Financialization and Endogenous Technological Change: a Post-Kaleckian Perspective

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Abstract

In post-Keynesian literature, Hein (2012a) was the first to incorporate financialization as an influential positive determinant of the rate of technological change. However, financialization is more like a two-edged sword which can affect technological change negatively as well. We capture both the positive as well as the negative effect of financialization on technological change which encapsulates the possibility of multiple equilibria. In analyzing the long run of the model we endogenize the financialization parameter as well and get richer dynamics than Hein (2012a). We show that under certain circumstances, higher speed of diffusion of technological innovation, more regulated financial markets, and higher intra-class competition among firms are desirable for stabilizing the economy. Finally, we provide some policy prescriptions for the same.

Keywords: Capital accumulation, Distribution, Financialization, Kaleckian model, technological change*, Andronov–Hopf bifurcation, Limit cycles*

JEL classification: C62, C69, D33, E12, G01, O16, O41

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1 *Introduction*

The phenomenon of 'financialization' has an important role to play in explaining developments in the world economy (specially for developed countries) over the past four decades. Financial markets and agents play a prominent role in the modern economy. Enormous increases in the size of the financial sector on one hand and deregulation of the sector on the other hand are associated with a significantly changed income distribution in this era of financialization. Financialization has transformed the functioning of the economic system at both the micro and macro levels. For the last four decades for US economy, on the one hand we observe continuous invention and innovation of new technologies and on the other hand an increasing engagement of non-financial businesses in financial markets. Since the last three decades financial fragility has increased enormously and finally there is financial crisis of the US economy (2007-08).

The intention of this chapter is, first, to focus on how technological change occurs through time, especially in the era of financialization in the context of the US economy. Second, to explain how financialization itself evolves over time. And third, how the interaction between the dynamics of technological change and financialization leads to fragility and instability in the economy. Our analysis develops over Hein (2012a) in the sense that unlike Hein(2012a) (where in the long run the economy always achieves a stable steady-state) by introducing the financialization dynamics and allowing the possibility of nonlinearity of the technological change dynamics we are able to open up the possibility of long-run instability in our model. While several economists and policymakers have tried to explain the recent financial crisis of the US economy, this chapter provides an alternative way of looking into the problem. This chapter also seeks to explain whether intra-class conflict among firms has any role to play in ensuring stability in the economy, especially when the economy is in a prolonged stagnation.

We focus on the concept of financialization first. After that, we briefly discuss the Keynesian and post-Keynesian literature regarding endogenous technological change. Then we explain the distinctive features and novelty of our analysis compared to the earlier literature. Finally we discuss the outline for the rest of the chapter.

‘Financialization’ has emerged as a concept like ‘globalization’ for which not only is a unique definition unavailable, but the precise form and usage of it is also unclear. As a result, we find several definitions and various uses of the term. The most cited definition of the term comes from Epstein (2005) to whom “Financialization means the increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of the domestic and international economies”. As the intention of this chapter is mainly to focus on the long run interaction between the financialization level and technological change, to make the model simple and tractable, following Dumenil and Levy (2004), in this chapter we define the concept of financialization as “the growth of financial enterprises, the rising involvement of non-financial enterprises in financial operations, the holding of large portfolios of shares and other securities by households, and so on”. We also assume financialization as associated with the notion of ‘shareholder value orientation’. Lazonick and O’Sullivan (2000) extensively discuss the concept of ‘shareholder value’ as a principle of corporate governance in the United States. As they point out, there is a massive “transformation of US corporate strategy from an orientation towards retention of corporate earnings and reinvestment in corporate growth through the 1970s to one of downsizing of corporate labour forces and distribution of corporate earnings to shareholders”[1] over the past few decades for satisfying shareholders’ demand for distributed profits and for maintaning high share prices. So, by the notion of ‘shareholder value orientation’ we emphasize this very change in the objective of firm managements[2].

Most of the neo-Keynesian and post-Keynesian literature which treats technological change as an endogenous phenomenon explains technological change as positively dependent on the rate of capital accumulation (e.g. Kaldor 1957, 1961, 1966; Rowthorn 1981; Dutt 1990; Taylor 1991; Lavoie 1992 etc). However, a significant amount of post-Keynesian literature considers technological innovation as being determined by income distribution as well (e.g. Taylor 1991; Cassetti 2003; Naastepad 2006; Dutt 2006, 2013). A basic argument of this literature is that as wage share rises, firms face higher labour costs[3]

[1] Lazonick and O’Sullivan (2000; pp. 13)

[2] For more on ‘shareholder value’ see Froud et. al. (2000).

[3] One can argue that as labour costs rise, firms can increase the existing levels of prices. Notwithstanding the fact that it might be possible, as firms face more difficulties in transferring higher costs into prices they feel stronger incentives for adopting labour-saving innovations.

and this accelerates the innovation of new labour-saving technologies, so that profit share can be prevented from falling further. According to Dutt (2006, 2013), technological change depends positively on the difference between the growth rate of labour demand and labour supply. A rise in aggregate demand leads to an enhancement of labour employment growth which in turn leads to a faster growth rate of technological (labour-augmenting) change so that the problem of labour shortage is taken care of. This argument is consistent with the impact of distributional variables on technological change in the sense that a shortage of labour puts an upward pressure on the wage share and this leads to labour-saving changes in technology[4].

Using a post-Kaleckian growth model, Hein (2010, 2012a, 2012b, 2014) examines the effect of financialization (and an increase in shareholder power) on the demand regime[5] and on the productivity regime separately and then on the overall regime of the model. Financialization and increasing shareholder power for the analysis of both the demand and the productivity regimes is considered to be an exogenous variable in Hein's model. When the demand regime is analysed, productivity growth is assumed to be an exogenous variable which is endogenized later for the analysis of the productivity regime. In the analysis of the overall regime, the equilibrium growth rate and the productivity growth

[4] Beyond these two variables (rate of capital accumulation and the wage/profit share), technological change can be influenced by other phenomena as well. For example in a neo-Schumpeterian post-Keynesian model of growth and distribution, Lima (2000) explores the relationship between market concentration and endogenous technological innovation. Borrowing an idea from Schumpeter (1912, 1942) he argues that higher market power (concentration) by providing more internal financial resources give firms the incentive to spend on innovative activities. On the other hand, high concentration (and hence weak competition) reduces the incentive to innovate as firms with high monopoly power feel less threatened by their rivals. So, as he says, the technological innovation depends non-linearly on market concentration.

Later on, in a post-Keynesian macro-model of accumulation, growth, and distribution Lima (2004) captures the endogeneity of technological innovation. In this paper the rate of labour-saving technological innovation by firms depends non-linearly on the distribution of income. Distribution plays the crucial role as it provides the incentive to innovate and at the same time provides the source (and availability) of funds for innovations. At a low level of wage share, the availability of fund to innovate is high and dominates the incentives to innovate. On the other hand, at a high level of wage share although the incentive for innovation is quite high the availability of funds is low. It is the intermediate level of wage share where the rate of technological innovation is maximum.

[5] In the analysis of demand regime, Hein (2010, 2012a, 2012b, 2014) analyzes the aggregate demand and the rate of capital accumulation where he fixes the labour productivity growth at a constant level. In the analysis of productivity regime he endogenizes the labour productivity growth.

both are determined endogenously and finally, the effect of financialization[6] (and a rise in shareholder power) on both the regimes is derived.

Tridico and Pariboni (2018) use an empirical analysis to explain the main causes of labour productivity slowdown in several developed countries. They first explain how financialization[7] leads to higher income inequality and then considering an extended version of Sylos-Labini's equation[8] they find the labour productivity growth rate to be positively dependent on the growth rate of GDP and the wage share whereas income inequality and financialization both have a negative impact on it.

The current chapter is most closely related to Hein (2012a). Following Bhaduri and Marglin (1990), Hein (2012a) assumes investment decisions to be positively influenced by expected sales and by the profit share as both positively affect the expected profit rate. Distributed profits by reducing the available internal funds and limiting the access to external funds negatively affects investment demand. He also incorporates technical progress as one of the variables determining the level of investment. In his own language, the explanation is as follows. "Since technical progress is embodied in capital stock, it will stimulate investment. Firms have to invest in new machines and equipment in order to gain from productivity growth that is made available by new technologies" (pp. 482).

An increase in shareholder power, as Hein (2012a) points out, affects the accumulation rate through three channels. First, through the 'preference channel'[9] which is negative. Second, through the 'internal finance channel',[10] the overall

[6]In our model, financialization captures the notion 'shareholder value orientation' as well. So we do not have to separately use the term 'shareholder value orientation'.

[7]They consider labour flexibility and 'shareholder value orientation' as the main aspects of financialization.

[8]According to Sylos Labini (1999), growth rate of labour productivity depends mainly positively on the growth rate of GNP (Gross National Product), growth rate of wage share, and the growth rate of relative cheapness of labour over capital.

[9]'Shareholder value orientation' influences managers' (here firms') to shift their preference from retaining profit and reinvesting it to enhance the rate of capital accumulation to downsizing the labour force and distributing the profit to shareholders. "The preference for growth, and hence the willingness to invest in capital stock, therefore suffers, too" (Hein ; 2012b, pp. 39). This route through which shareholder power works is called the 'preference channel'.

[10]Because of 'shareholder value orientation', firms are forced to distribute a higher share of profit to the shareholders and hence have a lower retention ratio. As a result, "internal means of finance for real investment are reduced, and the ability to invest hence suffers"

effect of which is ambiguous. And third, the 'distribution channel'[11] which also has an ambiguous effect on the capital accumulation. So the overall effect of a rise in shareholder power on the equilibrium accumulation rate is ambiguous. It can be 'expansive' i.e. there is a positive impact of a rise in shareholder power on the accumulation rate or it can be 'contractive' i.e. an increase in shareholder power will negatively affect the accumulation rate[12].

For a given capital accumulation rate, a change in shareholder power has a direct positive effect on productivity growth and a negative indirect effect via the profit share. So the overall effect of a rise in shareholder power on productivity growth is ambiguous.

If demand and productivity regime both are expansive, with a rise in shareholder power, an overall expansive regime can be achieved i.e. capital accumulation and productivity growth both increase in the face of rising shareholder power. Similarly, if both the regimes are contractive, the overall regime will be contractive too.

However, if the demand regime is contractive and the productivity regime is expansive and the contractive effect on the demand regime is relatively weak, we may obtain an overall expansive regime while if the contractive effect on the demand regime is relatively strong then we may obtain an overall contractive regime. If, however, the partial effects on demand regime and productivity regime are neither too strong nor too weak then an overall intermediate regime is possible i.e. a slow capital accumulation with fast productivity growth may co-exist. Exactly opposite of the above happens if the demand regime is expansive and the productivity regime is contractive.

(Hein; 2012b, pp. 39). This route through which shareholder power works is called as 'internal finance channel'. However, as rentiers' have higher propensity to consume, the consumption demand rises. So the overall effect is ambiguous.

[11] The route through which shareholder power influences the distribution of income (between wage share and profit share) is called 'distribution channel'.

[12] When the effect of a rise in shareholder power on equilibrium rate of capital accumulation is positive it is called (by Hein) as 'expansive' demand regime. On the contrary, if a rise in shareholder power negatively affects the equilibrium capital accumulation rate, it is called as 'contractive' demand regime. Similarly, a positive effect of shareholder power on productivity is called as an 'expansive' productivity regime and the negative effect is called as the 'contractive' productivity regime. In order to discuss the overall regime, the rate of capital accumulation and the growth rate of labor productivity are first determined endogenously. Then for the overall regime, the total effect of a change in shareholder power on the demand and productivity regimes are considered together.

Hein (2010, 2012a, 2012b, 2014) is the first and to the best of our knowledge is only contributor for the literature who focuses on the impact of financialization on productivity growth (or technological change) from a theoretical perspective. The basic structure of our model is based on Hein (2012a). However, compared to Hein (2010, 2012a, 2012b, 2014) this chapter has a few distinct features.

First, Hein (2012a) points out that if 'shareholder value orientation' goes too far, a potential negative impact of it on labour productivity growth is possible. Nonetheless, his basic analysis is based on a simple linear positive relationship between 'shareholder value orientation' and labour productivity which ensures the unique and stable steady state only. However, in this chapter by incorporating both positive and negative effects of financialization on the rate of technological change, we get a non-linear relationship between those two that allows the existence of multiple equilibria and opens the possibility of instability in the economy. In our analysis of the long run, we provide the rationale for the assumed non-linear relation between the level of financialization and technological change. This, in our opinion, is more appropriate for explaining developments in the US economy which has become more fragile and unstable for the last several decades.

Second, so far most of the literature captures financialization as an exogenous parameter and explain its impact on the economy by the change in that very parameter. The novelty of our work lies in the fact that we try to explain how this financialization parameter itself evolves through time (in other words we are trying to endogenize this financialization parameter in the long run). We then show how the interaction between one stable and one unstable subsystem (represented by technological change and financialization dynamics respectively) can produce instability and cycles in the whole system. We show that a lower degree of restrictiveness enforced by various intellectual property rights, more regulated financial markets, and more competition among firms are desirable for stabilizing the economy. We discuss some policy prescription for the same as well.

The outline of the rest of the chapter is as follows. Section 2 sets up the model and presents a short run analysis. Section 3 discusses the long run where we endogenize the financialization parameter and technological change. Section 4 talks about possible cases that may arise because of the interaction between financialization and technological change. This is followed by the discussion of Andronov-Hopf bifurcation where we analyze how the interaction between financialization and technological innovation can produce limit cycles. Section 5 discusses the comparative statics. Section 6 offers some concluding remarks.

2 *The Model*

Our short run analysis is completely based on Hein (2012a). We assume a simple one-sector, closed economy, post-Kaleckian growth model in which the economy consists of workers, rentiers, and firms. There is no government intervention in the economy. For simplicity we assume lack of depreciation of capital and only labour saving and capital-embodied technological change prevails in the economy. Technological change thus implies an increment in output-labour ratio or labour productivity ($a = Y/L$)[13] . The rate of capacity utilization (u) is given by the ratio of actual real output to capital stock. As long as the potential output-capital ratio is fixed, the actual output-capital ratio can be used as a proxy for the degree of capacity utilization.

The market is oligopolistic in nature where price (p) is determined by mark-up on prime cost. For simplicity, we assume away the cost of raw materials and overhead cost and consider labour cost as the only cost of production. So price is determined by the following equation as

$$p = [1 + m(\Omega)]\frac{WL}{Y}$$

$$\Rightarrow p = [1 + m(\Omega)]\frac{W}{a}; \quad m > 0, \frac{\partial m}{\partial \Omega} \geq 0 \tag{2.1}$$

m denotes the mark-up rate and $a = \frac{Y}{L}$ is labour productivity. Total wage share equals to $\frac{WL}{pY} = \frac{\omega}{a}$, where ω is real wage rate. Ω represents the level of financialization. We assume, for the mathematical possibilities only, that $\Omega \in (0, 1)$.

[13] The capital-labour ratio ($k = K/L$) increases at the same rate as labour productivity, and hence the capital-potential output ratio ($v = K/Y^P$) remains unchanged. Basically we assume a Harrod-neutral technical progress, as in Rowthorn (1981) and Hein (2010, 2012a, 2012b, 2014). In this chapter, technological change and labour productivity growth are used interchangeably.

So, share of profit is $\pi = (1 - \frac{\omega}{a})$. It can be expressed as the ratio of total profit to the nominal level of income as well i.e.

$$\pi = \frac{R}{pY} = \frac{m}{1+m}; \qquad \frac{\partial \pi}{\partial \Omega} \geq 0 \tag{2.2}$$

The markup and the profit share both may change with respect to a change in shareholder power vis-à-vis management and labourers[14]. A rise in shareholder power (because of mergers, acquisitions and hostile takeovers) can potentially reduce the degree of competition in the goods market and the 'downsize and redistribute' strategy of firms lowers the bargaining power of labour unions in the labour market. Thus an increase in the level of financialization (Ω) is associated with an increase in markup in firms' pricing which is expressed in equation (2.1) and thus it is associated with a rise in the share of profit[15] (equation (2.2)). Rate of profit is expressed as a product of share of profit and the degree of capacity utilization and is expressed in the following equation as

$$r = \frac{R}{K} = \pi u \tag{2.3}$$

A fraction of total profit is retained by the firms (R^F) and the rest is distributed as dividends (paid on equity held by rentiers (R^{Div})) and as interest payment (paid on debt to the rentiers (R^{Int})). Thus total distributed profit (R^R) consists of dividend and the interest payment to the rentiers. This argument is captured in the next equation as

$$R = R^F + R^{Int} + R^{Div} = R^F + R^R \tag{2.4}$$

Dividing both sides of the above equation with respect to the nominal value of capital stock we get rate of profit as a summation of firms' retained profit rate (r^F) and rentiers' profit rate (r^R) i.e.

$$r = r^F + r^R \tag{2.5}$$

$$r^R = \frac{R^R}{K}; \qquad \frac{\partial r^R}{\partial \Omega} > 0 \tag{2.6}$$

14 $\frac{\partial \pi}{\partial \Omega} = \frac{\partial \pi}{\partial m}\frac{\partial m}{\partial \Omega} = \frac{1}{(1+m)^2}\frac{\partial \pi}{\partial \Omega} \geq 0.$

15 For a detailed discussion on how financialization affects the markup, share of profits and distributed profits see Hein (2012a; pp. 480).

$$r^F = \frac{R^F}{K} \tag{2.7}$$

Following Hein (2012a), we assume that a rise in shareholder power leads to an enhancement in the rentiers' profit rate. As long as there is a given total rate of profit, a given capital-potential output ratio, given income distribution between capital and labour, and a given rate of capacity utilization, a rise in the rentiers' rate of profit leads to a decrease in the firms' profit rate. However, as long as the degree of capacity utilization itself is endogenous, there is a very little scope for the rate of profit to remain constant. When there is a strong contractive macroeconomic effect on the overall profit rate (r)[16], there is a possibility that a rise in shareholder power (Ω) can reduce the rentiers' profit rate (r^R). For simplicity, in accordance with Hein (2010, 2012a, 2012b, 2014), this possibility is excluded[17].

We assume workers spend all of their income (which is the wage income only) on consumption whereas a fraction (s_r) of rentiers' income is saved. So total savings of the economy consists of savings of the firms (which is essentially the retained profit) and the savings of the rentiers i.e.

$$S = R^F + s_r R^R = R - R^R + s_r R^R = R - (1 - s_r)R^R \tag{2.8}$$

Normalization of the above equation in terms of the existing capital stock yields,

$$\frac{S}{K} = \sigma = \pi u - (1 - s_r)r^R \tag{2.9}$$

Following Hein (2012a) and Bhaduri-Marglin (1990), we assume investment decisions to be positively influenced by expected sales (i.e. by the degree of capacity utilization) and by the profit share as both positively affect the expected profit rate. Distributed profits (i.e. dividends and interest payments

[16] That is a rise in shareholder power although increases profit share, here it reduces the capacity utilization rate. The latter is more than offsetting the former and causing a fall in the rate of profit.

[17] We assume $\frac{\partial r^R}{\partial \pi} = 0$. So $\frac{\partial r}{\partial \pi} = \frac{\partial r^F}{\partial \pi} = u$. The rationale behind this assumption is as follows: first, interest payment to the rentiers (which depends on interest rate and the outstanding debt level of firms to rentiers) is independent of the share of profit. Second, firms generally decide how much to pay as dividend first and then adjust their internal funds (retained earnings) for investment purposes accordingly. As Brav et. al. (2005) say "..there is not much reward in increasing dividends but there is perceived to be a large penalty for reducing dividends." Amount of dividend payment changes only when substantial and sustainable change in earnings are there. Managers are in fact ready to sell some positive NPV investment projects in order to maintain the dividend.

to rentiers), by reducing the available internal funds, negatively affect the investment demand while at the same time it imposes restrictions on the access to external funds à la Kalecki (1937). Following Hein (2012a), we assume inventions of new technologies also positively influence the investment demand. The reason is as follows. If firms want to gain from productivity growth (due to availability of new technologies), firms have to invest in new machines and equipment. This is happening because "firms have to invest in new machines and equipment in order to gain from productivity growth that is made available by new technologies[18]". So, the investment function is

$$\frac{I}{K} = g = \alpha_0 + \alpha_1 u + \alpha_2 \pi - \alpha_3 r^R + \alpha_4 \lambda; \;\; \alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4 > 0; \frac{\partial \alpha_0}{\partial \Omega} < 0, \frac{\partial r^R}{\partial \Omega} > 0 \tag{2.10}$$

Here λ represents the technological change or the growth rate of labour productivity. So $\lambda = \frac{\dot{a}}{a} = \hat{a}$.

