sigma r - \tau id, \quad \sigma = s_f + s_r(1 - s_f) \quad \text{and} \quad \tau = s_r(1 - s_f) \quad (5)$$

where d denotes the debt-capital ratio (D/pK) of firms.

As for the investment function, post-Keynesian economists usually indicate that the accumulation rate of capital stock is a linear function of capacity utilization and the profit factor. The positive effects of capacity utilization on investment reflect the accelerator principle. The positive effects of the profit factor on investment represent some financial considerations. Lower profit rates mean that borrowing firms have weak capacities to create cash inflows. Then, lenders evaluate firms' credit worthiness to be lower and constrain credit supplies that finance investment.

Lavoie (1995) considered net profits as a determinant of the accumulation rate and proposed that the gross profit rate and the interest rate would affect the rate of capital accumulation differently.³ The interest rate is combined with the debt-capital ratio in his investment function and this composite factor negatively affects the accumulation rate. Here, we modify the investment function of Lavoie (1995) to consider capacity utilization as an additional determinant of the rate of capital accumulation. Therefore, a simple linear function for the rate of capital accumulation (g^d), relating net investment to the capital stock, is formulated as follows.

$$g^d = \alpha + \beta u + \delta r - \theta id, \quad \alpha, \beta, \delta, \theta > 0 \quad (6)$$

This investment function may be understood as a revision of Steindl's arguments. Steindl (1952, p. 129) considered investment to be a function of capacity utilization, the profit rate, and the debt ratio of firms. One difference between our study and that by Sasaki and Fujita (2012) is that we consider the profit rate as a determinant

³ Lavoie's investment function represents Minsky's view on the investment decision. Minsky analyzed the investment decision from the perspective of the difference between prospective cash receipts and cash commitments that represents the margin of safety (Kregel, 2008, p. 4).

of the accumulation rate, whereas Sasaki and Fujita consider the profit share as a determinant of capital accumulation.

The short-run equilibrium requires the adjustment of saving to investment in the goods market. Therefore, the equilibrium condition is given as follows.

$$g^s = g^d \quad (7)$$

The values of the short-run equilibrium (r^*, g^*) are obtained as follows.

$$r^* = \frac{\alpha + (\tau - \theta)id}{\sigma - \frac{\beta}{h} - \delta} \quad (8)$$

$$g^* = \frac{\alpha\sigma + \left[\left(\frac{\beta}{h} + \delta \right) \tau - \sigma\theta \right] id}{\sigma - \frac{\beta}{h} - \delta} \quad (9)$$

The output adjustment process of the Keynesian equilibrium is stable when the elasticity of saving with respect to capacity utilization is greater than that of investment. We assume that the Keynesian stability condition holds, that is, $\sigma - \frac{\beta}{h} - \delta > 0$. Therefore, $\alpha + (\tau - \theta)id > 0$ and $\alpha\sigma + \left[\left(\frac{\beta}{h} + \delta \right) \tau - \sigma\theta \right] id > 0$ must be valid for $r^* > 0$ and $g^* > 0$. We assume that the debt-capital ratio is constant in the short run. Partially differentiating equation (9) with respect to the rate of interest yields the following equation.⁴

$$\frac{\partial g^*}{\partial i} = \frac{\left[\left(\frac{\beta}{h} + \delta \right) \tau - \sigma\theta \right] d}{\sigma - \frac{\beta}{h} - \delta} \quad (10)$$

Then, the sign of the comparative static analysis is given by inequality (11).

$$\left(\frac{\beta}{h} + \delta \right) \tau - \sigma\theta \geq 0 \Leftrightarrow \frac{\partial g^*}{\partial i} \geq 0 \quad (11)$$

⁴ The comparative static effect of changes in the profit share can be similarly examined. If we partially differentiate equation (9) with respect to the profit share, we obtain $\frac{\partial g^*}{\partial \theta} = \frac{-\beta\sigma[\alpha + (\tau - \theta)id]}{h^2(\sigma - \frac{\beta}{h} - \delta)^2} < 0$. Increases in the profit share negatively affect the rate of capital accumulation. This study shows a wage-led accumulation regime.

The above result is quite similar to that of Lavoie (1995). It is obvious that a higher interest rate does not uniformly affect the rate of capital accumulation. The investment function (equation (6)) shows that an increase in the interest rate negatively affects the rate of capital accumulation. However, the saving function (equation (5)) indicates that an increase in the interest rate raises rentier capitalists' earnings and, in turn, their consumption expenditures. Increase in consumption expenditures immediately raises the rate of capacity utilization and, depending on the sign, that is, provided $(\frac{\rho}{h} + \delta)\tau - \sigma\theta$ is positive, the rate of capital accumulation would rise. Lavoie (1995, p. 167) called this situation the "puzzling case."⁵ Hein (2007, p. 321) called the opposite situation, an increase in the interest rate leading to a decrease in the rate of capital accumulation, the "normal case."

III. Debt Dynamics and Long-Run Equilibrium

In the previous section, we examined the Keynesian equilibrium with the short-run condition of a constant debt-capital ratio. In this section, we consider corporate debt dynamics of how the debt-capital ratio changes over a time sequence. Debt dynamics is a familiar theme in the post-Keynesian literature (Lima and Meirelles, 2007; Charles, 2008; Lee and Ko, 2010; Taylor, 2012; Sasaki and Fujita, 2012). This study is an extension of these discussions.