In accordance with Hein (2012a), we assume increasing shareholder power vis-à-vis management can reduce the available funds for real investment through 'internal finance channel' and affects the management's 'animal spirits' through 'preference channel' which are captured by $\frac{\partial r^R}{\partial \Omega} > 0$ and $\frac{\partial \alpha_0}{\partial \Omega} < 0$ respectively.

In the short run equilibrium,

$$g = \sigma$$

$$\Rightarrow \alpha_0 + \alpha_1 u + \alpha_2 \pi - \alpha_3 r^R + \alpha_4 \lambda = \pi u - (1 - s_r) r^R$$

$$\Rightarrow u^\star = \frac{(\alpha_0 + \alpha_2 \pi + \alpha_4 \lambda) + (1 - s_r - \alpha_3) r^R}{(\pi - \alpha_1)} \tag{2.11}$$

Keynesian stability condition requires the responsiveness of investment demand to a change in aggregate demand to be less than that of the savings for the same unit change in aggregate demand, i.e. $\pi > \alpha_1$. Let's assume the Keynesian stability condition is satisfied. For a meaningful degree of capacity utilization the numerator of the equation (2.11) must be positive i.e. $(\alpha_0 + \alpha_2 \pi + \alpha_4 \lambda) + (1 - s_r - \alpha_3) r^R > 0$. When $(1 - s_r - \alpha_3) > 0$ the numerator is unambiguously positive for all values of Ω. But if $(1 - s_r - \alpha_3) < 0$ then for the numerator to be positive, for all values of Ω, $\alpha_0 + \alpha_2 \pi + \alpha_4 \lambda > \left|(1 - s_r - \alpha_3)\right| r^R$ is required. Substituting the short-run equilibrium degree of capacity utilization from (2.11) to (2.10) yields the short run equilibrium rate of capital accumu-

[18] Hein (2012a).

lation as

$$g^\star = \alpha_0 + \alpha_1 u^\star + \alpha_2 \pi - \alpha_3 r^R + \alpha_4 \lambda$$

$$\Rightarrow g^\star = \frac{\pi(\alpha_0 + \alpha_2 \pi + \alpha_4 \lambda) + [\alpha_1(1 - s_r) - \alpha_3 \pi] r^R}{(\pi - \alpha_1)} \tag{2.12}$$

Lemma 1. $(1 - s_r - \alpha_3) < 0 \rightarrow [\alpha_1(1 - s_r) - \alpha_3 \pi] < 0$

Proof. Suppose $(1 - s_r - \alpha_3) < 0$. $(1 - s_r - \alpha_3) < 0$ and $(\pi - \alpha_1) > 0$ implies $\alpha_1(1 - s_r) < \alpha_1 \alpha_3 < \alpha_3 \pi$ which in turn implies $[\alpha_1(1 - s_r) - \alpha_3 \pi] < 0$. □

Lemma 2. $[\alpha_1(1 - s_r) - \alpha_3 \pi] > 0 \rightarrow (1 - s_r - \alpha_3) > 0$.

Proof. Suppose $[\alpha_1(1-s_r) - \alpha_3 \pi] > 0$. $[\alpha_1(1-s_r) - \alpha_3 \pi] > 0$ and $(\pi - \alpha_1) > 0$ implies $\alpha_1(1 - s_r) > \alpha_3 \pi > \alpha_1 \alpha_3$ which in turn implies $(1 - s_r - \alpha_3) > 0$. □

Now let's check whether the economy is in a wage-led or profit-led demand regime. Partial differentiation of equation (2.11) w.r.t. π yields

$$\frac{\partial u^\star}{\partial \pi} = -\left\{ \frac{(\alpha_0 + \alpha_1 \alpha_2 + \alpha_4 \lambda) + (1 - s_r - \alpha_3) r^R}{(\pi - \alpha_1)^2} \right\} \tag{2.13}$$

Note that if $(1 - s_r - \alpha_3) > 0$, (i.e. when the consumption propensity of the rentiers is greater than the reduction in rate of capital accumulation per unit change in rentiers' profit rate) $\frac{\partial u^\star}{\partial \pi}$ is unambiguously negative. However if $(1 - s_r - \alpha_3) < 0$, $\frac{\partial u^\star}{\partial \pi} \gtreqless 0$ according to whether $\left|1 - s_r - \alpha_3\right| \gtreqless \frac{\alpha_0 + \alpha_1 \alpha_2 + \alpha_4 \lambda}{r^R}$. There is another way of expressing this. Rearranging the equation (2.11) and differentiating it w.r.t. π we get,

$$u^\star + (\pi - \alpha_1) \frac{\partial u^\star}{\partial \pi} = \alpha_2$$

$$\Rightarrow \frac{\partial u^\star}{\partial \pi} = \frac{\alpha_2 - u^\star}{(\pi - \alpha_1)} \tag{2.14}$$

So $\frac{\partial u^\star}{\partial \pi} \gtreqless 0$ according to whether $\alpha_2 \gtreqless u^\star$ i.e. whether the economy is in a wage-led or profit-led demand regime depends on the value of equilibrium degree of capacity utilization relative to α_2.

Differentiating $g^\star$ w.r.t. π and rearranging we get,

$$\frac{\partial g^\star}{\partial \pi} = \frac{(\alpha_2 \pi - \alpha_1 u^\star)}{(\pi - \alpha_1)} \tag{2.15}$$

So $\frac{\partial g^\star}{\partial \pi} \gtreqless 0$ according to whether $\alpha_2 \pi \gtreqless \alpha_1 u^\star$.

Proposition 1. *A profit-led demand regime implies a profit-led growth regime.*

Proof. Suppose the economy is in a profit-led demand regime. So from equation (2.14), $\alpha_2 > u^\star$. $\alpha_2 > u^\star$ and $(\pi - \alpha_1) > 0$ together imply $\alpha_2 \pi > \pi u^\star > \alpha_1 u^\star$ which means the economy is in a profit-led growth regime. □

Corollary 1. *A wage-led growth regime implies a wage-led demand regime.*

Proof. Suppose the economy is in a wage-led growth regime. So from equation (2.15), $\alpha_2 \pi < \alpha_1 u^\star$. $\alpha_2 \pi < \alpha_1 u^\star$ and $(\pi - \alpha_1) > 0$ together imply $\alpha_2 < u^\star$ which means the economy is in a wage-led demand regime. □

We assume that faster rate of adoption of labour saving innovations weakens the bargaining power of workers. Justification of this assumption can be found in Ellis and Smith (2007). As Ellis and Smith (2007) points out, according to Hornstein et. al. (2002), when there are search frictions in the labour market, a faster rate of innovation and obsolescence of putty-clay capital can raise the share of profit. Because of faster rate of innovation, new capital goods become more attractive to firms. Consequently, firms want to change their capital and production process more frequently. However, as firms want to use the new technology optimally, (because of putty-clay capital) this leads to more frequent changes in firms' employment level. As there is more employment churn *ex ante*, this would reduce the rate of matching between firms and workers. As a result, at least for some periods, workers are now more likely to lose their jobs. Consequently, bargaining power of firms vis-a-vis workers rises.

Hence, we assume that a rise in the growth rate of labour productivity raises the profit share i.e. $\frac{\partial \pi}{\partial \lambda} > 0$. For simplicity of exposition, however, we assume that $\frac{\partial \pi}{\partial \lambda}$ is a positive constant. We also assume that $\frac{\partial \pi}{\partial \Omega}$ and $\frac{\partial r^R}{\partial \Omega}$ are positive constants and $\frac{\partial \alpha}{\partial \Omega}$ is a negative constant[19].

[19] The purpose these assumptions is mentioned in Footnote 27

Starting with 1970s, real wage rate has not grown at the same pace as labour productivity in the US economy (see Figure ??). As a result, if labour productivity increases, wage share $\frac{\omega}{a}$ decreases which in turn increases the profit share $(\pi = (1 - \frac{\omega}{a}))$. Thus we can assume $\frac{\partial \pi}{\partial a} > 0$ i.e. a rise in labour productivity increases profit share. As $\lambda = \frac{\dot{a}}{a}$, $a = e^{\lambda t}$. Thus $\frac{\partial \pi}{\partial \lambda} = \frac{\partial \pi}{\partial a}\frac{\partial a}{\partial \lambda} = \frac{\partial \pi}{\partial a} t e^{\lambda t}$ which is positive.

Now we discuss the effect of a rise in growth rate of labour productivity (i.e. an improvement in technological change) on the aggregate demand and on the equilibrium rate of capital accumulation in Propositions 2 & 3 respectively.

Proposition 2. *When the economy is in a profit-led demand regime, a rise in the growth rate of labour productivity unambiguously increases the aggregate demand while in the wage-led demand regime, the effect is ambiguous and* $\frac{\partial u^\star}{\partial \lambda} \gtreqless 0$ *according to whether* $\alpha_4 \gtreqless \left|(\alpha_2 - u^\star)\frac{\partial \pi}{\partial \lambda}\right|$.

Proof. Differentiation of the equilibrium degree of capacity utilization w.r.t. λ yields

$$\frac{\partial u^\star}{\partial \lambda} = \frac{\alpha_4 + (\alpha_2 - u^\star)\frac{\partial \pi}{\partial \lambda}}{(\pi - \alpha_1)}$$

In a profit-led demand regime $(\alpha_2 - u^\star) > 0$ and so $\frac{\partial u^\star}{\partial \lambda}$ is unambiguously positive. But when the economy is in a wage-led demand regime, the effect of a rise in labour productivity on the aggregate demand is ambiguous and $\frac{\partial u^\star}{\partial \lambda} \gtreqless 0$ according to whether $\alpha_4 \gtreqless \left|(\alpha_2 - u^\star)\frac{\partial \pi}{\partial \lambda}\right|$. □

A unit rise in the growth rate of labour productivity on the one hand increases the investment demand by α_4 amount and on the other hand it enhances the share of profit. When the economy is in a profit-led demand regime, these two channels reinforce each other and as a result, there is an unambiguous positive effect of a rise in the growth rate of labour productivity on the aggregate demand. However, when the economy is in a wage-led demand regime, these two channels work in opposite directions and therefore there is an ambiguous result of a rise in the growth rate of labour productivity on the aggregate demand. If the direct impact of a change in the growth rate of labour productivity on the investment demand is higher than the indirect impact of it through the change in share of profit, the growth rate of labour productivity will have positive effect on the aggregate demand and vice-versa.

Proposition 3. *When the economy is in a profit-led growth regime, a rise in the growth rate of labour productivity unambiguously increases the equilibrium rate of capital accumulation while in the wage-led growth regime, the effect is ambiguous and* $\frac{\partial g^\star}{\partial \lambda} \gtreqless 0$ *according to whether* $\alpha_4 \pi \gtreqless \left|(\alpha_2 \pi - \alpha_1 u^\star) \frac{\partial \pi}{\partial \lambda}\right|$.

Proof. Differentiation of the equilibrium rate of capital accumulation w.r.t. λ yields

$$\frac{\partial g^\star}{\partial \lambda} = \frac{\alpha_4 \pi + (\alpha_2 \pi - \alpha_1 u^\star) \frac{\partial \pi}{\partial \lambda}}{(\pi - \alpha_1)}$$

In a profit-led growth regime $(\alpha_2 \pi - \alpha_1 u^\star) > 0$ and so $\frac{\partial u^\star}{\partial \lambda}$ is unambiguously positive. But when the economy is in a wage-led growth regime, the effect of a rise in the growth rate of labour productivity on the rate of capital accumulation is ambiguous and $\frac{\partial g^\star}{\partial \lambda} \gtreqless 0$ according to whether $\alpha_4 \pi \gtreqless \left|(\alpha_2 \pi - \alpha_1 u^\star) \frac{\partial \pi}{\partial \lambda}\right|$. □

The economic intuition behind the result is that a rise in the growth rate of labour productivity has a positive direct impact on the rate of capital accumulation and an indirect effect through its impact on share of profit. When the economy is in a profit-led growth regime, the growth rate of labour productivity enhances share of profit which in turn enhances the growth rate. As a result, the overall effect of a rise in the growth rate of labour productivity on the equilibrium rate of capital accumulation is positive. However, when the economy is in wage-led growth regime, these two effects (direct and indirect) work in opposite directions and as a consequence we get an ambiguous result. If the direct effect of a change in the growth rate of labour productivity is higher than the indirect effect of it through the change in share of profit, the growth rate of labour productivity will have positive effect on the equilibrium rate of capital accumulation and vice-versa.

Note that our results regarding the effect of a rise in growth rate of labour productivity on the aggregate demand and on the equilibrium rate of capital accumulation are different from Hein (2012a). The effect of a rise in growth rate of labour productivity on the aggregate demand and on the equilibrium rate of capital accumulation are always positive in Hein (2012a). On the contrary, the effect of a rise in growth rate of labour productivity in the wage-led demand and growth regime are negative in our model. We get these results because in our model, a rise in the growth rate of labour productivity increases the profit share.

Now we concentrate on the effect of a rise in the level of financialization (or a rise in shareholder power) on the equilibrium degree of capacity utilization and accumulation rate. Rearranging and partially differentiating equation (2.11) w.r.t. Ω we get,

$$\frac{\partial \pi}{\partial \Omega}u^\star + (\pi - \alpha_1)\frac{\partial u^\star}{\partial \Omega} = \frac{\partial \alpha_0}{\partial \Omega} + \alpha_2\frac{\partial \pi}{\partial \Omega} + (1 - s_r - \alpha_3)\frac{\partial r^R}{\partial \Omega}$$

$$\Rightarrow \frac{\partial u^\star}{\partial \Omega} = \frac{\overbrace{\frac{\partial \alpha_0}{\partial \Omega}}^{-} + \overbrace{(\alpha_2 - u^\star)\frac{\partial \pi}{\partial \Omega}}^{+/-} + \overbrace{(1 - s_r - \alpha_3)\frac{\partial r^R}{\partial \Omega}}^{+/-}}{(\pi - \alpha_1)} \tag{2.16}$$

The effect of financialization on the equilibrium degree of capacity utilization via the 'preference channel', that has been captured by the expression $\frac{\partial \alpha_0}{\partial \Omega}$, is negative. The impact of financialization via the 'finance channel', captured by the third term of the numerator, however, is ambiguous and depends on the rentiers' propensity to save and on the responsiveness of firms' investment decision with respect to distributed profits. Higher is the dividend payment, lower is the availability of internal funds for investment. However, higher dividend payments, on the other hand, increases rentiers' consumption demand. The overall effect of the 'finance channel' is hence ambiguous. Finally, the second term, that represents the 'distribution channel', is also ambiguous. This is due to the fact that either of the wage-led or the profit-led demand regimes can prevail in the economy. If there is a wage-led demand regime in the economy, the 'distribution channel' is negative. On the other hand if there is a profit-led demand regime in the economy, the 'distribution channel' will be positive.

Proposition 4. $((1 - s_r - \alpha_3) < 0) \wedge \left(\left|1 - s_r - \alpha_3\right| < \frac{\alpha_0 + \alpha_1\alpha_2 + \alpha_4\lambda}{r^R}\right) \longrightarrow \frac{\partial u^\star}{\partial \Omega} < 0$

Proof. Suppose $(1 - s_r - \alpha_3) < 0$ and $\left|1 - s_r - \alpha_3\right| < \frac{\alpha_0 + \alpha_1\alpha_2 + \alpha_4\lambda}{r^R}$. Given equation (2.13), these two together imply $\frac{\partial u^\star}{\partial \pi} < 0$ which means (from equation(2.14)) $(\alpha_2 - u^\star) < 0$. So, $\frac{\partial \alpha_0}{\partial \Omega} < 0$, $(\alpha_2 - u^\star) < 0$, $\frac{\partial \pi}{\partial \Omega} > 0$, $(1 - s_r - \alpha_3) < 0$, $\frac{\partial r^R}{\partial \Omega} > 0$ and $(\pi - \alpha_1) > 0$ together imply $\frac{\partial u^\star}{\partial \Omega}$ to be unambiguously negative. □

From Proposition 4 we infer that when $(1 - s_r - \alpha_3) < 0$ and the economy is in the wage-led demand regime, a rise in shareholder power (i.e. financialization) will have a contractionary effect on the aggregate demand (or the equilibrium degree of capacity utilization).

Proposition 5. $((1 - s_r - \alpha_3) > 0) \wedge \left((1 - s_r - \alpha_3) > \frac{-\frac{\partial \alpha_0}{\partial \Omega} - (\alpha_2 - u^\star)\frac{\partial \pi}{\partial \Omega}}{\frac{\partial r^R}{\partial \Omega}}\right) \longrightarrow \frac{\partial u^\star}{\partial \Omega} > 0$

Proof. Suppose $(1 - s_r - \alpha_3) > 0$. This implies $\frac{\partial u^\star}{\partial \pi} < 0$ which means (from equation(2.14)) $(\alpha_2 - u^\star) < 0$. Now if $(1 - s_r - \alpha_3) > \frac{-\frac{\partial \alpha_0}{\partial \Omega} - (\alpha_2 - u^\star)\frac{\partial \pi}{\partial \Omega}}{\frac{\partial r^R}{\partial \Omega}}$ then equation (2.16) yields $\frac{\partial u^\star}{\partial \Omega} > 0$. □

From Proposition 5 it can be inferred that when $(1 - s_r - \alpha_3) > 0$ (which implies the economy is in the wage-led demand regime), a rise in shareholder power will have an expansionary effect on the aggregate demand (or the equilibrium degree of capacity utilization) provided $(1 - s_r - \alpha_3) > \frac{-\frac{\partial \alpha_0}{\partial \Omega} - (\alpha_2 - u^\star)\frac{\partial \pi}{\partial \Omega}}{\frac{\partial r^R}{\partial \Omega}}$ holds. That means if the 'finance channel' (which is positive here) is sufficiently large, it can overcompensate the depressing effect of other two channels and hence the impact of a rise in financialization on the aggregate demand will be positive. Although Propositions 1, 4 and 5 are not explicitly discussed in Hein (2012a), one can easily derive these results from Hein (2012a).

Now let's focus on the impact of financialization on the equilibrium accumulation rate. Rearranging and partially differentiating equation (2.12) w.r.t. Ω we get,

$$g^\star \frac{\partial \pi}{\partial \Omega} + (\pi - \alpha_1)\frac{\partial g^\star}{\partial \Omega} = (\alpha_0 + \alpha_2 \pi + \alpha_4 \lambda)\frac{\partial \pi}{\partial \Omega} + \pi(\frac{\partial \alpha_0}{\partial \Omega} + \alpha_2 \frac{\partial \pi}{\partial \Omega}) \\ + [\alpha_1(1 - s_r) - \alpha_3 \pi]\frac{\partial r^R}{\partial \Omega} - \alpha_2 r^R \frac{\partial \pi}{\partial \Omega}$$

$$\Rightarrow \frac{\partial g^\star}{\partial \Omega} = \frac{\overbrace{\pi \frac{\partial \alpha_0}{\partial \Omega}}^{-} + \overbrace{[\alpha_1(1 - s_r) - \alpha_3 \pi]\frac{\partial r^R}{\partial \Omega}}^{+/-} + \overbrace{\left(\frac{\alpha_2 \pi - \alpha_1 u^\star}{(\pi - \alpha_1)}\right)\frac{\partial \pi}{\partial \Omega}}^{+/-}}{(\pi - \alpha_1)}$$

The effect of financialization via the 'preference channel', that has been captured by the expression $\pi \frac{\partial \alpha_0}{\partial \Omega}$, is negative. The impact of financialization via the 'finance channel', that has been captured by the second term of the numerator, however, is ambiguous and depends on the rentiers' propensity to

Table 2.1: Impact of changes in various parameters on $u^\star, g^\star$ and $r^\star$

	π	λ	Ω
$u^\star$	+/-	+/-	+/-
$g^\star$	+/-	+/-	+/-

save and on the responsiveness of firms' investment decision with respect to distributed profits as well as to capacity utilization. Higher the dividend payment lower the availability of internal fund for investment. However, higher dividend payment, on the other hand, increases rentiers' consumption demand that in turn indirectly increases the investment demand. The overall effect of the 'finance channel' is hence ambiguous. Finally, the third term, that represents the 'distribution channel', is also ambiguous. This ambiguity emerges since any kind of growth regime (wage-led or profit-led) is possible in the economy.

As a final result, whether the impact of financialization on capital accumulation is positive (or 'expansive') or negative (i.e. 'contractive') depends on the values of different parameters. This argument is encapsulated in Proposition 6.

Proposition 6. $\left((1-s_r) > \frac{1}{\alpha_1}\left[\frac{-\pi\frac{\partial\alpha_0}{\partial\Omega} - \left(\frac{\alpha_2\pi-\alpha_1 u^\star}{(\pi-\alpha_1)}\right)\frac{\partial\pi}{\partial\Omega}}{\frac{\partial r^R}{\partial\Omega}} + \alpha_3\pi\right]\right) \longrightarrow \frac{\partial g^\star}{\partial\Omega} > 0$

Proof. Suppose $(1-s_r) > \frac{1}{\alpha_1}\left[\frac{-\pi\frac{\partial\alpha_0}{\partial\Omega} - \left(\frac{\alpha_2\pi-\alpha_1 u^\star}{(\pi-\alpha_1)}\right)\frac{\partial\pi}{\partial\Omega}}{\frac{\partial r^R}{\partial\Omega}} + \alpha_3\pi\right]$. This, along with $(\pi-\alpha_1) > 0$, implies $\frac{\partial g^\star}{\partial\Omega} > 0$. □

Following Hein (2012a) we can say that the following conditions together ensure a positive impact of financialization on capital accumulation or an 'expansive' growth regime: (i) a low propensity to save out of rentiers' income (s_r) (ii) less importance of distributed profits (and hence, internal funds) for firms' investment decisions i.e. smaller value of α_3, (iii) comparatively lower importance of the 'preference channel' for firms' investment decisions relative to the 'finance channel', and (iv) a high responsiveness of investment demand with respect to the profit share. Otherwise the 'contractive' demand regime of capital accumulation will be obtained.

The above discussed short run comparative static results are encapsulated in Table 2.1. In the next section, we proceed for the long run dynamics.

3 *Long Run*

In this section, we analyse the dynamics of the technological change and the level of financialization. We assume that the short run equilibrium values are always attained in the long run. The long run equilibrium is defined as a situation in which the rate of technological change and the level of financialization remain constant over time. Let's first focus on the dynamics of technological change which is encapsulated in the following three equations.

$$\dot{\lambda} = \theta[\lambda^d - \lambda]; \qquad \theta > 0$$

$$\lambda^d = \xi_0 + \xi_1 g + \xi_2(\zeta\Omega - \Omega^2) - \xi_3\pi; \quad \zeta \in (0,1); \;\; \xi_0, \xi_1, \xi_2, \xi_3 > 0 \tag{3.1}$$

$$\text{So, } \dot{\lambda} = \theta[\xi_0 + \xi_1 g + \xi_2(\zeta\Omega - \Omega^2) - \xi_3\pi - \lambda] \tag{3.2}$$

The rate of technological innovation[20] varies according to the difference between the desired rate of technological improvement of firms (λ^d), and the actual rate of technological change, λ. Everything else being unchanged, whenever the desired rate is above the actual rate, the actual rate rises.

The desired rate of technological change depends positively on the rate of capital accumulation and negatively on the profit share. Beside Hein (2010, 2012a, 2012b, 2014) the first factor can be found in Kaldor (1957, 1961, 1966), Rowthorn (1981), Dutt (1990), Taylor (1991), Lavoie (1992) and the second type in Taylor (1991), Cassetti (2003), Lima (2004), Naastepad (2006), and Dutt (2006, 2013). Here ξ_1 represents the increase in the desired rate of technological change to a unit change in the accumulation rate whereas ξ_3 denotes the reduction in the same per unit change in the share of profit.

Following Hein (2010, 2012a, 2012b, 2014) we assume that financialization has an impact on the desired rate of technological change. Hein concludes this on the basis of the fact that increasing shareholder power (Jensen/ Meckling 1976), higher dividend payouts demanded by shareholders, weaker ability of firms to obtain new equity finance through stock issues[21], higher threat of hostile takeovers (Manne 1965), and the financial-market-oriented remuneration schemes (Fama 1980) push management to use the resources at their disposal

[20] In this chapter, rate of technological change or improvement means rate of labour productivity growth.

[21] Because if it happens share prices decrease.

more efficiently. As Hein (2010, 2012a, 2012b, 2014) argues, this should have positive impacts on labour productivity growth and potential growth of the economy, at least initially. However, as Hein (2010, 2012a, 2012b, 2014) points out, according to Jensen (2005) and Rappaport(2005), there may be a negative impact on labour productivity if 'shareholder value orientation' goes too far. In that case, share buybacks and dividend payouts can potentially dominate productivity-enhancing investment, and management's short-termism undermines the efficiency and productivity gains. So the effect of shareholder power on productivity growth may be non-linear. However, Hein considers only a direct linear positive effect of shareholder power on productivity. Some evidence of the negative impact of financialization on technology for the US economy can be found in Lazonick (2014) as well. As he points out, although Exxon Mobil spends about $21 billion a year on buybacks, it spends virtually no money on alternative energy research. In 2013 Intel's expenditures on share repurchasing were almost four times the total 'National Nano-technology Initiative' budget that was launched by the US government in 2001. Same is the story for US pharmaceutical companies. Instead of spending sufficient funds on R&D they are spending more on share buybacks. The novelty of our model is that we consider both the positive and negative impacts of financialization on technological change. At a lower level of financialization, an overall positive impact of financialization prevails whereas at a higher level the negative effect dominates. This argument is captured by the third term on the right-hand side of the equation (3.1)[22]. ξ_2 represents the increase in the desired rate of technological change to $(\zeta\Omega - \Omega^2)$ unit change in the level of financialization. In other words, $\xi_2(\zeta - 2\Omega)$ represents the increase in the desired rate of technological change to a unit change in the level of financialization.

ξ_0 is the autonomous part of desired technological change which represents all catchall variables other than g, Ω and π. One economic explanation for ξ_0 can be the following. For the sake of simplicity, suppose that there is neither any impact of financialization nor is there distributional effect on the desired rate of technological change of firms. Under this scenario, when there is a stagnation in the economy, it's the intra-class competition among firms that leads to

[22]Note that if we assume ξ_0, ξ_1 and ξ_3 to be zero then technological change depends only on the level of financialization. In that case $\lambda\big|_{\dot{\lambda}=0} = \xi_2(\zeta\Omega - \Omega^2)$ and so first order condition implies $\frac{d\lambda}{d\Omega} = \xi_2(\zeta - 2\Omega) = 0 \implies \Omega^0 = \frac{\zeta}{2}$. So $\forall\Omega \in [0, \Omega^0)$, $\frac{d\lambda}{d\Omega} > 0$ and $\forall\Omega \in (\Omega^0, 1]$, $\frac{d\lambda}{d\Omega} < 0$.

a positive desired rate of technological change. When the economy is in the period of stagnation, due to lack of sufficient demand, each firm tries to capture the existing market by out-competing others[23]. To prevail in this intra-class competition, they desire higher rate of growth in labour productivity (or desire higher technological change). This phenomenon is captured by the parameter [24]ξ_0.

θ represents the speed of adjustment parameter for the technological change dynamics. Higher the value of θ, more instantaneous the adjustment of actual technological change to its desired level. The speed of adjustment parameter, among many other things, depends on the degree of restrictiveness enforced by patents, copyrights, trademarks, industrial designs and other intellectual property rights. It also depends on the structure of the firms in the sense that more conducive environment a firm poses, faster is it to adopt (or implement) the desired technology. Lead times, learning-curve effects, costs and time required for duplication, superior sales and service efforts, secrecy etc. play crucial role for appropriability mechanisms[25] which in turn can influence θ.

In equilibrium $\dot{\lambda} = 0$. This implies

$$\lambda\Big|_{\dot{\lambda}=0} = \xi_0 + \xi_1 g + \xi_2(\zeta\Omega - \Omega^2) - \xi_3\pi \tag{3.3}$$

Putting $\Omega = 0$ in the above equation we get the vertical intercept of the $\dot{\lambda} = 0$ isocline in the $\Omega - \lambda$ plane as $\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3\pi(0)$. $g(0)$ represents the equilibrium value of capital accumulation when the level of financialization is the least. Similarly $\pi(0)$ represents the share of profit when there is minimum level of financialization. Let's assume $\xi_0 + \xi_1 g(0) - \xi_3\pi(0) > 0$, i.e. there is a positive vertical intercept for the $\dot{\lambda} = 0$ isocline. When the level of financialization is the least, $\xi_0 + \xi_1 g(0) - \xi_3\pi(0)$ represents the desired rate of technological change of the firms. In other words, as long as $\xi_0 + \xi_1 g(0) - \xi_3\pi(0) > 0$, even with the lowest degree of financialization,

[23] We borrow this idea from Bhaduri (2006a, 2006b) and Shaikh(1978) whereas they themselves find the idea in Marx (1976).

[24] We also can think of $\xi_0 = \xi_{01} + \xi_{02}$ where ξ_{01} represents the intra-class conflicts among capitalist whereas $(\xi_{02} - \xi_3\pi)$ represents the inter-class conflict i.e. the explanation for the negative dependence of the desired rate of technological change on the share of profit. So, as the share of profit falls, $(\xi_{02} - \xi_3\pi)$ becomes positive and results a higher desired rate of technological change. However for simplicity we can safely assume that $\xi_{02} = 0$ and so ξ_0 represents the intra-class conflict only.

[25] See Dosi (1988), Dosi et. al. (2006), Levin et. al. (1987), López (2009) for example.

positive technological change is possible. So the assumption $\lambda\Big|_{\dot{\lambda}=0}^{\dot{\Omega}=0} > 0$ is quite justified.

Slope of the $\dot{\lambda} = 0$ isocline in the $\Omega - \lambda$ plane can be obtained by differentiating equation (3.3) w.r.t. Ω as

$$\frac{d\lambda}{d\Omega} = \xi_1 \frac{\partial g}{\partial \lambda}\frac{d\lambda}{d\Omega} + \xi_1 \frac{\partial g}{\partial \Omega} + \xi_2(\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \lambda}\frac{d\lambda}{d\Omega} - \xi_3 \frac{\partial \pi}{\partial \Omega}$$

$$\Rightarrow \frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0} = \frac{\xi_1 \frac{\partial g}{\partial \Omega} + \xi_2(\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \Omega}}{1 - \xi_1 \frac{\partial g}{\partial \lambda} + \xi_3 \frac{\partial \pi}{\partial \lambda}} \tag{3.4}$$

Differentiating (3.2) partially w.r.t. λ we get,

$$\frac{\partial \dot{\lambda}}{\partial \lambda} = \theta \left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1 \right] = \theta P = J_{11} \tag{3.5}$$

Differentiating (3.2) partially w.r.t. Ω we get,

$$\frac{\partial \dot{\lambda}}{\partial \Omega} = \theta \left[\xi_1 \frac{\partial g}{\partial \Omega} + \xi_2(\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \Omega} \right] = \theta Q = J_{12} \tag{3.6}$$

Another way of getting the slope of the $\dot{\lambda} = 0$ isocline is

$$\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0} = -\frac{J_{12}}{J_{11}} = -\frac{\theta Q}{\theta P} = -\frac{Q}{P} = \frac{\xi_1 \frac{\partial g}{\partial \Omega} + \xi_2(\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \Omega}}{1 - \xi_1 \frac{\partial g}{\partial \lambda} + \xi_3 \frac{\partial \pi}{\partial \lambda}} \tag{3.7}$$

Intuition behind equations (3.5) & (3.6) are as follows. A unit rise in λ increases g by $\frac{\partial g}{\partial \lambda}$ unit which in turn increases the desired rate of technological change of the firms by $\xi_1 \frac{\partial g}{\partial \lambda}$ unit and so increases (or decreases) the change in the rate of technological change by $\theta \xi_1 \frac{\partial g}{\partial \lambda}$ unit. Similarly, a unit rise in λ increases π by $\frac{\partial \pi}{\partial \lambda}$ unit which in turn diminishes the desired rate of technological change of the firms by $\xi_3 \frac{\partial \pi}{\partial \lambda}$ unit and so decreases the change in the rate of technological change by $\theta \xi_3 \frac{\partial \pi}{\partial \lambda}$ unit. On the other hand, holding λ^d constant, the rate of technological change leads to a fall in the change in the rate of technological change by θ unit. So, the overall effect of an increase in the technological change on the change in the technological change is $\theta \left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1 \right]$, which is encapsulated in equation (3.5). Throughout this paper we assume $(1 - \xi_1 \frac{\partial g}{\partial \lambda} + \xi_3 \frac{\partial \pi}{\partial \lambda}) > 0$ i.e $J_{11} < 0$. The justification for the assumption is the following.

1. Suppose the economy is in a strong wage-led growth regime. The wage-led growth regime is so strong that here not only $(\alpha_2\pi - \alpha_1 u^\star)$ is negative but also $\left|(\alpha_2\pi - \alpha_1 u^\star)\right|\frac{\partial\pi}{\partial\lambda} > \alpha_4\pi$. So here $\frac{\partial g}{\partial\lambda} < 0$ and hence $(1 - \xi_1\frac{\partial g}{\partial\lambda} + \xi_3\frac{\partial\pi}{\partial\lambda})$ is unambiguously positive.

2. Suppose the economy is in a weak wage-led growth regime so that here $\left|(\alpha_2\pi - \alpha_1 u^\star)\right|\frac{\partial\pi}{\partial\lambda} < \alpha_4\pi$. So here $\frac{\partial g}{\partial\lambda} > 0$. Nonetheless $(1 - \xi_1\frac{\partial g}{\partial\lambda} + \xi_3\frac{\partial\pi}{\partial\lambda})$ is positive here as $0 < \frac{\partial g}{\partial\lambda} = \frac{\overbrace{\alpha_4\pi}^{+} + \overbrace{(\alpha_2\pi - \alpha_1 u^\star)\frac{\partial\pi}{\partial\lambda}}^{-}}{(\pi-\alpha_1)} < \frac{\alpha_4\pi}{(\pi-\alpha_1)}$ and as a result $(1 - \xi_1\frac{\partial g}{\partial\lambda} + \xi_3\frac{\partial\pi}{\partial\lambda})$ is equal to $\frac{\overbrace{\{(1-\xi_1\alpha_4)\pi - \alpha_1\}}^{+} - \overbrace{\left\{\xi_1(\alpha_2\pi - \alpha_1 u^\star)\frac{\partial\pi}{\partial\lambda}\right\}}^{-}}{(\pi-\alpha_1)} + \xi_3\frac{\partial\pi}{\partial\lambda}$ which in turn is greater than $\left\{\frac{\{(1-\xi_1\alpha_4)\pi-\alpha_1\}}{(\pi-\alpha_1)}\right\} > 0$[26].

3. Now suppose the economy is in a profit-led growth regime. Then $\frac{\partial g}{\partial\lambda}$ equals to $\frac{\overbrace{\alpha_4\pi}^{+} + \overbrace{(\alpha_2\pi - \alpha_1 u^\star)\frac{\partial\pi}{\partial\lambda}}^{+}}{(\pi-\alpha_1)} > \frac{\alpha_4\pi}{(\pi-\alpha_1)} > 0$. So there is a possibility that $(1 - \xi_1\frac{\partial g}{\partial\lambda} + \xi_3\frac{\partial\pi}{\partial\lambda}) = \frac{\overbrace{\{(1-\xi_1\alpha_4)\pi - \alpha_1\}}^{+} - \overbrace{\left\{\xi_1(\alpha_2\pi - \alpha_1 u^\star)\frac{\partial\pi}{\partial\lambda}\right\}}^{+}}{(\pi-\alpha_1)} + \xi_3\frac{\partial\pi}{\partial\lambda} < 0$. If we assume ξ_1 is adequately weak and/or if we assume ξ_3 is sufficiently large then we may have $(1 - \xi_1\frac{\partial g}{\partial\lambda} + \xi_3\frac{\partial\pi}{\partial\lambda}) > 0$. For the sake of simplicity let's assume that in the profit led growth regime, ξ_1 is adequately weak and/or ξ_3 is sufficiently large so that we get $(1 - \xi_1\frac{\partial g}{\partial\lambda} + \xi_3\frac{\partial\pi}{\partial\lambda})$ to be positive.

J_{12} (see equation (3.6)) shows the effect of an increase in the financialization level on the change in the rate of technological change. A rise in Ω increases g (by $\frac{\partial g}{\partial\Omega}$ unit) which in turn increases the desired rate of technological change of the firms (by $\xi_1\frac{\partial g}{\partial\Omega}$ unit) and so increases the change in the rate of technological

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[26] Suppose for the time being that $\frac{\partial\pi}{\partial\lambda} = 0$. Then $(1 - \xi_1\frac{\partial g}{\partial\lambda}) = \frac{(1-\xi_1\alpha_4)\pi-\alpha_1}{(\pi-\alpha_1)}$. Then we can easily justify that $(1 - \xi_1\frac{\partial g}{\partial\lambda}) = \frac{\{(1-\xi_1\alpha_4)\pi-\alpha_1\}}{(\pi-\alpha_1)} > 0$ (i.e.$\{(1-\xi_1\alpha_4)\pi - \alpha_1\} > 0$). Treeck (2008; pp. 396) mentions that for the USA for the period 1982-2004, the value of α_1 is 0.26 and the share of profit (π) for the period 1985-2004 is 30.05% (pp. 375). As stated by Knell (2004), the impact of (investment) demand growth on productivity growth (i.e. ξ_1) is 0.43 while Uni (2007) points out it to be 0.44-0.75. However, Hein and Tarassow (2010) find out it to be 0.11 only. The impact of technological change on the investment to capital ratio (α_4) is very small too. So the assumption that $\{(1-\xi_1\alpha_4)\pi - \alpha_1\} > 0$ and consequently $\left\{\frac{\{(1-\xi_1\alpha_4)\pi-\alpha_1\}}{(\pi-\alpha_1)}\right\} > 0$ is quite justified.

cahnage by $\theta\xi_1\frac{\partial g}{\partial\Omega}$ unit. Similarly, a rise in Ω increases π which in turn reduces the desired rate of technological change of the firms and so decreases the change in the rate of technological change by $\theta\xi_3\frac{\partial\pi}{\partial\Omega}$ unit. Finally, a rise in Ω directly increases Ω^d by $\xi_2(\zeta-2\Omega)$ unit and hence increases the change in the rate of technological change by $\theta\xi_2(\zeta-2\Omega)$ unit. As a result, the final effect of a rise in Ω on $\dot{\lambda}$ is ambiguous and depends on the level of financialization. If [27]$\Omega<\bar{\Omega}=\frac{\xi_1\frac{\partial g}{\partial\Omega}+\xi_2\zeta-\xi_3\frac{\partial\pi}{\partial\Omega}}{2\xi_2}$, $J_{12}>0$ and when $\Omega>\bar{\Omega}$, $J_{12}<0$.

Note that as long as $(1-\xi_1\frac{\partial g}{\partial\lambda}+\xi_3\frac{\partial\pi}{\partial\lambda})>0$, $\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0}\gtreqless 0$ depending on whether $\{\xi_1\frac{\partial g}{\partial\Omega}+\xi_2(\zeta-2\Omega)-\xi_3\frac{\partial\pi}{\partial\Omega}\}\gtreqless 0$. $\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0}=0$ if $\Omega=\bar{\Omega}=\frac{\xi_1\frac{\partial g}{\partial\Omega}+\xi_2\zeta-\xi_3\frac{\partial\pi}{\partial\Omega}}{2\xi_2}$. So, if $\Omega<\bar{\Omega}$ then $\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0}>0$ whereas $\Omega>\bar{\Omega}$ ensures $\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0}$ to be negative[28]. So, given the value of ξ_1, ξ_2, ξ_3, and $\frac{\partial\pi}{\partial\Omega}$, it's the level of financialization that plays a crucial role for determining the slope of the $\dot{\lambda}=0$ isocline. Higher the level of financialization compared to the critical level of Ω (i.e. $\bar{\Omega}$), the negative the slope of the $\dot{\lambda}=0$ isocline would be and vice versa.

Next proposition talks about the possibility of stable equilibrium rate of technological change provided that the level of financialization is fixed.