Recently, Sasaki and Fujita (2012) introduced corporate debt dynamics into Lavoie's Minsky–Steindl model and insisted that the long-run results of Lavoie (1995) and Hein (2007) are unacceptable. However, Hein (2013) argued that Sasaki and Fujita (2012) made the restrictive assumption that firms issue shares when they start to operate and do not issue new shares in the course of capital accumulation, which is only financed by retained earnings and credit obtained from rentier capitalists. In this study, we accept Hein's criticism of Sasaki and Fujita (2012) and consider investment financing through the issuance of new shares. The financial constraints of firms can be expressed as follows:

$$\dot{D} + \Pi + \epsilon I = (1 - s_f)(\Pi - iD) + iD + I \quad (12)$$

where \dot{D} denotes the time derivative with respect to firms' debts. I is investment expenditure and ϵ denotes a constant portion of investment financing through the issuance of new shares. The left-hand side of equation (12) represents

⁵ Hein and Ochsens (2003) presented an empirical analysis of how the interest rate affects the rate of capital accumulation. They concluded that "a positive relation between interest rate variations and changes in economic activity as well as in capital stock growth seem to be empirically possible in some countries and in some time periods" (Hein and Ochsens, 2003, p. 427).

sources of firms' finances, while the right-hand side represents uses of firms' finances. The equation indicates that the gross profits of firms are disposed into dividends, interest payments, and internal reserves for investment expenditures. When internal reserves are insufficient to finance investment, firms require external finances that can be obtained by borrowing funds or issuing new shares. This can be easier presented if equation (12) is reduced to the following equation.

$$\dot{D} + \epsilon I + s_f(\Pi - iD) = I \quad (13)$$

According to equation (13), investment is financed by external finances and internal reserves. Depending on whether investment expenditures exceed or are less than internal reserves, firms obtain new debts or pay back old debts. We normalize equation (13) by nominal capital stock and derive the following equation:⁶

$$\dot{d} + dg + \epsilon g + s_f(r - id) = g \quad (14)$$

where \dot{d} is the time derivative with respect to the debt-capital ratio. Now, we rearrange the saving function (equation (5)) as follows.

$$r = \frac{1}{\sigma}g + \frac{\tau}{\sigma}id \quad (15)$$

Substituting equation (15) into equation (14) and imposing the long-run equilibrium condition $\dot{d} = 0$ on equation (14), we obtain the first equation of a debt dynamics system that represents the long-run equilibrium locus.

$$d = \frac{\sigma - \sigma\epsilon - s_f}{\sigma} + \frac{(\sigma - \sigma\epsilon - s_f)(s_f s_r i)}{\frac{\sigma^2}{g - \frac{s_f s_r i}{\sigma}}} \quad (16)$$

The long-run equilibrium locus is given as a hyperbolic curve. A point on this curve may correspond to long-run equilibrium. Here, we assume that $\sigma - \sigma\epsilon - s_f$ is positive. This assumption is not unrealistic because the portion of investment financing by the issuance of new shares (ϵ) is normally small.

Our method of debt dynamics examines how the short-run equilibrium moves over a time sequence in the (g, d) space. Thus, the long-run equilibrium represents

⁶ If inflation is assumed to be zero, the derivation of $\frac{\dot{D}}{D}$ is as follows: $\frac{\dot{d}}{d} = \frac{\dot{D}}{D} = \frac{\dot{K}}{K} \rightarrow \dot{d} = \frac{\dot{D}}{D} - \frac{\dot{K}}{K} \rightarrow \frac{\dot{D}}{D} = \dot{d} + dg$.

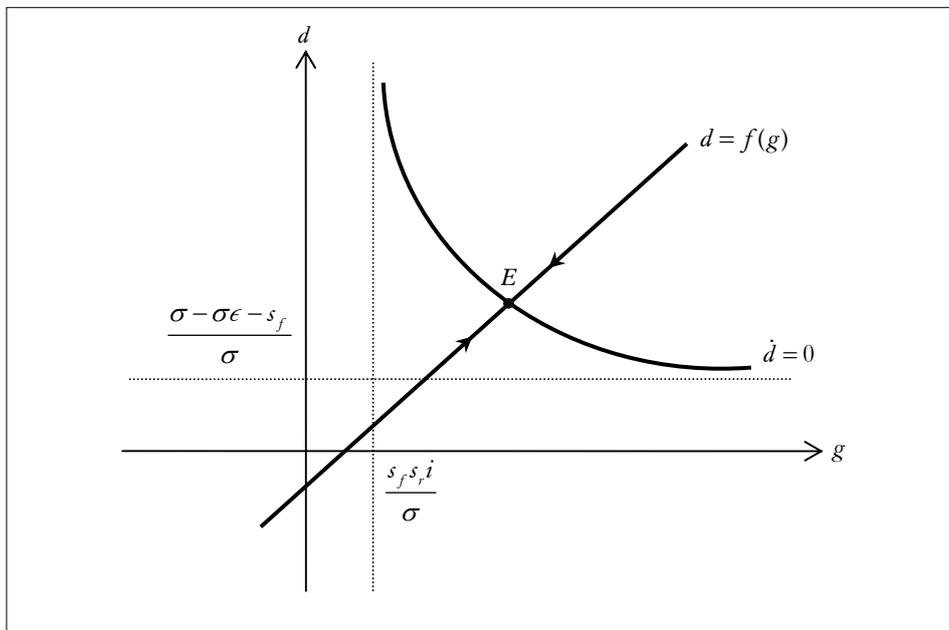
the position where the short-run equilibrium remains at a standstill. Rearranging equation (9), we obtain the following equation, which we will call the “Keynesian equilibrium line.”