Proposition 7. *For a fixed value of Ω, the steady state rate of technological change is stable.*

Proof. From equation (3.2) we get,

$$\frac{\partial\dot{\lambda}}{\partial\lambda}=\theta\left[\xi_1\frac{\partial g}{\partial\lambda}-\xi_3\frac{\partial\pi}{\partial\lambda}-1\right]<0 \qquad \text{(by assumption)}$$

So for a fixed values of Ω, the equilibrium technological change is stable. □

Let us now focus on the change in the financialization parameter. Financialization parameter changes according to the following set of equations as

$$\dot{\Omega}=\phi[\Omega^d-\Omega]; \qquad \phi>0,\ \Omega\in[0,1],\ \Omega^d\in[0,1] \tag{3.8}$$

[27] $\bar{\Omega}=\frac{\xi_1\frac{\partial g}{\partial\Omega}+\xi_2\zeta-\xi_3\frac{\partial\pi}{\partial\Omega}}{2\xi_2}=\frac{1}{2\xi_2}\left[\xi_1\left\{\frac{\pi\frac{\partial\alpha_0}{\partial\Omega}+[\alpha_1(1-s_r)-\alpha_3\pi]\frac{\partial r^R}{\partial\Omega}+\left(\frac{\alpha_2\pi-\alpha_1u^\star}{(\pi-\alpha_1)}\right)\frac{\partial\pi}{\partial\Omega}}{(\pi-\alpha_1)}\right\}+\xi_2\zeta-\xi_3\frac{\partial\pi}{\partial\Omega}\right]$. As we assume $\frac{\partial\pi}{\partial\Omega}$, $\frac{\partial\alpha_0}{\partial\Omega}$, and $\frac{\partial r^R}{\partial\Omega}$ to be constants, $\bar{\Omega}$ becomes independent of Ω.

[28] If $\frac{\partial g}{\partial\Omega}<0$ then $\bar{\Omega}$ is positive provided $\xi_2>\bar{\xi_2}=\left(\frac{-\xi_1\frac{\partial g}{\partial\Omega}+\xi_3\frac{\partial\pi}{\partial\Omega}}{\zeta}\right)$. But if $\frac{\partial g}{\partial\Omega}>0$ then there is a higher chance of $\bar{\Omega}$ to be positive and hence the possibility of existence of steady state on the upward sloping portion of the $\dot{\lambda}=0$ isocline.

$$\Omega^d = -\eta_0 + \eta_1\lambda + \eta_2 g; \qquad \eta_0, \eta_1, \eta_2 > 0 \tag{3.9}$$

$$\text{So, } \dot{\Omega} = \phi[-\eta_0 + \eta_1\lambda + \eta_2 g - \Omega] \tag{3.10}$$

Let us assume that, given the rate of technological change and given economic conditions, there is a level of financialization (i.e. Ω^d) at which the economy would settle in the long run. The level of financialization in the long run varies according to the difference between Ω^d and the actual level of financialization, Ω. *Ceteris paribus*, whenever Ω^d is above the actual level, the actual level rises and vice versa.

To capture the idea that for Ω^d to prevail decent economic conditions (or a positive growth rate) and/or a minimum technological sophistication are/is required, a negative constant term ($-\eta_0$) is introduced here.

Technological innovations[29] (especially innovations in information and communications technology) has a positive impact on Ω^d. It is taken into account by the second term of the right hand side of the equation (3.9). η_1 represents the increase in Ω^d to a unit change in technological change.

In the long run good economic conditions, captured here by the rate of capital accumulation, positively influence Ω^d. During good times the optimism of firms and financial institutions provides the environment for adopting riskier financial innovations and setups which increases the rate of financialization. The justification of this argument can be found in Minsky (1986). Minsky (1986, pp.199) says "During periods of tranquil expansion, profit-seeking financial institutions invent and reinvent 'new' forms of money, substitutes for money in portfolios, and financing techniques for various types of activity: financial innovation is a characteristic of our economy in good times". Minsky (1986, pp. 271) also argues "...during good times, when banks are confronted with a large demand for accommodation by apparently credit worthy clients, the banking system is characterized by innovations that try to circumvent Federal Reserve constraint. That is, bankers aim at having assets and non-equity liabilities grow at least as fast (if not faster) than bank equity, whereas the Federal Reserve tries to have bank liabilities subject to check grow at a slower rate than bank equity." However, this characteristic can increase financial instability, as is clear from this argument of Minsky (1986, pp. 354). "[A]s

[29] Evidence regarding the impact of technological innovations on financialization can be found in Drummer et. al (2017), Frame and White (2010).

bankers pursue profits they change the composition of their assets and liabilities; in particular, during good times the interactions between bankers and their borrowing customers increase the weight of assets reflecting speculative and Ponzi finance in the balance sheet of banks." η_2 represents the increase in Ω^d to a unit change in the rate of capital accumulation, whereas, ϕ represents the speed of adjustment parameter of the financialization dynamics. This speed of adjustment parameter ϕ depends, among many other things, on the government's role in the regulation of the financial markets. A strictly regulated financial market is associated with a smaller value of ϕ.

In equilibrium $\dot{\Omega} = 0$. This implies

$$\lambda\Big|_{\dot{\Omega}=0} = \frac{\eta_0 + \Omega - \eta_2 g}{\eta_1} \tag{3.11}$$

Putting $\Omega = 0$ in the above equation we get the vertical intercept term as $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} \gtrless 0$. $g(0)$ represents the equilibrium rate of capital accumulation when the level of financialization is the least[30]. Rearranging the vertical intercept of the $\dot{\Omega} = 0$ isocline we get $[-\eta_0 + \eta_1\lambda + \eta_2 g(0)]$, the level of financialization at which the economy would settle in the long run when negligible level of financialization is there.

Slope of the $\dot{\Omega} = 0$ isocline can be yielded by differentiating and rearranging equation (3.11) w.r.t. Ω as

$$\eta_1 \frac{d\lambda}{d\Omega} = 1 - \eta_2 \frac{\partial g}{\partial \lambda}\frac{d\lambda}{d\Omega} - \eta_2 \frac{\partial g}{\partial \Omega}$$

$$\Rightarrow \frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0} = \frac{1 - \eta_2 \frac{\partial g}{\partial \Omega}}{\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}} \tag{3.12}$$

Differentiating (3.10) w.r.t. λ we get,

$$\frac{\partial \dot{\Omega}}{\partial \lambda} = \phi \left[\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}\right] = \phi M = J_{21} \tag{3.13}$$

Note that as $\frac{\partial g}{\partial \lambda} \gtrless 0$. For simplicity let's assume $[\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}]$[31] is always positive i.e. $M > 0$.

[30] On the other hand, the horizontal intercept for the $\dot{\Omega} = 0$ isocline is $\Omega\Big|_{\dot{\Omega}=0}^{\lambda=0} = \eta_2 g(0) - \eta_0$

[31] $[\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}] = \left[\eta_1 + \eta_2 \left\{\frac{\alpha_4\pi(\pi-\alpha_1) + \left\{\alpha_2\pi(\pi-\alpha_1) - \alpha_1(\alpha_0+\alpha_2\pi+\alpha_4\lambda) - \alpha_1(1-s_r-\alpha_3)r^R\right\}\frac{\partial \pi}{\partial \lambda}}{(\pi-\alpha_1)^2}\right\}\right]$

Differentiating (3.10) w.r.t. Ω we get,

$$\frac{\partial \dot{\Omega}}{\partial \Omega} = \phi \left[\eta_2 \frac{\partial g}{\partial \Omega} - 1 \right] = \phi N = J_{22} \tag{3.14}$$

Another way of getting the slope of the $\dot{\Omega} = 0$ isocline is N

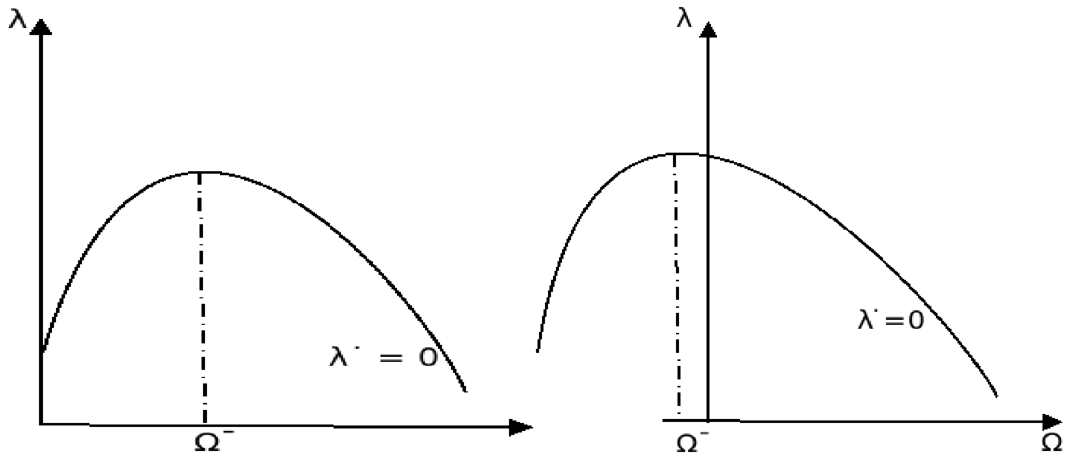
$$\left. \frac{d\lambda}{d\Omega} \right|_{\dot{\Omega}=0} = -\frac{J_{22}}{J_{21}} = -\frac{\phi N}{\phi M} = -\frac{N}{M} = \frac{1 - \eta_2 \frac{\partial g}{\partial \Omega}}{\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}} \tag{3.15}$$

Intuition behind equations (3.13) & (3.14) are as follows. J_{21} shows the effect of an increase in the rate of technological change on the change in the financialization level. A rise in λ directly raises Ω^d by η_1 amount. On the other hand, a rise in λ changes g by $\frac{\partial g}{\partial \lambda}$ amount and so by its indirect effect through g, a rise in the rate of technological change changes Ω^d by $\eta_2 \frac{\partial g}{\partial \lambda}$ amount. One can safely assume that this indirect effect (i.e. $\eta_2 \frac{\partial g}{\partial \lambda}$) is smaller than the direct effect (i.e. η_1) and hence ***irrespective of the sign of*** $\frac{\partial g}{\partial \lambda}$, J_{21} ***is unambiguously positive.***

J_{22} shows the effect of an increase in the financialization level on the change in the financialization level itself. A rise in Ω changes g which in turn changes Ω^d and so changes the rate of change in the financialization level by $\phi \eta_2 \frac{\partial g}{\partial \Omega}$ amount. On the other hand, the financialization level erodes its own change at a speed of ϕ, holding Ω^d constant. If the impact of financialization on capital accumulation is 'contractive' (i.e. if $\frac{\partial g}{\partial \Omega} < 0$), the effect of an increase in the financialization level on the change in the financialization level itself is unambiguously negative i.e. $J_{22} < 0$. On the contrary, if the impact of financialization on capital accumulation is 'expansive' (i.e. if $\frac{\partial g}{\partial \Omega} > 0$), the effect is ambiguous and $J_{22} \gtreqless 0$ depending on whether $\frac{\partial g}{\partial \Omega} \gtreqless \frac{1}{\eta_2}$ or not.

Now let's check for a given level of technological change, how the financialization dynamics behaves. This analysis is captured by the following proposition.

Proposition 8. *For a fixed value of λ, a contractionary effect of financialization on the rate of capital accumulation implies a stable equilibrium level of financialization. However in case of an expansionary effect of financialization on the rate of capital accumulation, an unstable equilibrium level of financialization is possible.*



(a) when $\bar{\Omega} > 0$ (b) when $\bar{\Omega} < 0$

Figure 3.1: Diagram of $\dot{\lambda} = 0$ isocline

Proof. From equation (3.10) we get,

$$\frac{\partial \dot{\Omega}}{\partial \Omega} = \phi \left[\eta_2 \frac{\partial g}{\partial \Omega} - 1 \right]$$

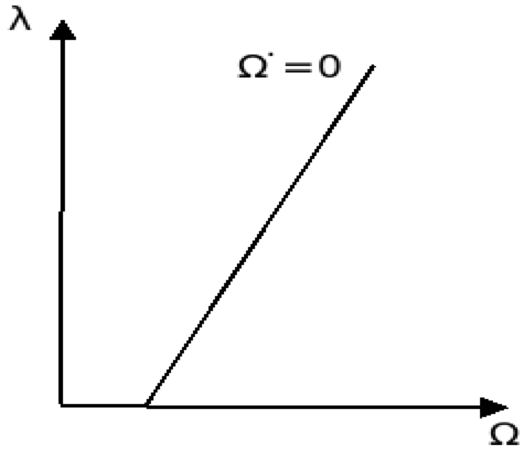
If $\frac{\partial g}{\partial \Omega} < 0$ then $\frac{\partial \dot{\Omega}}{\partial \Omega}$ is unambiguously negative and hence for a fixed value of λ, there would be a stable equilibrium level of financialization. However, if $\frac{\partial g}{\partial \Omega} > 0$ then sign of $\frac{\partial \dot{\Omega}}{\partial \Omega}$ would be ambiguous. For $\frac{\partial g}{\partial \Omega} > \frac{1}{\eta_2} > 0$, $\frac{\partial \dot{\Omega}}{\partial \Omega} > 0$ is attained. □

The diagrams of the $\dot{\lambda} = 0$ isocline and the $\dot{\Omega} = 0$ isocline in $\Omega - \lambda$ plane are given in Figure 3.1 and 3.2 respectively.

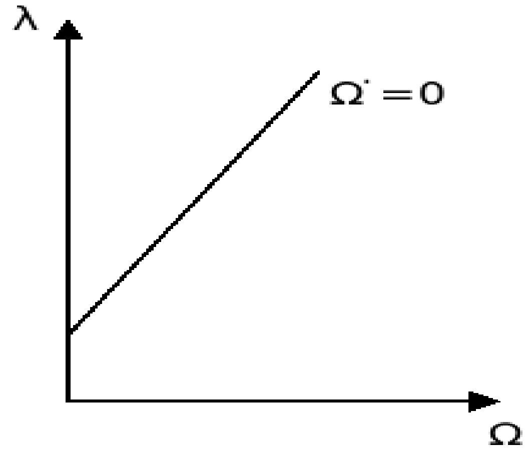
In the next section we discuss the possible cases that may arise due to the interaction between the financialization and technological change dynamics.

4 *Possible Cases*

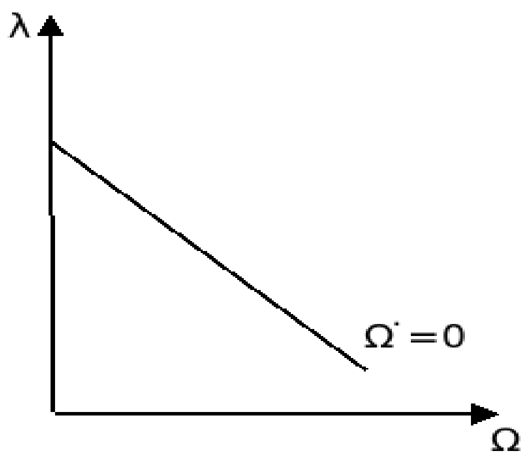
The assumption that $(1 - \xi_1 \frac{\partial g}{\partial \lambda} + \xi_3 \frac{\partial \pi}{\partial \lambda}) > 0$ ensures P to be negative (i.e. $J_{11} < 0$) and the assumption that $\left[\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}\right] > 0$ ensures M to be positive (i.e. $J_{21} > 0$)



(a) when $\left.\frac{d\lambda}{d\Omega}\right|_{\dot{\Omega}=0} > 0$ (i.e. either $\frac{\partial g}{\partial \Omega} < 0$ or $0 < \frac{\partial g}{\partial \Omega} < \frac{1}{\eta_2}$) and $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} < 0$



(b) when $\left.\frac{d\lambda}{d\Omega}\right|_{\dot{\Omega}=0} > 0$ (i.e. either $\frac{\partial g}{\partial \Omega} < 0$ or $0 < \frac{\partial g}{\partial \Omega} < \frac{1}{\eta_2}$) and $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} > 0$



(c) when $\left.\frac{d\lambda}{d\Omega}\right|_{\dot{\Omega}=0} < 0$ (i.e. $\frac{\partial g}{\partial \Omega} > \frac{1}{\eta_2} > 0$) and $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} > 0$

Figure 3.2: diagrams of $\dot{\Omega} = 0$ isoclines

4.1 *Case 1: contractionary effect of financialization on the rate of capital accumulation*

For *case 1* we assume $\frac{\partial g^{\star}}{\partial \Omega} < 0$ i.e. there is a contractionary effect of financialization on the rate of capital accumulation. $\frac{\partial g^{\star}}{\partial \Omega} < 0$ implies N to be unambiguously negative (i.e. $J_{22} < 0$).

Three different sub-cases are possible under *case 1.* These are *cases 1.1, 1.2* and *1.3* respectively. Under *case 1*, the necessary and sufficient condition for a unique equilibrium to exist is that the $\dot{\Omega} = 0$ isocline intersects the $\dot{\lambda} = 0$ isocline from below. We get a unique equilibrium in *cases 1.1* and *1.2.* This is because the $\dot{\Omega} = 0$ isocline is positively sloped and the vertical intercept of the $\dot{\Omega} = 0$ isocline is lower than the vertical intercept of the $\dot{\lambda} = 0$ isocline here. On the other hand, the necessary and sufficient condition for multiple equilibria to exist is that the $\dot{\Omega} = 0$ isocline must intersect the $\dot{\lambda} = 0$ isocline from above in the positively sloped section of the latter curve. As the $\dot{\Omega} = 0$ isocline is positively sloped and the vertical intercept of the $\dot{\Omega} = 0$ isocline is higher than the vertical intercept of the $\dot{\lambda} = 0$ isocline in *case 1.3,* there are multiple equilibria in *case 1.3.* In what follows, we begin by discussing all the sub-cases under *Case1.*

4.1.1 *Case 1.1*

Here the vertical intercept of the $\dot{\Omega} = 0$ isocline is negative i.e. $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} < 0$. This is possible when $\eta_2 g(0) > \eta_0$. Remember that $g(0)$ represents the equilibrium rate of capital accumulation when the level of financialization is the least. Only a unique equilibrium is possible here- it is either A or B.

Consider point A**:** Here $P < 0$ (i.e. $J_{11} < 0$), $M > 0$ (i.e. $J_{21} > 0$), $\frac{\partial g^{\star}}{\partial \Omega} < 0$ and equation (3.14) implies $N < 0$ (i.e. $J_{22} < 0$). As $\Omega > \bar{\Omega}$, equation (3.6) yields that $Q < 0$ (i.e.$J_{12} < 0$). Thus at A the determinant of the Jacobian matrix is $det(J) = (\overbrace{J_{11}}^{-}\overbrace{J_{22}}^{-} - \overbrace{J_{12}}^{-}\overbrace{J_{21}}^{+}) > 0$ and the trace of the Jacobian matrix $tr(J) = (\overbrace{J_{11}}^{-} + \overbrace{J_{22}}^{-}) < 0$. Hence Point A is a stable steady state (see Figure 4.1(a)).

Let us explain the stability of the steady state A intuitively. Consider the financialization level deviates from its steady state value due to the occurrence of some exogenous shock. Suppose that the financialization level is greater than its steady state value, for instance. First, if Ω is greater than the steady state value $\Omega^{\star}$, it must fall due to $J_{22} < 0$. This is the direct effect. Second, as the financialization level is greater than its steady state value, the rate of technological change (λ) falls due to $J_{12} < 0$, which in turn leads to a fall in the financialization level due to $J_{21} > 0$. This is the indirect effect. At point A, both the direct and indirect effects are stable. As a result, in this case, if the financialization level rises from the steady state value, it again comes back to the steady state and consequently, the steady state is stable.

Consider point B: Here $P < 0$ (i.e. $J_{11} < 0$), $M > 0$ (i.e. $J_{21} > 0$), $\frac{\partial g^{\star}}{\partial \Omega} < 0$ and equation (3.14) implies $N < 0$ (i.e. $J_{22} < 0$). However, as $\Omega < \bar{\Omega}$, equation (3.6) yields that $Q > 0$ (i.e.$J_{12} > 0$). At point B, slope of the $\dot{\Omega} = 0$ isocline is greater than the slope of the $\dot{\lambda} = 0$ isocline i.e.