$$d = \frac{-\alpha\sigma}{\phi i} + \frac{\psi}{\phi i} g, \quad \phi = \left(\frac{\beta}{h} + \delta\right)\tau - \sigma\theta \quad \text{and} \quad \psi = \sigma - \frac{\beta}{h} - \delta \quad (17)$$

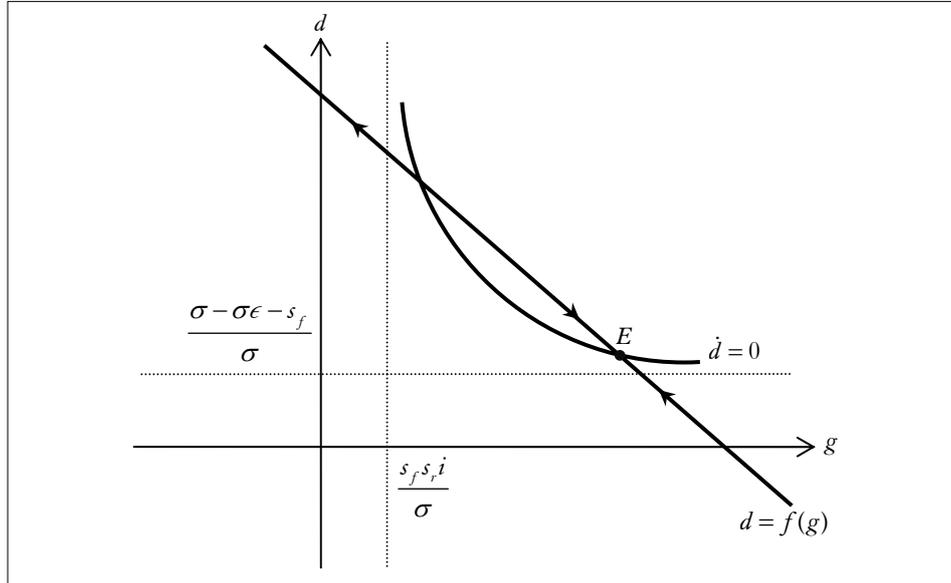
Equation (17) represents the second equation of a debt dynamics system. If the short-run stability condition holds, that is, ψ is positive, the sign of the slope of this line depends on the sign of ϕ . If ϕ is positive, the slope of the Keynesian equilibrium line is positive. Debt-capital ratio and accumulation rate move in the same direction. The short-run equilibrium exhibits debt-led growth. If, on the other hand, ϕ is negative, the slope of the Keynesian equilibrium line is negative. Debt-capital ratio and accumulation rate move in the opposite direction. The short-run equilibrium exhibits debt-burdened growth.

The economy is assumed to exist on the Keynesian equilibrium line and the long-run equilibrium is determined at the intersection of this line and the long-run equilibrium locus.

[Figure 1] Long-Run Equilibrium: Debt-Led Growth Regime



[Figure 2] Long-Run Equilibrium: Debt-Burdened Growth Regime



The notations $d = f(g)$ and $\dot{d} = 0$ represent the Keynesian equilibrium line and long-run equilibrium locus, respectively. The dynamic path of the debt-capital ratio is expressed through the directions of arrows. As clearly shown, each regime has a stable long-run equilibrium with positive values for the debt-capital ratio and rate of capital accumulation.

We examine stability properties of the long-run equilibrium debt-capital ratio in terms of phase diagram analysis in more detail. Substituting equations (9) and (15) into (14) and rearranging it, we obtain the following equation.

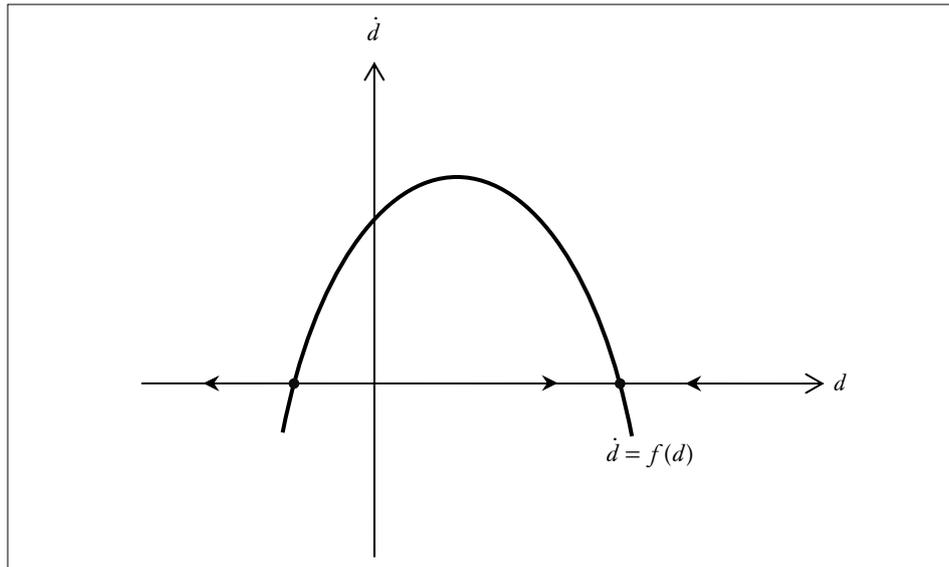
$$\dot{d} = \frac{-\sigma\phi i}{\sigma\psi} d^2 + \frac{[(\sigma - \sigma\epsilon - s_f)\phi i + \psi s_f s_r i - \alpha\sigma^2]}{\sigma\psi} d + \frac{\alpha(\sigma - \sigma\epsilon - s_f)}{\psi} \quad (18)$$

If the short-run equilibrium exhibits debt-led growth ($\phi > 0$), the coefficient of d^2 is negative and the constant is positive. There are two solutions for the long-run equilibrium debt-capital ratio, one is positive and the other is negative. Since the long-run stability condition is $\partial\dot{d}/\partial d < 0$, the positive solution is stable and the negative solution is unstable. If the short-run equilibrium exhibits debt-burdened growth ($\phi < 0$), the coefficient of d^2 and the constant are both positive, while the coefficient of d is negative.⁷ Therefore, there are two positive solutions. From the

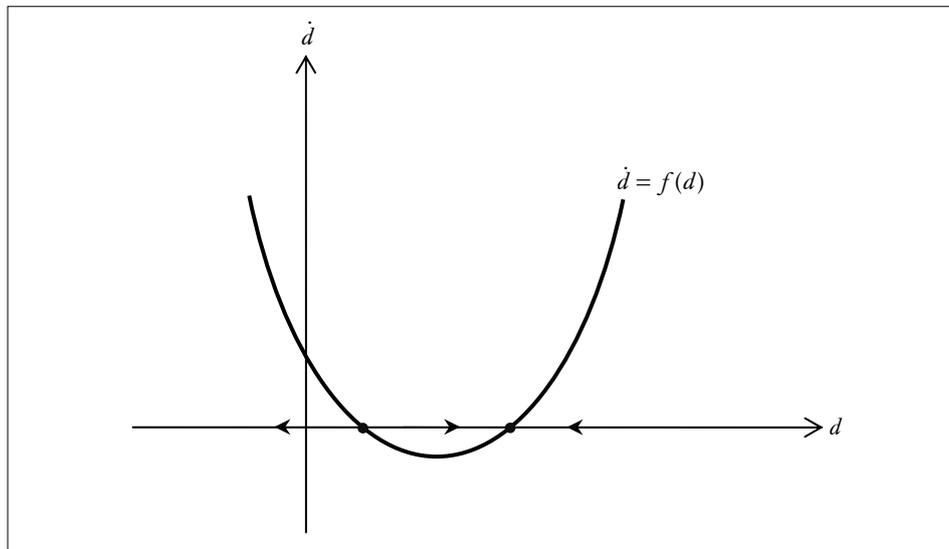
⁷ From equation (18), we obtain $\frac{\partial\dot{d}}{\partial d} = \frac{(\sigma - \sigma d - \sigma\epsilon - s_f)\phi i + \psi s_f s_r i - \sigma(\alpha\sigma + \phi id)}{\sigma\psi}$. Under the assumption that the long-run stability condition holds, $(\sigma - \sigma d - \sigma\epsilon - s_f)\phi i + \psi s_f s_r i - \sigma(\alpha\sigma + \phi id) < 0$ is valid. Since we

long-run stability condition, we know that the smaller solution is stable. Figures 3 and 4 show phase diagrams of the long-run equilibrium debt-capital ratio. The dynamic path of the debt-capital ratio is expressed through the directions of arrows.

[Figure 3] Long-Run Stability of Debt-Capital Ratio: Debt-Led Growth Regime



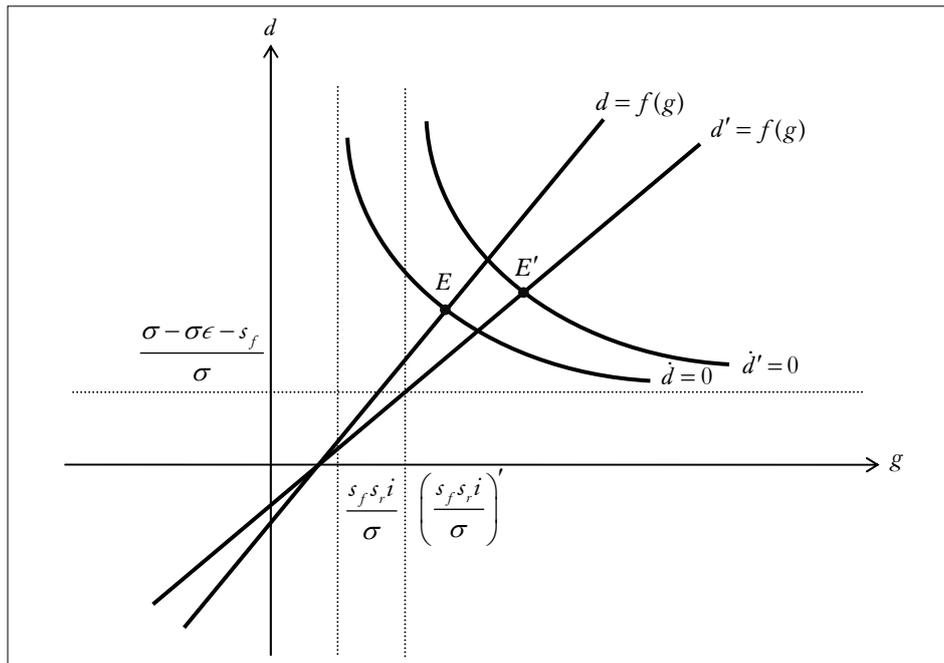
[Figure 4] Long-Run Stability of Debt-Capital Ratio: Debt-Burdened Growth Regime



assume that $\sigma - \sigma\epsilon - s_f > 0$ holds, $(\sigma - \sigma\epsilon - s_f)\phi i + \psi s_f s_i - \alpha\sigma^2 < 0$ is valid in the debt-burdened growth regime.