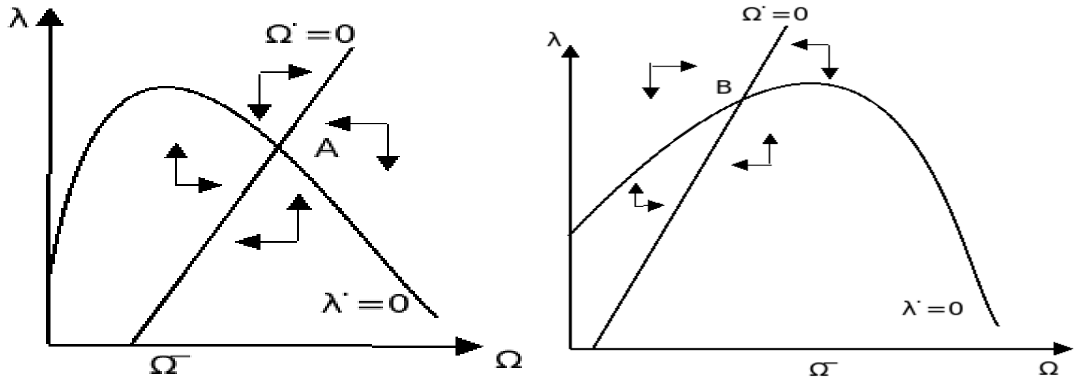
$$\left.\frac{d\lambda}{d\Omega}\right|_{\dot{\Omega}=0} > \left.\frac{d\lambda}{d\Omega}\right|_{\dot{\lambda}=0} > 0$$

$$\Rightarrow -\frac{\phi N}{\phi M} > -\frac{\theta Q}{\theta P}$$

$$\Rightarrow \theta\phi(NP - MQ) > 0 \quad (\because P < 0 \text{ and } M > 0)$$

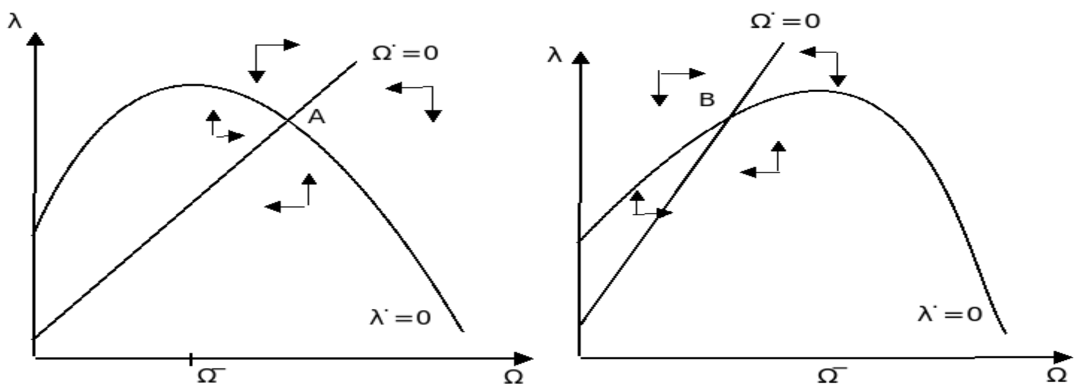
So the determinant of the Jacobian matrix $Det(J) = (J_{11}J_{22} - J_{12}J_{21}) = \theta\phi(NP - MQ) > 0$. Trace of the matrix $tr(J) = (J_{11} + J_{22}) = (\theta P + \phi N) < 0$. Thus point B is a stable equilibrium which is shown in Figure 4.1(b).

Financialization level, suppose due to some reason, deviates from the steady state and is now higher than its steady state value. There exist two opposite effects near the steady state B. First, as the financialization level is higher than its steady state value, it must fall due to equation (3.14) (as $J_{22} < 0$). This is the direct stable effect. Second, a rise in the financialization level leads to a rise in the rate of technological change due to $J_{12} > 0$. As $J_{21} > 0$, this rise in the rate of technological change leads to a rise in the financialization level. This second effect is an indirect unstable effect. However, as slope of the $\dot{\Omega} = 0$ isocline is relatively steeper, absolute value of J_{21} is relatively weak. As a result, a rise in λ through equation (3.13) leads to a negligible amount of rise in the financialization level. Therefore, the direct stable effect dominates



(a) (b)

Figure 4.1: *Case 1.1*



(a) (b)

Figure 4.2: *Case 1.2*

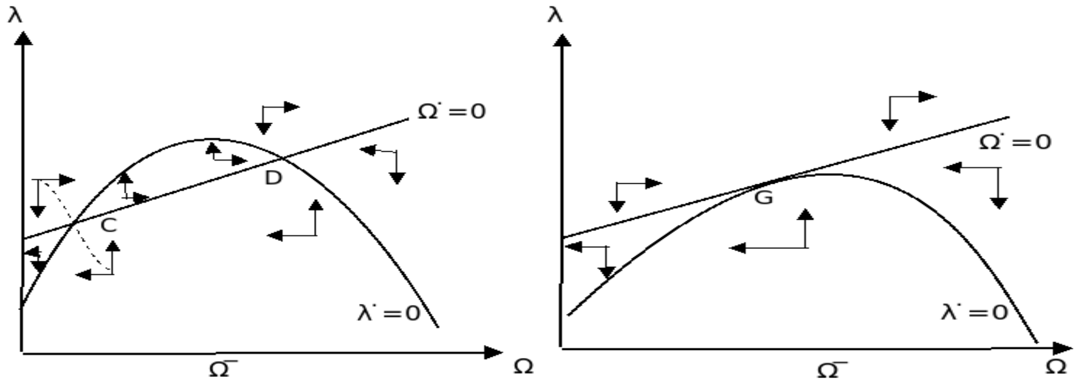
the indirect unstable effect and results the steady state to be stable.

4.1.2 *Case 1.2*

Let's assume that the vertical intercept of the $\dot{\Omega} = 0$ isocline is positive i.e. $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} > 0$. This is possible when $\eta_2 g(0) < \eta_0$. Let's also assume that the vertical intercept of the $\dot{\Omega} = 0$ isocline is less than the vertical intercept of the $\dot{\lambda} = 0$ isocline i.e. $\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3 \pi(0) > \lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} > 0.$

The equilibrium can be either A or B. The analysis here is similar to that of *case 1.1*. The diagram for this sub-case is represented in Figure 4.2.

From points A and B of *case 1.1.* or *case 1.2* we can infer the following



(a) Multiple equilibria (b) Unique equilibrium

Figure 4.3: *Case 1.3*

proposition.

Proposition 9. *In case 1.1 or in case 1.2, as long as steady state exists, it is stable.*

4.1.3 *Case 1.3*

Let's assume that the vertical intercept of the $\dot{\Omega} = 0$ isocline is positive and is greater than the vertical intercept of the $\dot{\lambda} = 0$ isocline i.e. $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} > \lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3 \pi(0) > 0$. Multiple equilibria ($C$ and D) arises in *case 1.3*. Figure 4.3(a) represents the diagram of *case 1.3*. However, under a special circumstances (when both the isoclines are tangent to each other), we may get a unique equilibrium (G). See Figure 4.3(b) for this.

Consider point C**:** Here $P < 0$ (i.e. $J_{11} < 0$), $M > 0$ (i.e. $J_{21} > 0$), $\frac{\partial g^\star}{\partial \Omega} < 0$ and equation (3.14) implies $N < 0$ (i.e. $J_{22} < 0$). As $\Omega < \bar{\Omega}$, equation (3.6) yields that $Q > 0$ (i.e.$J_{12} > 0$). At point C, slope of the $\dot{\Omega} = 0$ isocline is less than the slope of the $\dot{\lambda} = 0$ isocline i.e.

$$\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0} > \frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0} > 0$$

$$\Rightarrow -\frac{\theta Q}{\theta P} > -\frac{\phi N}{\phi M}$$

$$\Rightarrow \theta\phi(PN - QM) < 0 \quad (\because P < 0 \text{ and } M > 0)$$

So the determinant of the Jacobian matrix $Det(J) < 0$ and hence point C is a saddle point.

Let us discuss it intuitively. Suppose the financialization level, due to some exogenous reason, is now higher than its steady state value. There exist two opposite effects near the steady state C. First, as the financialization level is higher than its steady state value, it must fall due to equation $J_{22} < 0$. This is the direct stable effect. Second, a rise in the financialization level leads to a rise in the rate of technological change (due to $J_{12} > 0$) which in turn raises the financialization level (due to $J_{21} > 0$). This second effect is an indirect unstable effect. However, as slope of the $\dot{\Omega} = 0$ isocline is relatively flatter, absolute value of J_{21} is relatively strong. As a result, the rise in financialization level leads to a significant amount of rise in λ which in turn through equation (3.13) leads to a significant amount of rise in the financialization level. Therefore, the indirect unstable effect dominates the direct stable effect and results the steady state to be saddle point unstable.

Consider point D**:** Here $P < 0$ (i.e. $J_{11} < 0$), $M > 0$ (i.e. $J_{21} > 0$), $\frac{\partial g^\star}{\partial \Omega} < 0$ and equation (3.14) implies $N < 0$ (i.e. $J_{22} < 0$). However, as $\Omega > \bar{\Omega}$, equation (3.6) yields that $Q < 0$ (i.e.$J_{12} < 0$). At point D, slope of the $\dot{\Omega} = 0$ isocline is greater than the slope of the $\dot{\lambda} = 0$ isocline i.e.

$$\frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0} > 0 > \frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0}$$

$$\Rightarrow -\frac{\phi N}{\phi M} > -\frac{\theta Q}{\theta P}$$

$$\Rightarrow \theta\phi(PN - QM) > 0 \quad (\because P < 0 \text{ and } M > 0)$$

So the determinant of the Jacobian matrix $Det(J) > 0$. Trace of the matrix $tr(J) = \theta P + \phi N < 0$. Thus point D is a stable equilibrium.

Suppose that due to some exogenous shock the financialization level deviates from its steady state value and after deviation it is now higher than its initial steady state value. First, near D, if Ω is higher than the steady state value $\Omega^\star$, it must fall due to $J_{22} < 0$. This is the direct stable adjustment process. On the other hand, as $\Omega > \bar{\Omega}$, a rise in Ω decreases λ ($\because J_{12} < 0$). This in turn decreases the financialization level due to $J_{21} > 0$. This is the indirect effect which is also stable. As the direct and the indirect effects both are stable, if financialization level rises from its steady state value (D), it again comes back to the steady state. Hence, the steady state is stable.

Consider point G: As illustrated in Figure 4.3(b), $\dot{\Omega} = 0$ isocline is tangent to the $\dot{\lambda} = 0$ isocline at G. As isoclines are tangent, slope of the $\dot{\lambda} = 0$ isocline $(-\frac{J_{12}}{J_{11}})$ is equal to the slope of the $\dot{\Omega} = 0$ isocline $(-\frac{J_{22}}{J_{21}})$. Therefore, the determinant of the Jacobian matrix $Det(J) = (J_{11}J_{22} - J_{12}J_{21})$ is zero. As a result, G is a saddle node.

From the above analysis of *case 1.3*, one can state the following proposition.

Proposition 10. *In case 1.3, as long as steady state exists, a higher value of financialization level* $(\Omega > \bar{\Omega})$ *is sufficient to ensure the stability of the steady state. However, if* $\Omega < \bar{\Omega}$*, the steady state is a saddle point.*

Now we focus on *case 2*.

4.2 *Case 2: weak expansionary effect of financialization on the rate of capital accumulation*

For *case 2* we assume $\frac{\partial g^\star}{\partial \Omega} > 0$ but $\frac{\partial g^\star}{\partial \Omega} < \frac{1}{\eta_2}$ i.e. there is a weak expansionary effect of financialization on the rate of capital accumulation. $\frac{1}{\eta_2} > \frac{\partial g^\star}{\partial \Omega} > 0$ implies N to be negative (i.e. $J_{22} < 0$). Three different sub-cases are possible under *case 2*. These are *cases 2.1, 2.2* and *2.3* respectively. The analysis of *cases 2.1, 2.2* and *2.3* are same as the analysis in *cases 1.1, 1.2* and *1.3* respectively.

From *cases 1* & *case 2* we can infer the following argument. Suppose the vertical intercept of the $\dot{\Omega} = 0$ isocline is less than the vertical intercept of the $\dot{\lambda} = 0$ isocline i.e. $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} > \lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3 \pi(0)$. Then the following proposition holds.

Proposition 11. *If there is a contractionary effect of financialization on the rate of capital accumulation, then existence of a unique steady state is sufficient to ensure the stability of the steady state. However, if the effect of financialization on the equilibrium rate of capital accumulation is expansionary and weak (i.e.* $0 < \frac{\partial g^\star}{\partial \Omega} < \frac{1}{\eta_2}$*) then also a stable steady state can be achieved.*

4.3 *Case 3: strong expansionary effect of financialization on the rate of capital accumulation*

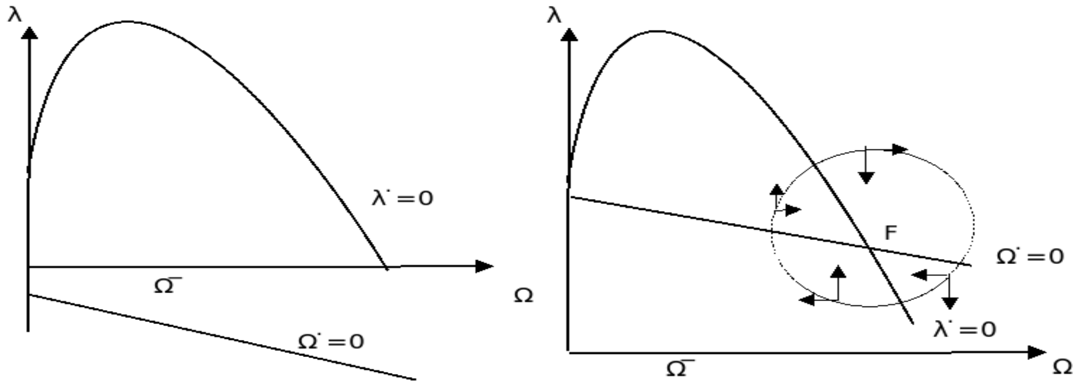
For *case 3* we assume $\frac{\partial g^\star}{\partial \Omega} > \frac{1}{\eta_2} > 0$ i.e. there is a strong expansionary effect of financialization on the rate of capital accumulation. $\frac{\partial g^\star}{\partial \Omega} > \frac{1}{\eta_2} > 0$ implies N to be positive (i.e. $J_{22} > 0$). As a result, the $\dot{\Omega} = 0$ isocline is negatively sloped in *case 3.*

Three different sub-cases are possible under *case 3.* These are *cases 3.1, 3.2* and *3.3* respectively. The vertical intercept of the $\dot{\Omega} = 0$ isocline is negative in *case 3.1.* Vertical intercept of the $\dot{\Omega} = 0$ isocline is positive but less than the vertical intercept of the $\dot{\lambda} = 0$ isocline in *case 3.2.* In *case 3.3,* vertical intercept of the $\dot{\Omega} = 0$ isocline is not only positive but greater than the vertical intercept of the $\dot{\lambda} = 0$ isocline also.

Under *case* 3, the sufficient condition for a unique equilibrium to exist is that the $\dot{\Omega} = 0$ isocline must intersect the $\dot{\lambda} = 0$ isocline from below (However, it is not a necessary condition. If $\dot{\Omega} = 0$ and $\dot{\lambda} = 0$ isoclines are tangent to each other, then also we get a unique equilibrium). We get a unique equilibrium in *case 3.2.* This is because the $\dot{\Omega} = 0$ isocline is negatively sloped and the vertical intercept of the $\dot{\Omega} = 0$ isocline is lower than the vertical intercept of the $\dot{\lambda} = 0$ isocline here. On the other hand, the necessary condition for multiple equilibria to exist is that the $\dot{\Omega} = 0$ isocline must intersect the $\dot{\lambda} = 0$ isocline from above in the positively sloped section of the latter curve (However, it is not a sufficient condition. See Figure 4.5(b) for example). As the $\dot{\Omega} = 0$ isocline is negatively sloped and the vertical intercept of the $\dot{\Omega} = 0$ isocline is higher than the vertical intercept of the $\dot{\lambda} = 0$ isocline in *case 3.3,* we get multiple equilibria here (We can get a unique equilibrium too in *case 3.3.* See Figure 4.5(c)). In what follows, we discuss all the sub-cases under *case 3* now.

4.3.1 *Case 3.1*

The vertical intercept of the $\dot{\Omega} = 0$ isocline is negative i.e. $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} < 0$. This is possible when $\eta_2 g(0) > \eta_0$. However, no steady state is possible here. See Figure 4.4(a).



(a) *Case 3.1*: no equilibrium (b) *Case 3.2*: unique equilibrium

Figure 4.4: *Case 3*

4.3.2 *Case 3.2*

Let's assume that the vertical intercept of the $\dot{\Omega} = 0$ isocline is positive i.e. $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} > 0$. This is possible when $\eta_2 g(0) < \eta$. Let's also assume that the vertical intercept of the $\dot{\Omega} = 0$ isocline is less than the vertical intercept of the $\dot{\lambda} = 0$ isocline i.e. $\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3 \pi(0) > \lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} > 0$. A unique equilibrium F arises here. Here $P < 0$ (i.e. $J_{11} < 0$), $M > 0$ (i.e. $J_{21} > 0$), $\frac{\partial g^\star}{\partial \Omega} > \frac{1}{\eta_2} > 0$ and equation (3.14) implies $N > 0$ (i.e. $J_{22} > 0$). As $\Omega > \bar{\Omega}$, equation (3.6) yields that $Q < 0$ (i.e.$J_{12} < 0$). At point F, slope of the $\dot{\Omega} = 0$ isocline is greater than the slope of the $\dot{\lambda} = 0$ isocline i.e.

$$0 > \frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0} > 0 \frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0}$$

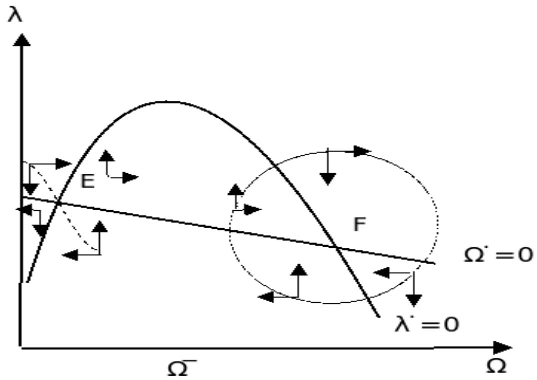
$$\Rightarrow -\frac{\phi N}{\phi M} > -\frac{\theta Q}{\theta P}$$

$$\Rightarrow \theta\phi(PN - QM) > 0 \qquad (\because P < 0 \text{ and } M > 0)$$

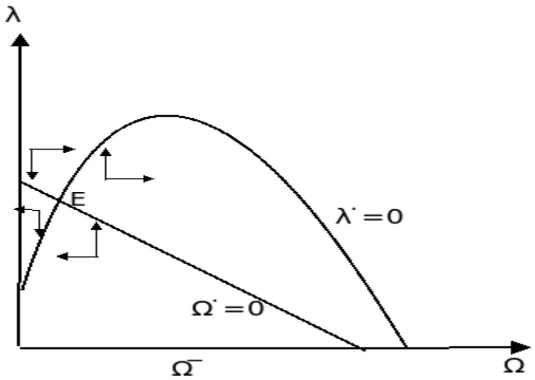
So the determinant of the Jacobian matrix $Det(J) > 0$. Trace of the matrix $tr(J) = (\theta P + \phi N) \gtreqless 0$. Thus point F can be either stable or an unstable equilibrium. See Figure 4.4(b) for the diagrammatic explanation.

Give the value of ϕ, if $\theta = \hat{\theta} = \frac{-\phi(\eta_2 \frac{\partial g}{\partial \Omega} - 1)}{\{\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\}}$, or given the value of θ, if $\phi = \hat{\phi} = \frac{-\theta\{\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\}}{(\eta_2 \frac{\partial g}{\partial \Omega} - 1)}$, limit cycles occur due to Hopf-bifurcation. More discussion regarding Hopf-bifurcation is provided in section 4.4.

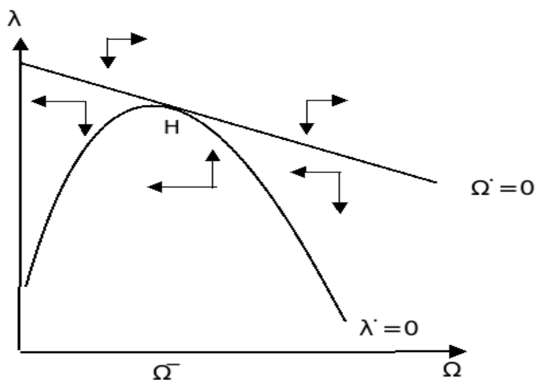
Intuition behind the stability at point F is as follows. First, here the self-



(a) *Case 3.3*: multiple equilibria



(b) *Case 3.3*: unique equilibrium



(c) *Case 3.3*: unique equilibrium

Figure 4.5: *Case 3*

feedback effect of the rate of technological change negative, i.e. $J_{11} = \frac{\partial \dot{\lambda}}{\partial \lambda} = \theta P < 0$. Besides, here the self-feedback effect of the financialization level is positive, i.e. $J_{22} = \frac{\partial \dot{\Omega}}{\partial \Omega} = \phi N > 0$. Given the speed of adjustment parameter of the financialization dynamics (ϕ), when the speed of adjustment parameter of the rate of technological change (θ) is sufficiently high (i.e. $\theta > \hat{\theta} = \frac{-\phi(\eta_2 \frac{\partial g}{\partial \Omega} - 1)}{\{\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\}}$), or given θ, when ϕ is sufficiently small (i.e. $\phi < \hat{\phi} = \frac{-\theta\{\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\}}{(\eta_2 \frac{\partial g}{\partial \Omega} - 1)}$), the dynamics of the system could become stable because the negative self-feedback effect of the rate of technological change becomes strong and dominates the unstable self-feedback effect of the financialization level.