Now, we consider the effects of an increase in the interest rate on the stable long-run equilibrium in the (g, d) space. In the debt-led growth regime, a higher interest rate shifts the Keynesian equilibrium line downward and the long-run equilibrium locus upward. The long-run equilibrium rate of capital accumulation always rises, whereas it is not obvious whether the long-run equilibrium debt-capital ratio rises or falls.⁸ The involved mechanism can be explained as follows. When the interest rate rises, consumption expenditure out of interest earnings rises. Such expenditure raises capacity utilization and profits, which subsequently have positive effects on investment. Since these positive effects dominate the negative effect of an increase in the interest rate on investment, the rate of capital accumulation rises. However, the effect on the debt-capital ratio is unclear, since profits rise with a higher rate of capital accumulation. Lavoie's so-called puzzling case may happen, in which a higher interest rate induces both a higher rate of capital accumulation and a higher debt-capital ratio (see Figure 5).

[Figure 5] Effects of the Rising Interest Rate: Puzzling Case

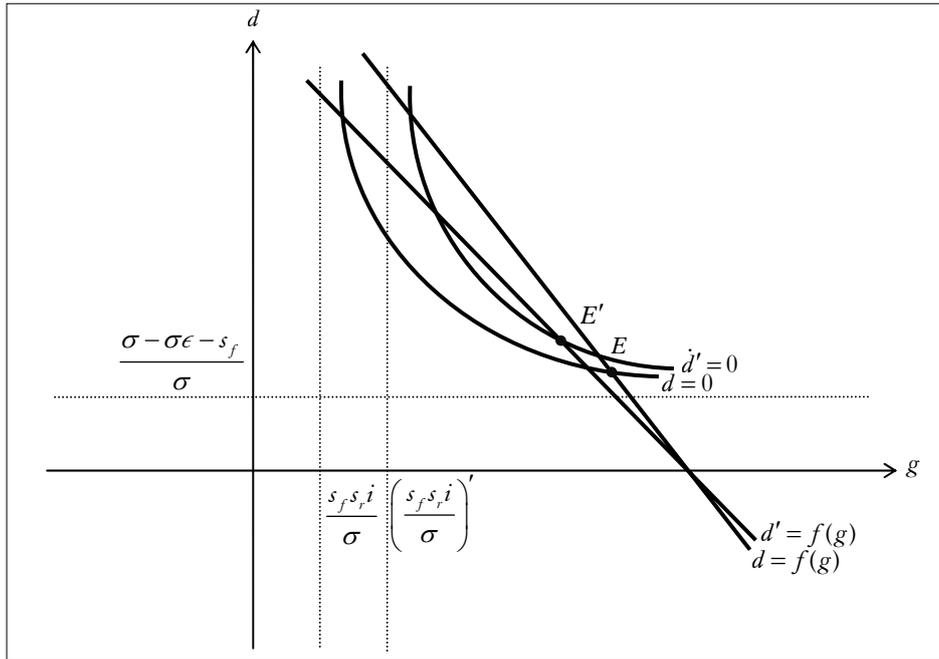


Consider the debt-burdened growth regime. As the interest rate rises, the long-run equilibrium locus shifts upward and the Keynesian equilibrium line shifts downward, flattening the slope. The long-run equilibrium debt-capital ratio rises

⁸ For the proof, see the Appendix. Sasaki and Fujita (2012) incorrectly argued that a higher interest rate raises both the debt-capital ratio and rate of accumulation in the debt-led growth regime.

and the long-run equilibrium rate of capital accumulation falls. The reason for this is as follows. A higher interest rate raises interest payments, which, in turn, would reduce capital accumulation and raise the debt-capital ratio. The so-called normal case occurs (see Figure 6).

[Figure 6] Effects of the Rising Interest Rate: Normal Case



Lavoie (1995) asserted that for a flexible debt-capital ratio in the long run, equilibrium is stable only in the debt-led growth regime (the puzzling case) and a stable equilibrium does not exist in the debt-burdened growth regime (the normal case). He compared the situation of an unstable long-run equilibrium to Steindl’s paradox of debt:⁹ “Although entrepreneurs and their bankers may wish to reduce leverage ratios in a recession, the macroeconomics may be such that this reduction need not occur” (Lavoie, 1995, p. 171). However, the above discussion does not support Lavoie’s assertion. Figure 6 shows that the stable long-run equilibrium exists in the normal case, where a higher interest rate decreases the rate of capital accumulation and raises the debt-capital ratio. Thus, Lavoie’s (1995) perspective, which makes a connection between Steindl’s paradox of debt and an unstable long-run equilibrium, would not be maintained.

⁹ The paradox of debt refers to the phenomenon where individual firms attempt to reduce their indebtedness by cutting investment expenditures, which leads to increasing indebtedness because the consequent reduction in aggregate demand and profits causes firms to rely more on debt finance.

IV. An Interpretation of Macroeconomic Instability

According to Lavoie and Seccareccia (2001), the key idea in Minsky's financial instability hypothesis is based on the proposition that the interest rate, rates of capital accumulation, and debt-capital ratios would possibly rise concurrently in boom phases of business cycles.¹⁰ In the evolutionary process of this concurrence, the economy becomes more unstable. Lavoie (1995) and Hein (2007) argued that such a concurrence happens only if long-run equilibrium is stable (see Figure 5), while the situation of long-run instability, which corresponds to Steindl's paradox of debt, excludes the positive correlation among the interest rate, rates of capital accumulation, and debt-capital ratios. Accordingly, they considered Minsky's financial instability hypothesis to be unpersuasive in the macroeconomic context. For example, Hein denied Minsky's financial instability hypothesis and its implicit structuralist theory of endogenous money as follows:

This paradox of debt also invalidates the macroeconomic relevance of Minsky's (1975) 'financial instability hypothesis' in so far as it is related to the financing of real investment. It has to rely on a co-movement of investment and debt finally leading to a breakdown in investment because of increasing financial fragility. Our results for the unstable case also question those post-Keynesian views by Minsky (1986) ... arguing for commercial banks endogenously increasing interest rates because of increasing indebtedness of firms when investment *rises*. (Hein, 2007, p. 329).