4.3.3 *Case 3.3*

Let's assume that the vertical intercept of the $\dot{\Omega} = 0$ isocline is positive and is greater than the vertical intercept of the $\dot{\lambda} = 0$ isocline i.e. $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1} >$

$\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3 \pi(0) > 0.$

Consider point E**:** Here $P < 0$ (i.e. $J_{11} < 0$), $M > 0$ (i.e. $J_{21} > 0$), $\frac{\partial g^\star}{\partial \Omega} > \frac{1}{\eta_2} > 0$ and equation (3.14) implies $N > 0$ (i.e. $J_{22} > 0$). As $\Omega < \bar{\Omega}$, equation (3.6) yields that $Q > 0$ (i.e.$J_{12} > 0$). At point E, slope of the $\dot{\Omega} = 0$ isocline is less than the slope of the $\dot{\lambda} = 0$ isocline i.e.

$$\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0} > 0 > \frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0}$$

$$\Rightarrow -\frac{\theta Q}{\theta P} > -\frac{\phi N}{\phi M}$$

$$\Rightarrow \theta\phi(PN - QM) < 0 \quad (\because P < 0 \text{ and } M > 0)$$

So the determinant of the Jacobian matrix $Det(J) < 0$. Thus point E is a saddle point.

Consider point F**:** Here the analysis is the same as in *case 3.2*. See Figure 4.5(a) for the diagrammatic explanation.

Consider point H**:** As illustrated in Figure 4.5(c), $\dot{\Omega} = 0$ isocline is tangent to the $\dot{\lambda} = 0$ isocline at H. As isoclines are tangent, slope of the $\dot{\lambda} = 0$ isocline $(-\frac{J_{12}}{J_{11}})$ is equal to the slope of the $\dot{\Omega} = 0$ isocline $(-\frac{J_{22}}{J_{21}})$. Therefore, the determinant of the Jacobian matrix $Det(J) = (J_{11}J_{22} - J_{12}J_{21})$ is zero. As a result, H is a saddle node.

From the above said analysis of *case 3.3*, we conclude the following remark.

Remark 1. *In case 3.3, as long as steady state exists, a higher value of financialization level* $(\Omega > \bar{\Omega})$ *is a necessary condition to ensure the stability of the steady state. However, it is not a sufficient condition.*

Table 4.1 summarizes the results of the stability related to various steady states.

4.4 *Andronov-Hopf Bifurcation*

In this sub-section, we discuss the possibilities of emergence of cycle as a solution to the dynamical systems represented by equation (3.2) and (3.10).

Table 4.1: *Summary of stability of the steady states*

Case	Whether multiple equilibria are possible	Steady state	Sign of the elements of Jacobian Matrix	Nature of the steady state
1.1	No	A	$J_{11} < 0,\ J_{12} < 0,$ $J_{21} > 0,\ J_{22} < 0$	stable
		B	$J_{11} < 0,\ J_{12} > 0,$ $J_{21} > 0,\ J_{22} < 0$	stable
1.2	same as in *case 1.1*			
1.3	Yes	C	$J_{11} < 0,\ J_{12} > 0,$ $J_{21} > 0,\ J_{22} < 0$	saddle point unstable
		D	$J_{11} < 0,\ J_{12} < 0,$ $J_{21} > 0,\ J_{22} < 0$	stable
		G	$J_{11} < 0,\ J_{12} > 0,$ $J_{21} > 0,\ J_{22} < 0$	saddle node
2.1	same as in *case 1.1*			
2.2	same as in *case 1.2*			
2.3	same as in *case 1.3*			
3.1	no steady state is possible			
3.2	No	F	$J_{11} < 0,\ J_{12} < 0,$ $J_{21} > 0,\ J_{22} > 0$	stable / unstable / limit cycle
3.3	Yes	E	$J_{11} < 0,\ J_{12} > 0,$ $J_{21} > 0,\ J_{22} > 0$	saddle point unstable
		F	$J_{11} < 0,\ J_{12} < 0,$ $J_{21} > 0,\ J_{22} > 0$	stable / unstable / limit cycle
		H	$J_{11} < 0,\ J_{12} < 0,$ $J_{21} > 0,\ J_{22} > 0$	saddle node

Consider the steady state F of *case 3.2* or *3.3*. We get the following proposition.

Proposition 12. *For an appropriate value of the speed of adjustment parameter, θ, the characteristic equation to (3.2) & (3.10) evaluated at the steady state F of the case 3.2 or 3.3 has purely imaginary roots and for the same dynamical system, $\theta = \hat{\theta} = \frac{-\phi\left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]}{\left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right]}$ provides a point of Andronov-Hopf bifurcation*[32].

Proof. The characteristic equation to (3.2) & (3.10) is $\{\mu^2 + (-tr(J))\mu + Det(J) = 0\}$. A necessary condition of the Hopf bifurcation for complex roots is $Det(J) > 0$, which is satisfied at the equilibrium F of *cases 3.2* and *3.3*. The trace of the Jacobian matrix can be made either positive or negative by appropriately selecting the value of θ while leaving the other parameters constant. To see this, notice that $tr(J) = J_{11} + J_{22} = \theta\left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right] + \phi\left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]$. Hence when $\theta = \hat{\theta} = \frac{-\phi N}{P} = \frac{-\phi\left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]}{\left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right]} > 0$ ($\because N > 0$, $P < 0$), the following equation holds exactly:

$$tr(J) = 2 * \mathrm{Re}(\mu) = \theta\left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right] + \phi\left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right] = 0$$

where $tr(J)$ is the trace of J and $\mathrm{Re}(\mu)$ is the real part of its characteristic roots. As the determinant of the Jacobian matrix is positive, the product of the roots is positive in a neighborhood of the equilibrium, assuring $\mathrm{Im}(\mu) \neq 0$. Now differentiating the trace of the Jacobian matrix with respect to θ and then evaluating it at $\theta = \hat{\theta}$ we get

$$\left.\frac{\partial(\frac{tr(J)}{2})}{\partial \theta}\right|_{\theta=\hat{\theta}} = \frac{\left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right]}{2} < 0 \ (\because P < 0)$$

So the trace is smooth, differentiable and monotonically decreasing in the speed of adjustment parameter, θ. The trace disappears at $\theta = \hat{\theta}$. Also note that $tr(J) \gtreqless 0 \iff \theta \lesseqgtr \hat{\theta}$. From the preceding discussion, all conditions for Hopf bifurcation are satisfied at $\theta = \hat{\theta}$[33]. □

Note that for $\theta < \hat{\theta}$, the trace become positive and hence we have an unstable equilibrium. However when $\theta > \hat{\theta}$, the equilibrium is stable. When θ

[32] For further discussion regarding Hopf-bifurcation see Gandolfo (1997), Izhikevich (2007).
[33] The method of the proof is based on Gandolfo (1997).

falls to $\hat{\theta}$, the system with a stable equilibrium point loses its stability and gives birth to a limit cycle. Similarly if θ rises to $\hat{\theta}$, the system with an unstable steady state produces a limit cycle[34]. We already have discussed that the speed of adjustment parameter depends on the speed of diffusion of technological innovations. Bhaduri (2006b) points out that faster diffusion rate of technological innovations is an important parameter for fueling growth whereas at the very same time it has potential to destabilize the steady growth path. In our model, on the contrary, higher speed of diffusion of technological innovation is not necessary for fueling growth (as it cannot stimulate the technological change itself), but is important for stabilizing the economy. We already have discussed that the speed of adjustment parameter depends on the degree of restrictiveness enforced by patents, copyrights and other intellectual property rights. So government intervention for loosening the degree of restrictiveness enforced by various intellectual property rights are desirable for ensuring the stability in the economy.

Proposition 13. *For an appropriate value of the speed of adjustment parameter, ϕ, the characteristic equation to (3.2) & (3.10) evaluated at the steady state F of the case 3.2 or 3.3 has purely imaginary roots and for the same dynamical system, $\phi = \hat{\phi} = \frac{-\theta\left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right]}{\left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]}$ provides a point of Andronov-Hopf bifurcation.*

Proof. The proof is similar to the poof of Proposition 12. Here $\hat{\phi} = \frac{-\theta\left[\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right]}{\left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]} > 0$ and $\left.\frac{\partial(\frac{tr(J)}{2})}{\partial \phi}\right|_{\phi=\hat{\phi}} = \frac{\left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]}{2} > 0$. Hence $tr(J) \gtreqless 0 \iff \phi \lesseqgtr \hat{\phi}$. □

Note that for $\phi > \hat{\phi}$, the trace become positive and hence we have an unstable equilibrium. However when $\phi < \hat{\phi}$, the equilibrium is stable. When ϕ rises to $\hat{\phi}$, the system with a stable equilibrium point loses its stability and gives birth to a limit cycle. Similarly if ϕ falls to $\hat{\phi}$, the system with an unstable steady state produces a limit cycle. This speed of adjustment parameter ϕ that is associated with the change in financialization level depends, among many other things, on the government's role in the regulation of the financial markets. Lower the level of government regulation in the financial sector, higher is the

[34] Note that the limit cycle can arise only when the strong expansionary effect of financialization on the equilibrium rate of capital accumulation prevails.

speed of adjustment associated with the change in the level of financialization and hence higher is the possibility that the stable system losing its stability produces limit cycle. So government intervention for more regulated financial market is desirable for ensuring stability of the system (economy).

5 *Comparative Statics*

In this section we investigate how various parameters influence the equilibrium values of the rate of technological change and the financialization level. Table 5.1 summarizes the results of the comparative statics.

5.1 *Effect of a change in* ξ_0

Setting equation (3.2) to zero and differentiating it partially w.r.t. ξ_0 we get,

$$P\frac{\partial\lambda}{\partial\xi_0} + Q\frac{\partial\Omega}{\partial\xi_0} = -1 \tag{5.1}$$

Setting equation (3.10) to zero and differentiating it partially w.r.t. ξ_0 we get,

$$M\frac{\partial\lambda}{\partial\xi_0} + N\frac{\partial\Omega}{\partial\xi_0} = 0 \tag{5.2}$$

where $P = \left(\xi_1\frac{\partial g}{\partial\lambda} - \xi_3\frac{\partial\pi}{\partial\lambda} - 1\right)$; $Q = \left[\xi_1\frac{\partial g}{\partial\Omega} + \xi_2(\zeta - 2\Omega) - \xi_3\frac{\partial\pi}{\partial\Omega}\right]$; $M = \left[\eta_1 + \eta_2\frac{\partial g}{\partial\lambda}\right]$; $N = \left[\eta_2\frac{\partial g}{\partial\Omega} - 1\right]$

Rewriting equations (5.1) & (5.2) in matrix form we get,

$$\begin{pmatrix} P & Q \\ M & N \end{pmatrix}\begin{pmatrix} \frac{\partial\lambda}{\partial\xi_0} \\ \frac{\partial\Omega}{\partial\xi_0} \end{pmatrix} = \begin{pmatrix} -1 \\ 0 \end{pmatrix} \tag{5.3}$$

$$\text{So, } \frac{\partial\lambda}{\partial\xi_0} = \frac{-N}{(NP - MQ)} \tag{5.4}$$

$$\text{and } \frac{\partial\Omega}{\partial\xi_0} = \frac{M}{(NP - MQ)} \tag{5.5}$$

<u>Case 1.1:</u>

Table 5.1: *Summary of comparative statics results for changes in parameters*

	Case	Steady state	Effect on $\lambda^\star$	Effect on $\Omega^\star$	Effect on $g^\star$ when $\frac{\partial g^\star}{\partial \lambda} > 0$	Effect on $g^\star$ when $\frac{\partial g^\star}{\partial \lambda} < 0$
Δ in ξ_0	*1.1*	A	$+$	$+$	ambiguous	$-$
		B	$+$	$+$	ambiguous	$-$
	1.2	same as in *case 1.1*				
	1.3	D	$+$	$+$	ambiguous	$-$
	2.1	same as in *case 1.1*			$+$	ambiguous
	2.2	same as in *case 1.1*			$+$	ambiguous
	2.3	same as in *case 1.3*			$+$	ambiguous
	3.2/3.3	F	$-$	$+$	ambiguous	$+$
Δ in ξ_1	similar to that of a change in ξ_0					
Δ in ξ_3	opposite to that of a change in ξ_0					
Δ in η_0	*1.1*	A	$+$	$-$	$+$	ambiguous
		B	$-$	$-$	ambiguous	$+$
	1.2	same as in *case 1.1*				
	1.3	D	$+$	$-$	$+$	ambiguous
	2.1	A	$+$	$-$	ambiguous	$-$
		B	$+$	$-$	$-$	ambiguous
	2.2	same as in *case 2.1*				
	2.3	D	$+$	$-$	ambiguous	$-$
	3.2/3.3	F	$+$	$-$	ambiguous	$-$
Δ in η_1	*1.1*	A	$-$	$+$	$-$	ambiguous
		B	$+$	$+$	ambiguous	$-$
	1.2	same as in *case 1.1*				
	1.3	D	$-$	$+$	$-$	ambiguous
	2.1	A	$-$	$+$	ambiguous	$+$
		B	$+$	$+$	$+$	ambiguous
	2.2	same as in *case 2.1*				
	2.3	D	$-$	$+$	ambiguous	$+$
	3.2/3.3	F	$-$	$+$	ambiguous	$+$
Δ in η_2	similar to that of a change in η_1					

Consider point A: Here $P < 0$, $Q < 0$, $M > 0$, $N < 0$. So from equation (5.4) we get $\frac{\partial \lambda}{\partial \xi_0} = \frac{-N}{(NP-MQ)} > 0$ and from equation (5.5) we can say $\frac{\partial \Omega}{\partial \xi_0} = \frac{M}{(NP-MQ)} > 0$. Thus as ξ_0 increases, both the equilibrium values of $\lambda^\star$ and $\Omega^\star$ rise and a fall in ξ_0 has a dampening effect on both $\lambda^\star$ and $\Omega^\star$. When $\frac{\partial g^\star}{\partial \lambda} > 0$ i.e. when technological change has a expansionary effect on the equilibrium rate of capital accumulation, the impact of a rise in ξ_0 on the long run equilibrium rate of capital accumulation is ambiguous which is shown in equation (5.6).

$$\frac{dg^\star}{d\xi_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \xi_0}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{-} \overbrace{\frac{\partial \Omega}{\partial \xi_0}}^{+} \right\} \gtreqless 0 \tag{5.6}$$

This is happening because of the following reason. A rise in ξ_0 raises Ω. Under *case 1* there is a contractionary effect of financialization on $g^\star$ (i.e. $\frac{\partial g^\star}{\partial \Omega} < 0$) and so a rise in Ω leads to a fall in $g^\star$. On the other hand, a rise in ξ_0 raises λ which in turn leads to an increment in $g^\star$. Hence the final effect of a rise in ξ_0 on $g^\star$ is ambiguous. However, if there is a strong wage-led growth regime, we get $\frac{\partial g^\star}{\partial \lambda} < 0$. Under this scenario the impact of a rise in ξ_0 on the long run equilibrium rate of capital accumulation is unambiguously negative (see equation (5.7)).

$$\frac{dg^\star}{d\xi_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{-} \overbrace{\frac{\partial \lambda}{\partial \xi_0}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{-} \overbrace{\frac{\partial \Omega}{\partial \xi_0}}^{+} \right\} < 0 \tag{5.7}$$

Now let us do the analysis graphically. The vertical intercept of the $\dot{\lambda} = 0$ curve is $\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3 \pi(0)$. So partially differentiating it with respect to ξ_0 yields $\frac{\partial\left(\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0}\right)}{\partial \xi_0} = 1 > 0$. Slope of the $\dot{\lambda} = 0$ isocline is $\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0} = \frac{\xi_1 \frac{\partial g}{\partial \Omega} + \xi_2(\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \Omega}}{1 - \xi_1 \frac{\partial g}{\partial \lambda} + \xi_3 \frac{\partial \pi}{\partial \lambda}}$ and so the slope in invariant with respect to the change in ξ_0. Thus when ξ_0 rises, only the vertical intercept increases. As a result, for a rise in ξ_0, the $\dot{\lambda} = 0$ isocline shifts to the upward direction and we get the new equilibrium point A' where $\Omega^\star$ and $\lambda^\star$ both rise. See Figure 5.1(a) for the diagram. The red curve shows the shift in the $\dot{\lambda} = 0$ isocline[35].

[35] From here onward in this chapter, after the change (or shift), the new position of an isocline is represented through the red line. However, after the change (or shift) if the new position of the isocline is tangent to the other isocline, we use blue line to show it.

Intuitively, a rise in ξ_0, *ceteris paribus*, raises λ^d and thereby pushes the $\dot{\lambda} = 0$ isocline upwards. For a given λ, at the old steady state A, Ω is lower than required for $\dot{\lambda} = 0$ to be satisfied. This lower level of Ω puts upward pressure on the rate of technological change through equation (3.6) (as $\Omega > \bar{\Omega}$, $J_{12} < 0$ here). As a result, λ starts rising. As soon as λ rises, $\dot{\Omega} = 0$ no more holds. Given the level of Ω, λ is now higher than required for $\dot{\Omega} = 0$ to be satisfied. As $J_{21} = \frac{\partial \dot{\Omega}}{\partial \lambda} > 0$, Ω must rise. Combination of higher λ and Ω ultimately ensure to achieve the new equilibrium point A' either monotonically or spiraling around A'. Therefore at the new steady state A', $\Omega^\star$ and $\lambda^\star$ both rise.

Consider point B**:** Here $P < 0$, $Q > 0$, $M > 0$, $N < 0$. So from equation (5.4) we get $\frac{\partial \lambda}{\partial \xi_0} = \frac{-N}{(NP-MQ)} > 0$ and from equation (5.5) we can say $\frac{\partial \Omega}{\partial \xi_0} = \frac{M}{(NP-MQ)} > 0$. Therefore an expansion in ξ_0 increases the equilibrium values of both $\lambda^\star$ and $\Omega^\star$ whereas a decline in ξ_0 lowers the equilibrium values of both $\lambda^\star$ and $\Omega^\star$. See Figure 5.1(b) for the diagram. Here also when $\frac{\partial g^\star}{\partial \lambda} > 0$, the impact of a rise in ξ_0 on the long run equilibrium rate of capital accumulation is ambiguous (see equation (5.6)) and if there is a wage-led growth regime which is so strong that $\frac{\partial g^\star}{\partial \lambda} < 0$, then the impact of a rise in ξ_0 on the long run equilibrium rate of capital accumulation is unambiguously negative.

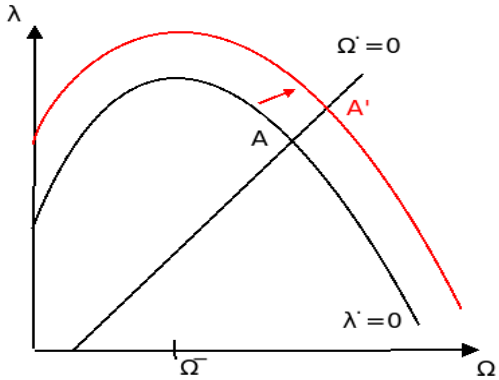
So, in *case 1.1,* we can conclude that regardless of the initial value of the financialization level (i.e. whether $\Omega > \bar{\Omega}$ or $\Omega < \bar{\Omega}$), the effect of a rise in ξ_0 is expansionary for both the equilibrium values of $\lambda^\star$ and $\Omega^\star$.

We get a similar result in *case 1.2.* Therefore we are not analyzing *case 1.2* separately.

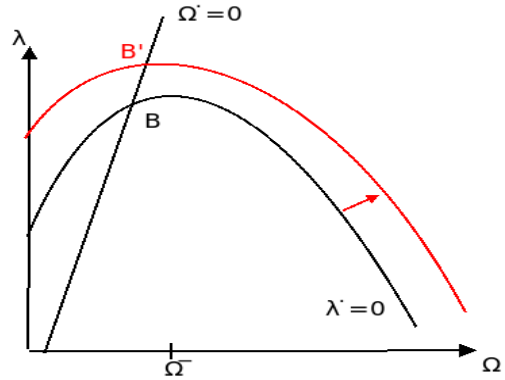
Case 1.3:

Consider point D**:** Here $P < 0$, $Q < 0$, $M > 0$, $N < 0$. So equation (5.4) yields $\frac{\partial \lambda}{\partial \xi_0} = \frac{-N}{(NP-MQ)} > 0$ and equation (5.5) yields $\frac{\partial \Omega}{\partial \xi_0} = \frac{M}{(NP-MQ)} > 0$. So ξ_0 has a positive impact on the equilibrium values of both- $\lambda^\star$ and $\Omega^\star$. It is shown in Figure 5.1(c). Similar to *case 1.1,* when $\frac{\partial g^\star}{\partial \lambda} > 0$, the impact of a rise in ξ_0 on the equilibrium rate of capital accumulation is ambiguous. However, when $\frac{\partial g^\star}{\partial \lambda} < 0$, the impact of a rise in ξ_0 on the long run equilibrium rate of capital accumulation is negative.

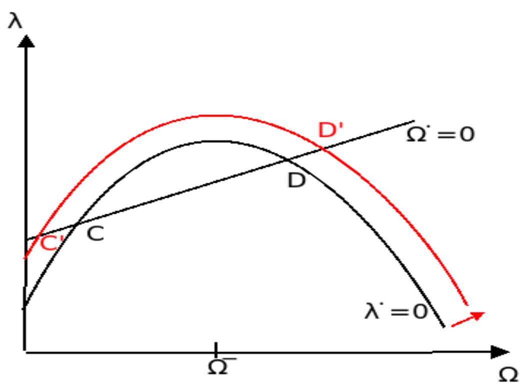
Note that, in the period of stagnation, it's the intra-class conflict among firms that plays an important role. It is important not only for achieving the new



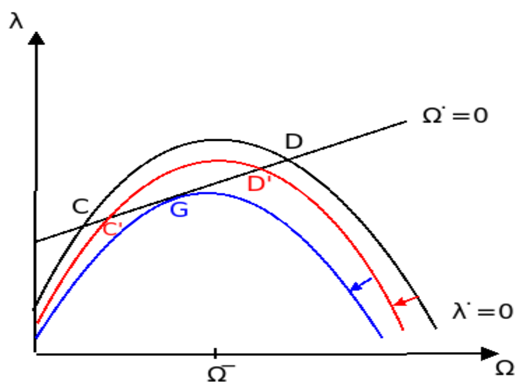
(a) *Case 1.1:* a rise in ξ_0 (when the economy starts from point A where $\Omega > \bar{\Omega}$)



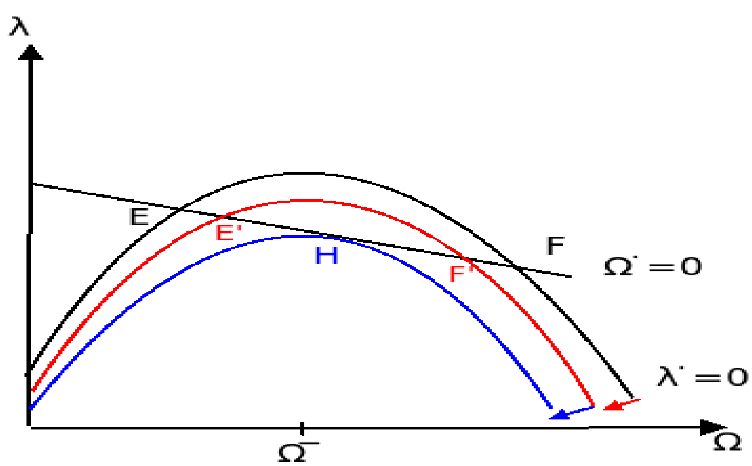
(b) *Case 1.1:* a rise in ξ_0 (when the economy starts from point B where $\Omega < \bar{\Omega}$)



(c) *Case 1.3:* a rise in ξ_0



(d) *Case 1.3:* a fall in ξ_0



(e) *Case 2.3:* a fall in ξ_0

Figure 5.1: Effect of a change in ξ_0

equilibrium level of $\lambda^\star$ and $\Omega^\star$, but if there is a large enough deterioration in the class conflict among firms, the economy that starts from a stable steady state D, may reach to the saddle node G i.e. instability may arise in the economy (see Figure 5.1(d)).

Summary of the above analysis of *case 1.3* yields the following proposition.

Proposition 14. *Suppose the economy is in the stable steady state D of case 1.3. Then a rise in ξ_0 leads to an increase in both $\Omega^\star$ and $\lambda^\star$. On the other hand, a fall in ξ_0 leads to a reduction in both $\Omega^\star$ and $\lambda^\star$ and no stable steady state exists for a sufficiently large fall in ξ_0.*

Case 2: The analysis for *cases 2.1* & *2.2* are similar to *case 1.1* whereas the analysis of *case 2.3* is similar to *case 1.3*. However, in *case 2*, $\frac{\partial g^\star}{\partial \Omega} \in (0, \frac{1}{\eta_2})$ and so when $\frac{\partial g^\star}{\partial \lambda} > 0$, a rise in ξ_0 has a positive effect on the equilibrium rate of capital accumulation,

$$\frac{dg^\star}{d\xi_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \xi_0}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \xi_0}}^{+} \right\} > 0 \tag{5.8}$$

On the other hand, if there is a strong wage-led growth regime (so that $\frac{\partial g^\star}{\partial \lambda} < 0$), the impact of a rise in ξ_0 on the long run equilibrium rate of capital accumulation is ambiguous,

$$\frac{dg^\star}{d\xi_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{-} \overbrace{\frac{\partial \lambda}{\partial \xi_0}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \xi_0}}^{+} \right\} \gtreqless 0 \tag{5.9}$$

This result is applicable for all of the sub-cases i.e. for *cases 2.1, 2.2* and *2.3*.

Case 3.2/3.3: Consider point F. Here $P < 0$, $Q < 0$, $M > 0$, $N > 0$. So from equation (5.1) we get $\frac{\partial \lambda}{\partial \xi_0} = \frac{-N}{(NP-MQ)} < 0$ and from equation (5.5) we can say $\frac{\partial \Omega}{\partial \xi_0} = \frac{M}{(NP-MQ)} > 0$. Thus for an increment in ξ_0, the equilibrium value of $\Omega^\star$ rises but $\lambda^\star$ falls. When $\frac{\partial g^\star}{\partial \lambda} > 0$, the impact of a rise in ξ_0 on the equilibrium rate of capital accumulation is ambiguous as

$$\frac{dg^\star}{d\xi_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \xi_0}}^{-} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \xi_0}}^{+} \right\} \gtreqless 0. \tag{5.10}$$

However, when $\frac{\partial g^\star}{\partial \lambda} < 0$, the impact of a rise in ξ_0 on the equilibrium rate of capital accumulation is unambiguously positive.

Note that if ξ_0 decreases, in case 3.3 the two equilibria E and F come closer and for an appropriate fall in ξ_0, both the equilibria merge to unite at a saddle point (see Figure 5.1(e)).

Summary of the above analysis of *case 3.3* yields the following proposition.

Proposition 15. *Suppose the economy is in the stable steady state F of case 3.3. Then a rise in ξ_0 leads to an increase in $\Omega^\star$ and a fall in $\lambda^\star$. On the other hand, a fall in ξ_0 leads to a decrease in $\Omega^\star$ and an increase $\lambda^\star$ and no stable steady state exists for a sufficiently large fall in ξ_0.*

Thus, when the economy is either in *case 1.3* or in *case 2.3* or in *case 3.3*, a decent degree of intra-class conflict among firms in the period of stagnation is desirable as it preserves macroeconomic stability. On the contrary, a sufficiently low level of intra-class conflict among firms causes instability in the economy.

5.2 *Effect of a change in ξ_1*

Setting equation (3.2) to zero and differentiating it partially w.r.t. ξ_1 we get,

$$P\frac{\partial \lambda}{\partial \xi_1} + Q\frac{\partial \Omega}{\partial \xi_1} = -g \tag{5.11}$$

Setting equation (3.10) to zero and differentiating it partially w.r.t. ξ_1 we get,

$$M\frac{\partial \lambda}{\partial \xi_1} + N\frac{\partial \Omega}{\partial \xi_1} = 0 \tag{5.12}$$

where $P = \left(\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right)$; $Q = \left[\xi_1 \frac{\partial g}{\partial \Omega} + \xi_2(\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \Omega}\right]$; $M = \left[\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}\right]$; $N = \left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]$

Rewriting equations (5.11) & (5.12) in matrix form we get,

$$\begin{pmatrix} P & Q \\ M & N \end{pmatrix} \begin{pmatrix} \frac{\partial \lambda}{\partial \xi_1} \\ \frac{\partial \Omega}{\partial \xi_1} \end{pmatrix} = \begin{pmatrix} -g \\ 0 \end{pmatrix} \tag{5.13}$$

$$\text{So,} \ \frac{\partial \lambda}{\partial \xi_1} = \frac{-Ng}{(NP - MQ)} \tag{5.14}$$

$$\text{and} \ \frac{\partial \Omega}{\partial \xi_1} = \frac{Mg}{(NP - MQ)} \tag{5.15}$$

A rise in ξ_1, other things being constant, unambiguously shifts the $\dot{\lambda} = 0$ isocline in an upward direction as, $\frac{\partial \left(\lambda \big|_{\dot{\lambda}=0} \right)}{\partial \xi_1} = g > 0$. Note that the comparative static results for a change in ξ_1 is qualitatively similar to that of a change in ξ_0 and so we are not discussing it further.

5.3 *Effect of a change in* ξ_3

Setting equation (3.2) to zero and differentiating it partially w.r.t. ξ_3 we get,

$$P \frac{\partial \lambda}{\partial \xi_3} + Q \frac{\partial \Omega}{\partial \xi_3} = \pi \tag{5.16}$$

Setting equation (3.10) to zero and differentiating it partially w.r.t. ξ_3 we get,

$$M \frac{\partial \lambda}{\partial \xi_3} + N \frac{\partial \Omega}{\partial \xi_3} = 0 \tag{5.17}$$

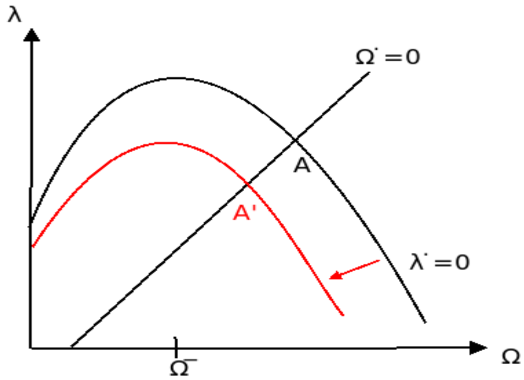
where $P = \left(\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1 \right)$; $Q = \left[\xi_1 \frac{\partial g}{\partial \Omega} + \xi_2 (\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \Omega} \right]$; $M = \left[\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda} \right]$; $N = \left[\eta_2 \frac{\partial g}{\partial \Omega} - 1 \right]$

Rewriting equations (5.16) & (5.17) in matrix form we get,

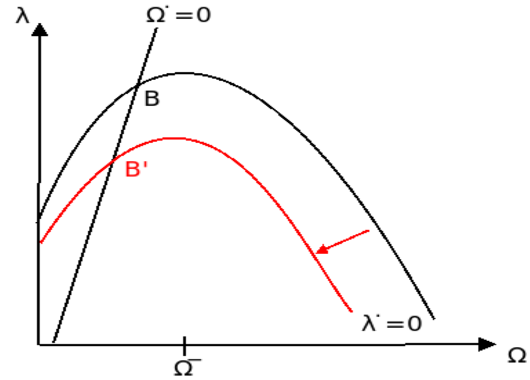
$$\begin{pmatrix} P & Q \\ M & N \end{pmatrix} \begin{pmatrix} \frac{\partial \lambda}{\partial \xi_3} \\ \frac{\partial \Omega}{\partial \xi_3} \end{pmatrix} = \begin{pmatrix} \pi \\ 0 \end{pmatrix} \tag{5.18}$$

$$\text{So,} \ \frac{\partial \lambda}{\partial \xi_3} = \frac{\pi N}{(NP - MQ)} \tag{5.19}$$

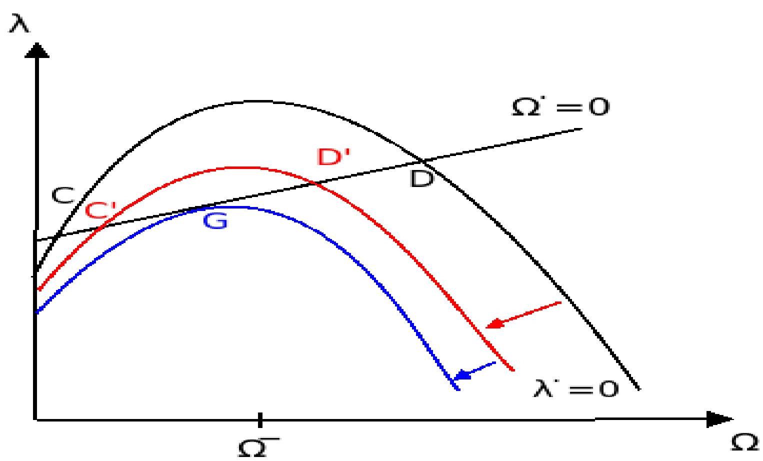
$$\text{and} \ \frac{\partial \Omega}{\partial \xi_3} = \frac{-\pi M}{(NP - MQ)} \tag{5.20}$$



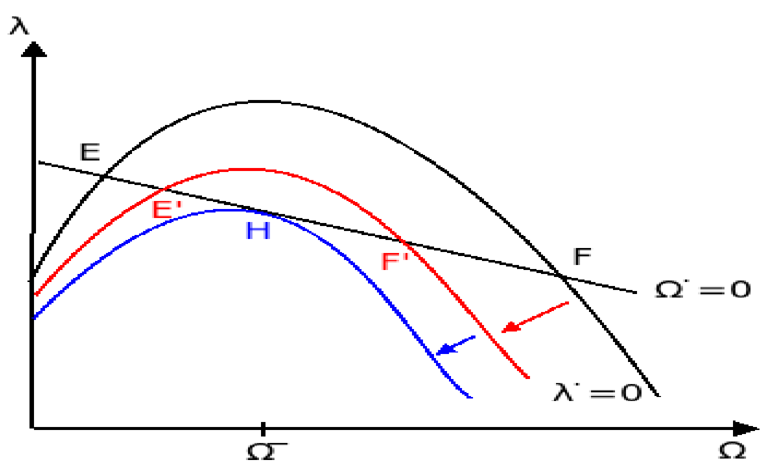
(a) *Case 1.1:* a rise in ξ_3 (when the economy starts from point A where $\Omega > \bar{\Omega}$)



(b) *Case 1.1:* a rise in ξ_3 (when the economy starts from point B where $\Omega < \bar{\Omega}$)



(c) *Case 1.3:* a rise in ξ_3



(d) *Case 3.3:* a rise in ξ_3

Figure 5.2: Effect of a change in ξ_3

The vertical intercept of the $\dot{\lambda} = 0$ curve is $\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0} = \xi_0 + \xi_1 g(0) - \xi_3\pi(0)$. So partially differentiating it with respect to ξ_3 yields $\frac{\partial\left(\lambda\Big|_{\dot{\lambda}=0}^{\Omega=0}\right)}{\partial\xi_3} = -\pi(0) < 0$. Slope of the $\dot{\lambda} = 0$ isocline is $\frac{d\lambda}{d\Omega}\Big|_{\dot{\lambda}=0} = \frac{\xi_1\frac{\partial g}{\partial\Omega}+\xi_2(\zeta-2\Omega)-\xi_3\frac{\partial\pi}{\partial\Omega}}{1-\xi_1\frac{\partial g}{\partial\lambda}+\xi_3\frac{\partial\pi}{\partial\lambda}}$ and so the slope becomes flatter for all $\Omega < \bar{\Omega}$ and steeper for all $\Omega > \bar{\Omega}$ when there is a rise in ξ_3. So due to a rise in ξ_3, the $\dot{\lambda} = 0$ isocline shifts to the downward direction (see Figure 5.2). Note that the comparative static results for a change in ξ_3 is qualitatively exactly opposite to that of a change in ξ_0 or ξ_1 and so we are not discussing it further. From Figure 5.2 we can infer the following propositions.

Proposition 16. *Suppose the economy is in the stable steady state D of case 1.3. Then a fall in ξ_3 leads to an increase in both $\Omega^\star$ and $\lambda^\star$. On the other hand, a rise in ξ_3 leads to a decrease in both $\Omega^\star$ and $\lambda^\star$ and for a sufficient rise in ξ_3 the economy moves from a stable steady state to a situation in which no stable steady state exists.*

Proposition 17. *Suppose the economy is in the stable steady state F of case 3.3. Then a fall in ξ_3 leads to a rise in $\Omega^\star$ and a fall in $\lambda^\star$. On the other hand, a rise in ξ_3 leads to a fall in $\Omega^\star$ and a rise in $\lambda^\star$ and for a sufficient rise in ξ_3, there does not exist any stable steady in the economy.*

5.4 *Effect of a change in* η_0

Setting equations (3.2) and (3.10) to zero and differentiating partially w.r.t. η_0 we get,

$$P\frac{\partial\lambda}{\partial\eta_0} + Q\frac{\partial\Omega}{\partial\eta_0} = 0 \tag{5.21}$$

$$M\frac{\partial\lambda}{\partial\eta_0} + N\frac{\partial\Omega}{\partial\eta_0} = 1 \tag{5.22}$$

where $P = \left(\xi_1\frac{\partial g}{\partial\lambda} - \xi_3\frac{\partial\pi}{\partial\lambda} - 1\right)$; $Q = \left[\xi_1\frac{\partial g}{\partial\Omega} + \xi_2(\zeta - 2\Omega) - \xi_3\frac{\partial\pi}{\partial\Omega}\right]$; $M = \left[\eta_1 + \eta_2\frac{\partial g}{\partial\lambda}\right]$; $N = \left[\eta_2\frac{\partial g}{\partial\Omega} - 1\right]$

Rewriting equations (5.21) & (5.22) in matrix form we get,

$$\begin{pmatrix} P & Q \\ M & N \end{pmatrix}\begin{pmatrix} \frac{\partial\lambda}{\partial\eta_0} \\ \frac{\partial\Omega}{\partial\eta_0} \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} \tag{5.23}$$

$$\text{So, } \frac{\partial \lambda}{\partial \eta_0} = \frac{-Q}{(NP - MQ)} \tag{5.24}$$

$$\text{and } \frac{\partial \Omega}{\partial \eta_0} = \frac{P}{(NP - MQ)} \tag{5.25}$$

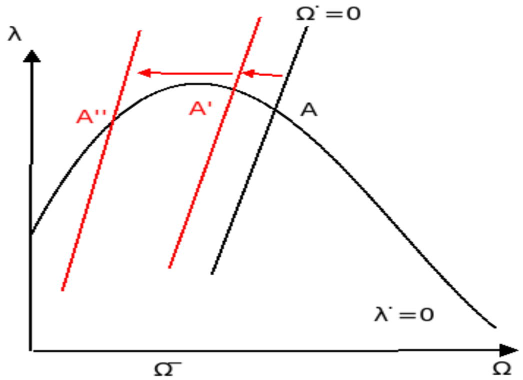
Case 1.1:

Consider point A**:** Here $P < 0$, $Q < 0$, $M > 0$, $N < 0$. So from equation (5.24) we get $\frac{\partial \lambda}{\partial \eta_0} = \frac{-Q}{(NP-MQ)} > 0$ and from equation (5.25) we can say $\frac{\partial \Omega}{\partial \eta_0} = \frac{P}{(NP-MQ)} < 0$. Thus as η_0 increases, the equilibrium value $\lambda^\star$ rises while the equilibrium value $\Omega^\star$ falls. For a decrease in η_0 exactly opposite happens. When $\frac{\partial g^\star}{\partial \lambda} > 0$, the impact of a rise in η_0 on the equilibrium rate of capital accumulation is, however, unambiguously positive which is encapsulated in equation (5.26). Nonetheless, when $\frac{\partial g^\star}{\partial \lambda} < 0$, a rise in η_0 has an ambiguous effect on long run $g^\star$.