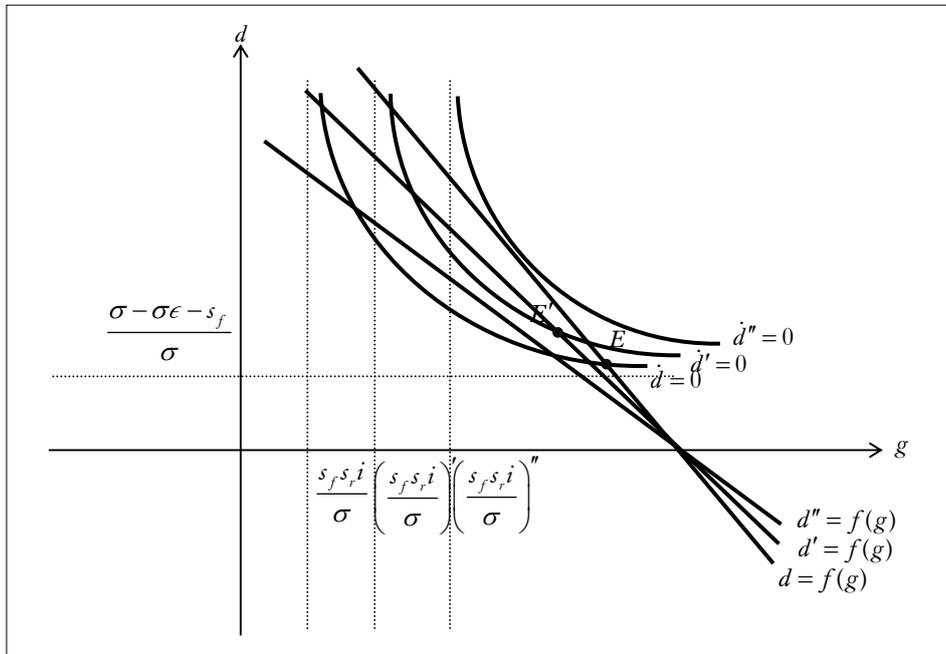
Our arguments in the previous section suggest that stable long-run equilibria exist not only in the debt-led growth regime, but also in the debt-burdened growth regime. In this section, we conduct comparative dynamic analyses to understand how increases in the interest rate would cause macroeconomic instability. The main idea is to examine shifts in the long-run equilibrium and distinguish between dynamic instability and structural instability.

Let us first consider how the long-run equilibrium shifts with an increase in the interest rate in the debt-burdened growth regime. Figure 7 shows that an increase in the interest rate shifts the stable long-run equilibrium from E to E' . Therefore,

¹⁰ Minsky (1975) proposed that in the boom phases of business cycles, firms form optimistic expectations about the future. Accordingly, they tend to accept risks more willingly and increase borrowing. As their leverage ratios rise, their financial conditions are transformed from hedge, through speculative, to Ponzi status. A higher interest rate further deteriorates their financial conditions and ultimately the Minskian meltdown occurs. Lavoie and Seccareccia (2001, p. 87) argued in this context that Minsky's financial instability hypothesis presupposes "a positive correlation between the aggregate leverage ratio of the non-financial corporate sector and real output growth."

the debt-capital ratio rises and the rate of capital accumulation falls. However, when the interest rate successively rises, macroeconomic instability gradually increases and a situation may arise where the long-run equilibrium does not exist. This corresponds to the situation where the Keynesian equilibrium line is $d'' = f(g)$ and the long-run equilibrium locus is $\dot{d}'' = 0$ in Figure 7. The short-run equilibrium is located on the Keynesian equilibrium line and moves northwest. Therefore, the debt-capital ratio rises and the rate of capital accumulation falls continuously in the context of long-run disequilibrium. We may call this situation the “stagnation regime.”

[Figure 7] Stagnation Regime: Steindl’s Paradox of Debt as Dynamic Instability



In the debt-led growth regime, macroeconomic instability may take a form of Minskian financial instability. As shown in Figure 8, an increase in the interest rate shifts the long-run equilibrium from E to E' . Thus, the debt-capital ratio and the rate of capital accumulation rise together.¹¹ As the interest rate rises further, however, firms’ margins of safety may shrink and financial fragility in the economy

¹¹ In the debt-led growth regime, a higher interest rate does not raise the debt-capital ratio unconditionally. Minsky’s financial instability can occur in the debt-led growth regime only under the condition that the debt-capital ratio for the initial long-run equilibrium has a relatively small value. Specifically, the following condition can be derived from equation (A) in the Appendix: $d^* < \frac{\psi s_f s_r + (\sigma - \sigma \epsilon - s_f) \phi}{\sigma \phi}$. Henceforth, we assume that this condition holds.

gradually increases. A margin of safety is defined as the ratio of gross profits to interest payments. A margin of safety might have a lower limit below which firms have to change their investment plans radically owing to overburdening debts. If ϖ represents the lower limit of an aggregate margin of safety, we obtain the following constraint condition from equation (8):

$$\frac{r}{id} = \frac{\alpha + (\tau - \theta)id}{\left(\sigma - \frac{\beta}{h} - \delta\right)id} > \varpi \quad (19)$$

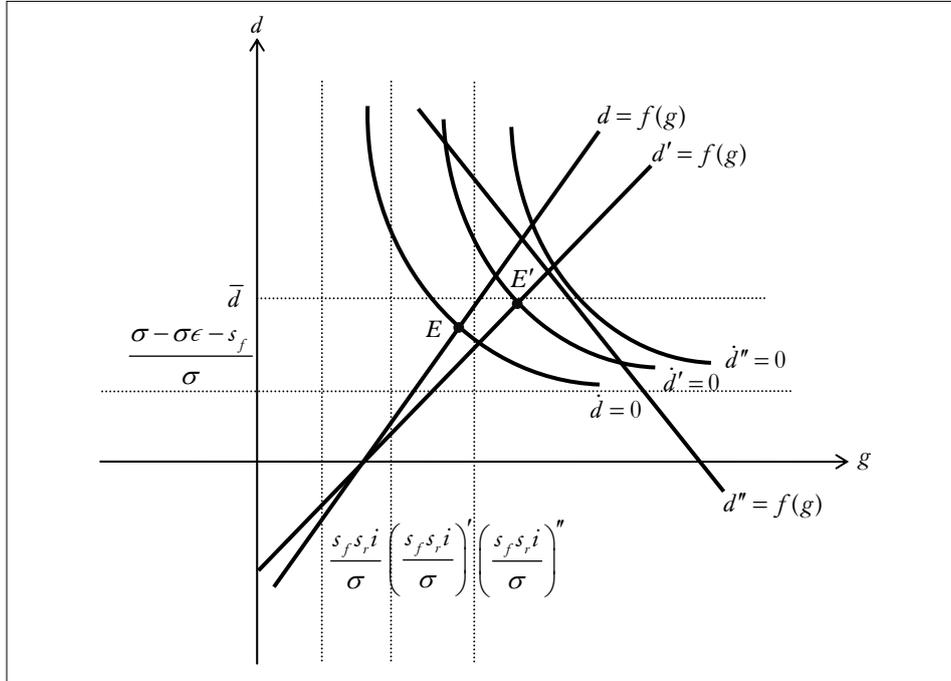
Rearranging inequality (19), we obtain an upper limit for the debt-capital ratio:

$$d < \bar{d} \equiv \frac{\alpha}{\left[\left(\sigma - \frac{\beta}{h} - \delta\right)\varpi - (\tau - \theta)\right]i} \quad (20)$$

If the debt-capital ratio exceeds the upper limit, firms would change their investment spending behavior so radically that sensitivities of investment to capacity utilization (β) and profit rates (δ) would decrease, while sensitivities of interest payments (θ) would increase. These revisions of the parameters of the investment function may transform the sign of ϕ from positive to negative. The Keynesian equilibrium line of $d'' = f(g)$ in Figure 8 depicts the effect of this change. As the long-run equilibrium locus shifts from $\dot{d}' = 0$ to $\dot{d}'' = 0$, a long-run equilibrium does not exist. Then, the story of the stagnation regime would unfold. Structural fluctuations would arise with a regime shift toward the stagnation regime, where the Minskian meltdown would be the final solution. This discussion about how the stagnation regime emerges out of changes in investment strategies corresponds to the arguments of Vercelli (2001). He proposed that the essential property of Minsky's financial instability exists not in dynamic instability but in structural instability.¹² In our model, structural instability comes from structural changes in parameters that reflect changes in firms' investment decisions when faced with insolvency risks.

¹² Vercelli (2011) interpreted the Minsky process as a phase of business cycles in the Lotka–Volterra equation system. He suggested that when firms' financial conditions encroach on their margins of safety, firms' behaviors change fundamentally and the Minsky process begins. According to Vercelli's reading of Minsky's financial instability hypothesis, the positive correlation between rates of capital accumulation and debt ratios, a critical precondition of Minsky's financial instability hypothesis, appears in boom phases of business cycles.

[Figure 8] Stagnation Regime: Minskian Meltdown as Parametric Structural Instability



In the above discussion, we interpreted that the stagnation regime corresponds to the situation of long-run disequilibrium, where the debt-capital ratio rises and the rate of capital accumulation falls continuously. Now, we consider some policy prescriptions to manage the stagnation regime and stabilize the economy. First, monetary policy that lowers the interest rate would serve to stabilize the economy. A lower interest rate reduces the burden on firms to pay interest and positively affects capital accumulation. The long-run equilibrium would emerge again and the economy would stabilize. Second, financial expenditures by the government that clear firms' debts would reduce insolvency risks faced by firms. Such expenditures would also serve to reduce lenders' risks of providing investment finance. Firms' financial structures would become more robust, which would create more optimistic investment environments. Firms would change their investment strategies accordingly. Third, policy prescriptions that decrease the propensity to save out of financial sources of income may contribute to stabilizing the economy. Such prescriptions would lead to higher capacity utilization, which, in turn, would induce an increase in the rate of capital accumulation. Then, firms would earn more profits, thus raising margins of safety and lowering debt-capital ratios. The long-run equilibrium would emerge again and the economy would stabilize.

V. Conclusion

We considered a simple model of corporate debt dynamics within the framework of the post-Keynesian theory of growth and distribution. Introducing corporate debt dynamics into a modified version of Lavoie's Minsky–Steindl model, we drew long-run results that are different from those of Lavoie (1995) and Hein (2007). According to Lavoie (1995), a stable long-run equilibrium exists only in the puzzling case, whereas the normal case shows an unstable long-run equilibrium. He described the long-run unstable phenomenon as Steindl's paradox of debt and denied that Minsky's financial instability hypothesis could be considered a relevant theory of macroeconomic instability. Contrary to Lavoie's results, we showed that stable long-run equilibria exist not only in the puzzling case but also in the normal case. On the basis of these long-run results, we demonstrated how an increase in the interest rate would cause macroeconomic instability. The main idea was to examine shifts in the long-run equilibrium and distinguish between dynamic instability and structural instability. Macroeconomic instability takes the form of dynamic instability in the normal case, whereas it represents the form of structural instability in the puzzling case. In the normal case, an increase in the interest rate raises the long-run equilibrium debt-capital ratio and lowers the long-run equilibrium rate of capital accumulation. When the interest rate successively rises, macroeconomic instability gradually increases and the stagnation regime may arise, where the long-run equilibrium does not exist. In the puzzling case, macroeconomic instability may take the form of structural instability. An increase in the interest rate raises the long-run equilibrium debt-capital ratio and the long-run equilibrium rate of capital accumulation. As the interest rate rises further, however, firms' margins of safety may shrink and the financial fragility of the economy gradually increases. If an aggregate margin of safety falls below the lower limit, firms would radically change their investment spending behavior. Structural fluctuations would arise with a regime shift toward the stagnation regime.

We suggested some policy prescriptions to stabilize an economy set to embark on the self-reinforcing process of stagnation. First, monetary policy that lowers the interest rate would alleviate firms' burdens of interest payments and positively affect capital accumulation. Second, as a lender of last resort, the government may intervene to clear firms' overburdening debts. On the one hand, such intervention directly reduces the debt-capital ratio. On the other hand, it decreases lenders' risks and creates an optimistic atmosphere, wherein firms change their investment strategies accordingly. Both of these effects would contribute to the emergence of a stable long-run equilibrium. Third, the government may take some measures to decrease the propensity to save out of financial sources of income, which would contribute to stabilizing the economy by increasing the rate of capacity utilization, the rate of capital accumulation, and profit rates.

Appendix

Assuming that the long-run equilibrium condition of $\dot{d}=0$ holds, equation (18) in the text can be expressed as $f(d^*;i)=0$. Totally differentiating $f(d^*;i)=0$ yields the following derivative of the long-run equilibrium debt-capital ratio with respect to the rate of interest.

$$\frac{dd^*}{di} = - \left(\frac{\partial f(d^*;i)}{\partial i} \right) / \left(\frac{\partial f(d^*;i)}{\partial d^*} \right) = - \frac{(\sigma - \sigma d^* - \sigma \epsilon - s_f) \phi d^* + \psi s_f s_r d^*}{(\sigma - \sigma d^* - \sigma \epsilon - s_f) \phi i + \psi s_f s_r i - \sigma(\alpha \sigma + \phi i d^*)} \quad (\text{A})$$

In this study, we only consider stable long-run equilibrium. Thus, the sign of $\frac{\partial f(d^*;i)}{\partial d^*}$ is negative from the stability condition for the long-run equilibrium, $\frac{\partial \dot{d}}{\partial d} < 0$.

$$\frac{\partial f(d^*;i)}{\partial d^*} = \frac{(\sigma - \sigma d^* - \sigma \epsilon - s_f) \phi i + \psi s_f s_r i - \sigma(\alpha \sigma + \phi i d^*)}{\sigma \psi} < 0 \quad (\text{B})$$

Since $\sigma \psi > 0$ holds, $(\sigma - \sigma d^* - \sigma \epsilon - s_f) \phi i + \psi s_f s_r i - \sigma(\alpha \sigma + \phi i d^*) < 0$ has to be valid. Now, the sign of (A) depends on the sign of the numerator. Substituting equation (15) in equation (14) in the text and rearranging it, we obtain $\dot{d} = f(d;i) = \frac{s_f s_r i}{\sigma} d - g d + \frac{\sigma - \sigma \epsilon - s_f}{\sigma} g$. The long-run equilibrium rate of capital accumulation can be represented by $g^* = \frac{s_f s_r i d^*}{-(\sigma - \sigma d^* - \sigma \epsilon - s_f)}$. Since the long-run equilibrium debt-capital ratio and the long-run equilibrium rate of accumulation are positive, the sign of $\sigma - \sigma d^* - \sigma \epsilon - s_f$ has to be negative. Thus, the sign of (A) is positive in the debt-burdened growth regime ($\phi < 0$) and the sign of (A) is indeterminate when the short-run equilibrium exhibits debt-led growth ($\phi > 0$).

Differentiating the long-run equilibrium rate of capital accumulation $g^* = \frac{\alpha \sigma + \phi i d^*}{\psi}$ with respect to the rate of interest, we obtain the following equation.

$$\frac{dg^*}{di} = \frac{\partial g^*}{\partial i} + \frac{\partial g^*}{\partial d} \frac{dd^*}{di} = \frac{\phi}{\psi} \left(\frac{-\sigma d^* (\alpha \sigma + \phi i d^*)}{(\sigma - \sigma d^* - \sigma \epsilon - s_f) \phi i + \psi s_f s_r i - \sigma(\alpha \sigma + \phi i d^*)} \right) \quad (\text{C})$$

Since $(\sigma - \sigma d^* - \sigma \epsilon - s_f) \phi i + \psi s_f s_r i - \sigma(\alpha \sigma + \phi i d^*) < 0$ and $-\sigma d^* (\alpha \sigma + \phi i d^*) < 0$ hold, the effect of an increase in the interest rate on the long-run equilibrium rate of accumulation is positive in the debt-led growth regime. In the debt-burdened growth regime, however, an increase in the rate of interest would decrease the long-run equilibrium rate of capital accumulation.

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