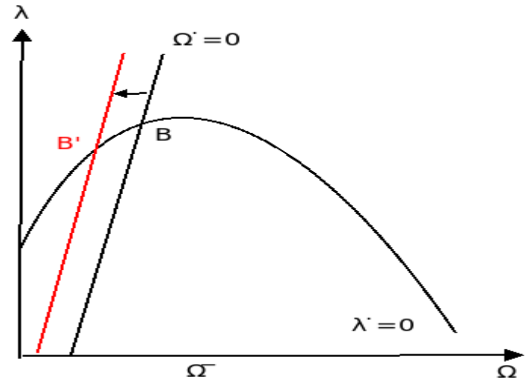
$$\frac{dg^\star}{d\eta_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_0}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{-} \overbrace{\frac{\partial \Omega}{\partial \eta_0}}^{-} \right\} > 0 \tag{5.26}$$

The above analysis can be represented through a diagram as well (See Figure 5.3(a)). The vertical intercept of the $\dot{\Omega} = 0$ curve is $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1}$. So partially differentiating it with respect to η_0 yields $\frac{\partial\left(\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0}\right)}{\partial \eta_0} = \frac{1}{\eta_1} > 0$. The horizontal intercept for the $\dot{\Omega} = 0$ isocline is $\Omega\Big|_{\dot{\Omega}=0}^{\lambda=0} = \eta_2 g(0) - \eta_0$. So partially differentiating it with respect to η_0 yields $\frac{\partial\left(\Omega\Big|_{\dot{\Omega}=0}^{\lambda=0}\right)}{\partial \eta_0} = -1 < 0$. Slope of the $\dot{\Omega} = 0$ isocline is $\frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0} = \frac{1 - \eta_2 \frac{\partial g}{\partial \Omega}}{\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}}$ and so the slope is invariant with respect to the change in η_0. Thus when η_0 rises, the vertical intercept increases and the horizontal intercept decreases.

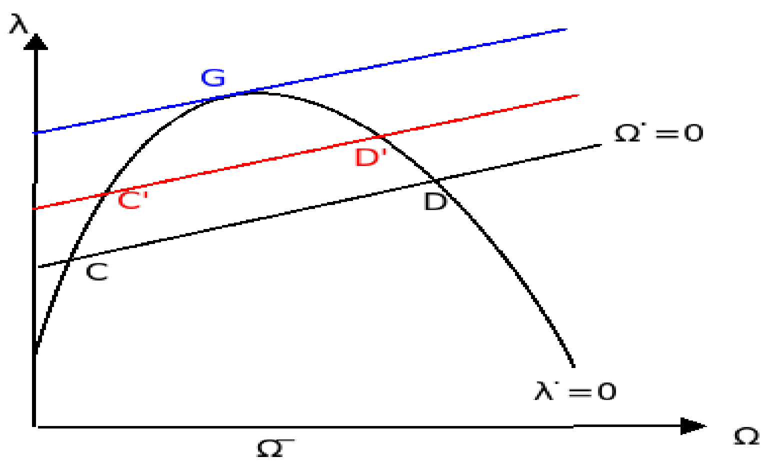
Note that, for a rise in η_0, steady state shifts from A to A' and so $\lambda^\star$ rises and $\Omega^\star$ falls. If η_0 rises further, A'' emerges as a new steady state where $\lambda^\star$ and $\Omega^\star$ both fall. The reason is as follows. As η_0 rises, the desired level of financialization of firms falls and so $\dot{\Omega} < 0$ i.e. the actual level of financialization itself falls. On the other hand, as $\frac{\partial g}{\partial \Omega} < 0$ (here) and as $\frac{\partial \pi}{\partial \Omega} > 0$, as long as $\Omega > \bar{\Omega}$, this fall in Ω increases the desired rate of technological change (λ^d) and as a result the



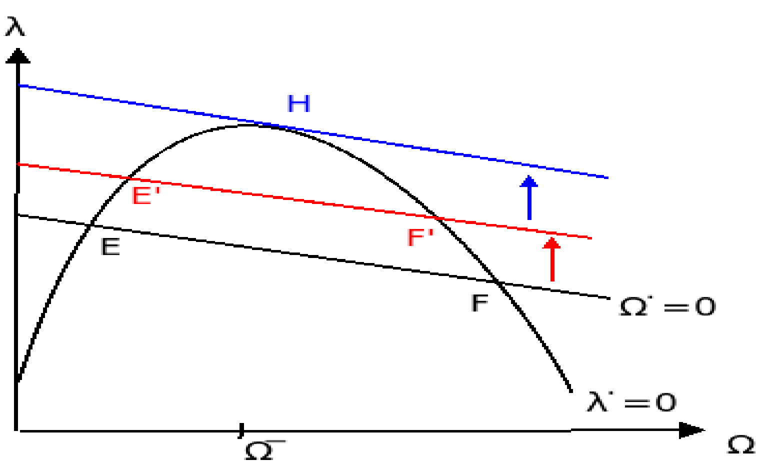
(a) *Case 1.1:* a rise in η_0 (when the economy starts from point A where $\Omega > \bar{\Omega}$)



(b) *Case 1.1:* a rise in η_0 (when the economy starts from point B where $\Omega < \bar{\Omega}$)



(c) *Case 1.3:* a rise in η_0



(d) *Case 3.3:* a rise in η_0

Figure 5.3: Effect of a change in η_0

actual rate of technological change improves (i.e. λ rises or $\dot{\lambda} > 0$). On the contrary, if $\Omega < \bar{\Omega}$, this fall in Ω then decreases the desired rate of technological change (λ^d) and as a result the actual rate of technological change deteriorates (i.e. λ falls or $\dot{\lambda} < 0$).

As η_0 rises, *ceteris paribus*, Ω^d falls and it pushes the $\dot{\Omega} = 0$ isocline leftwards. For a given λ, at the old steady state A, Ω is higher than required for $\dot{\Omega} = 0$ to be satisfied. This higher level of Ω puts pressure on the financialization level through equation (3.14) (as $\frac{\partial g}{\partial \Omega} < 0$, $J_{22} < 0$ here). As a result, Ω starts falling. As soon as Ω falls, $\dot{\lambda} = 0$ no more holds. Given the level of λ, Ω is now lower than required for $\dot{\lambda} = 0$ to be satisfied. As $\Omega > \bar{\Omega}$ near A, $J_{12} = \frac{\partial \dot{\lambda}}{\partial \Omega} < 0$ and therefore λ must rise. Combination of higher λ and lower Ω ultimately ensure to achieve the new equilibrium point A' either monotonically or spiraling around A'. Therefore at the new steady state A', $\lambda^\star$ rises but $\Omega^\star$ falls. However, if η_0 rises by a sufficiently large amount, Ω falls significantly making $\Omega < \bar{\Omega}$. As a result, $J_{12} = \frac{\partial \dot{\lambda}}{\partial \Omega}$ becomes positive and therefore λ starts falling. If the rise in η_0 is significantly high, an initial rise in λ can be overcompensated by a fall in λ. Consequently, A'' emerges as a new steady state where $\lambda^\star$ and $\Omega^\star$ both fall.

Consider point B**:** Here $P < 0$, $Q > 0$, $M > 0$, $N < 0$. So from equation (5.24) we get $\frac{\partial \lambda}{\partial \eta_0} = \frac{-Q}{(NP-MQ)} < 0$ and from equation (5.25) we can say $\frac{\partial \Omega}{\partial \eta_0} = \frac{P}{(NP-MQ)} < 0$. Thus as η_0 decreases, the equilibrium values $\lambda^\star$ and $\Omega^\star$ both rise and when η_0 increases, both equilibrium values $\lambda^\star$ and $\Omega^\star$ fall. See Figure 5.3(b) for the diagram. The impact of a rise in η_0 on the equilibrium rate of capital accumulation under the profit-led or a weak wage-led growth regime is ambiguous which can be represented by the following equation as

$$\frac{dg^\star}{d\eta_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_0}}^{-} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{-} \overbrace{\frac{\partial \Omega}{\partial \eta_0}}^{-} \right\} \gtreqless 0 \tag{5.27}$$

Nonetheless, under a strong wage-led growth regime (which is so strong that $\frac{\partial g^\star}{\partial \lambda} < 0$) a rise in η_0 has a positive effect on the long run equilibrium rate of capital accumulation.

Case 1.3:

Consider point D**:** Here $P < 0$, $Q < 0$, $M > 0$, $N < 0$. So from equation (5.24) we get $\frac{\partial \lambda}{\partial \eta_0} = \frac{-Q}{(NP-MQ)} > 0$ and from equation (5.25) we can say $\frac{\partial \Omega}{\partial \eta_0} = \frac{P}{(NP-MQ)} < 0$. Thus as η_0 increases, the equilibrium value $\lambda^\star$ rises and $\Omega^\star$ falls and when η_0 decreases, the equilibrium value $\lambda^\star$ decreases and $\Omega^\star$ rises. The effect of a rise in η_0 on the equilibrium rate of capital accumulation is the same as at point A of *case 1.1.*

Note that if η_0 increases the two equilibria C and D come closer and for a sufficient fall in η_0, both the equilibria converge to a single saddle-node equilibrium G (see Figure 5.3(c)).

Summary of the above analysis of *case 1.3* yields the following proposition.

Proposition 18. *Suppose the economy is in the stable steady state D of case 1.3. Then a rise in η_0 leads to a rise in $\lambda^\star$ and a fall in $\Omega^\star$ and for a sufficient rise in η_0, there exists no stable steady state in the economy.*

Case 2.1:

Here $\frac{1}{\eta_2} > \frac{\partial g^\star}{\partial \Omega} > 0$. The analysis here is similar to that in *case 1.1.* However, when $\frac{\partial g^\star}{\partial \lambda} > 0$, a rise in η_0 has an ambiguous effect on the equilibrium rate of capital accumulation for point A which is shown in by the following equation as

$$\frac{dg^\star}{d\eta_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_0}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \eta_0}}^{-} \right\} \gtreqless 0 \tag{5.28}$$

On the contrary, when $\frac{\partial g^\star}{\partial \lambda} < 0$, the effect of a rise in η_0 on the long run equilibrium rate of capital accumulation is unambiguously negative.

On the other hand, for point B, when $\frac{\partial g^\star}{\partial \lambda} > 0$, a rise in η_0 has an unambiguously negative effect on the equilibrium rate of capital accumulation (see equation 5.29) while in a strong wage-led growth regime η_0 has an ambiguous effect on the long run $g^\star$.

$$\frac{dg^\star}{d\eta_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_0}}^{-} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \eta_0}}^{-} \right\} < 0 \tag{5.29}$$

The same is true for *case 2.2* as well.

Case 2.3:

The analysis is same as *case 1.3* except that at point D, when $\frac{\partial g^\star}{\partial \lambda} > 0$, the impact of a rise in η_0 on the equilibrium rate of capital accumulation is ambiguous, while in the strong wage-led growth regime, the impact of a rise in η_0 on the equilibrium rate of capital accumulation is unambiguously negative.

Case 3.2/3.3:

Consider point F: Here $P < 0$, $Q < 0$, $M > 0$, $N > 0$. So from equation (5.21) we get $\frac{\partial \lambda}{\partial \eta_0} = \frac{-Q}{(NP-MQ)} > 0$ and from equation (5.25) we can say $\frac{\partial \Omega}{\partial \eta_0} = \frac{P}{(NP-MQ)} < 0$. Thus as η_0 increases, the equilibrium value $\lambda^\star$ rises and $\Omega^\star$ falls and when η_0 decreases, the equilibrium value $\lambda^\star$ reduces and $\Omega^\star$ rises. Here, under the profit-led or a weak wage-led growth regime the impact of a rise in η_0 on the equilibrium rate of capital accumulation is ambiguous and demonstrated by

$$\frac{dg^\star}{d\eta_0} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_0}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \eta_0}}^{-} \right\} \gtreqless 0. \tag{5.30}$$

However, under the strong wage-led growth regime there is a negative effect of a rise in η_0 on the long run equilibrium rate of capital accumulation.

As illustrated in Figure 5.3(d), a rise in η_0 leads the equilibria E and F to come closer and for a sufficient rise in η_0, both the equilibria converge to a single saddle-node equilibrium H. Thus, when the economy is either in *case 1.3* or in *case 2.3* or in *case 3.3,* a low level of η_0 is desirable to preserve stability in the economy.

5.5 *Effect of a change in* η_1

Setting equations (3.2) and (3.10) to zero and differentiating partially w.r.t. η_1 we get,

$$P\frac{\partial \lambda}{\partial \eta_1} + Q\frac{\partial \Omega}{\partial \eta_1} = 0 \tag{5.31}$$

$$M\frac{\partial\lambda}{\partial\eta_1} + N\frac{\partial\Omega}{\partial\eta_1} = -\lambda \tag{5.32}$$

where $P = \left(\xi_1\frac{\partial g}{\partial\lambda} - \xi_3\frac{\partial\pi}{\partial\lambda} - 1\right)$; $Q = \left[\xi_1\frac{\partial g}{\partial\Omega} + \xi_2(\zeta - 2\Omega) - \xi_3\frac{\partial\pi}{\partial\Omega}\right]$; $M = \left[\eta_1 + \eta_2\frac{\partial g}{\partial\lambda}\right]$; $N = \left[\eta_2\frac{\partial g}{\partial\Omega} - 1\right]$

Equations (5.31) & (5.32) can be arranged in matrix form as,

$$\begin{pmatrix} P & Q \\ M & N \end{pmatrix}\begin{pmatrix} \frac{\partial\lambda}{\partial\eta_1} \\ \frac{\partial\Omega}{\partial\eta_1} \end{pmatrix} = \begin{pmatrix} 0 \\ -\lambda \end{pmatrix} \tag{5.33}$$

$$\text{So, } \frac{\partial\lambda}{\partial\eta_1} = \frac{\lambda Q}{(NP - MQ)} \tag{5.34}$$

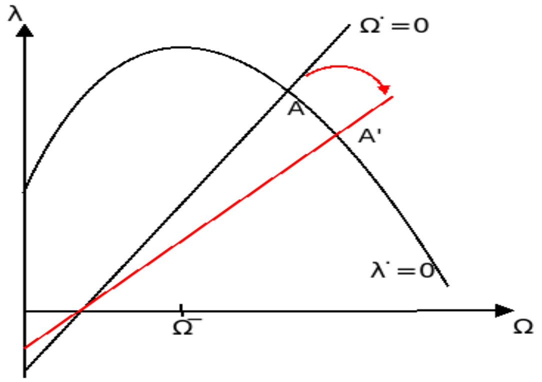
$$\text{and } \frac{\partial\Omega}{\partial\eta_1} = \frac{-\lambda P}{(NP - MQ)} \tag{5.35}$$

<u>Case 1.1:</u>

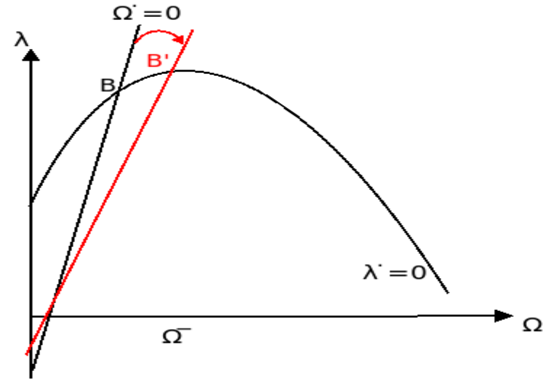
Consider point A**:** $P < 0$, $Q < 0$, $M > 0$, and $N < 0$ ensure $\frac{\partial\lambda}{\partial\eta_1} = \frac{\lambda Q}{(NP-MQ)} < 0$ and $\frac{\partial\Omega}{\partial\eta_1} = \frac{-\lambda P}{(NP-MQ)} > 0$. Thus as η_1 increases, the equilibrium value $\lambda^\star$ falls and $\Omega^\star$ rises and when η_1 decreases, the equilibrium value $\lambda^\star$ increases and $\Omega^\star$ falls. When $\frac{\partial g^\star}{\partial\lambda} > 0$, the impact of a rise in η_1 on the equilibrium rate of capital accumulation is unambiguously negative which is captured by equation (5.36). Nonetheless, when $\frac{\partial g^\star}{\partial\lambda} < 0$, a rise in η_1 has an ambiguous effect on long run $g^\star$.

$$\frac{dg^\star}{d\eta_1} = \left\{ \overbrace{\frac{\partial g^\star}{\partial\lambda}}^{+}\overbrace{\frac{\partial\lambda}{\partial\eta_1}}^{-} + \overbrace{\frac{\partial g^\star}{\partial\Omega}}^{-}\overbrace{\frac{\partial\Omega}{\partial\eta_1}}^{+} \right\} < 0 \tag{5.36}$$

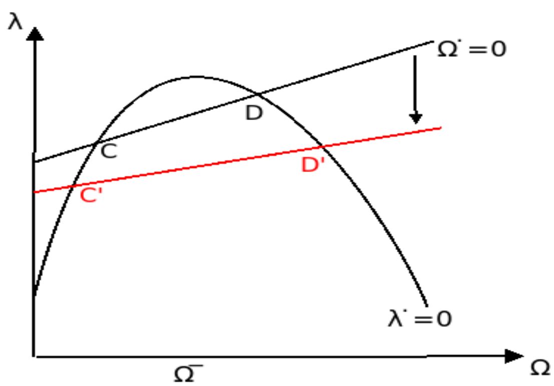
The above analysis can be represented through a diagram as well (see Figure 5.4(a)). The vertical intercept of the $\dot{\Omega} = 0$ curve is $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1}$. So partially differentiating it with respect to η_1 yields $\frac{\partial\left(\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0}\right)}{\partial\eta_1} = -\frac{\eta_0-\eta_2 g(0)}{\eta_1^2} > 0$ (as $\eta_0 - \eta_2 g(0) < 0$ here). The horizontal intercept for the $\dot{\Omega} = 0$ isocline is $\Omega\Big|_{\dot{\Omega}=0}^{\lambda=0} = \eta_2 g(0) - \eta_0$. So partially differentiating it with respect to η_1 yields $\frac{\partial\left(\Omega\Big|_{\dot{\Omega}=0}^{\lambda=0}\right)}{\partial\eta_1} = 0$. Slope of the $\dot{\Omega} = 0$ isocline is $\frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0} = \frac{1-\eta_2\frac{\partial g}{\partial\Omega}}{\eta_1+\eta_2\frac{\partial g}{\partial\lambda}}$ and so the slope



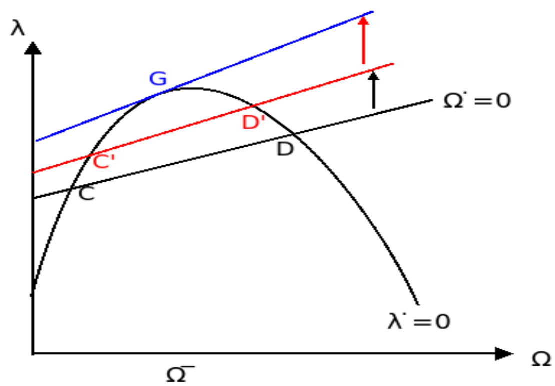
(a) *Case 1.1*: a rise in η_1 (when the economy starts from point A where $\Omega > \bar{\Omega}$)



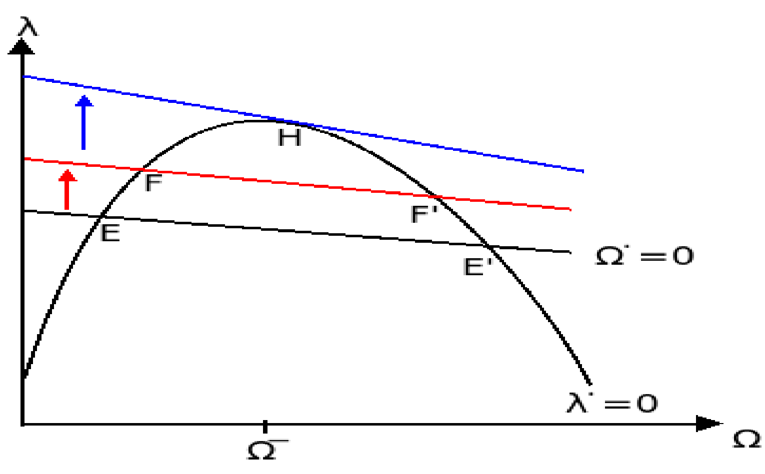
(b) *Case 1.1*: a rise in η_1 (when the economy starts from point B where $\Omega < \bar{\Omega}$)



(c) *Case 1.3*: a rise in η_1



(d) *Case 1.3*: a fall in η_1



(e) *Case 3.3*: a fall in η_1

Figure 5.4: Effect of a change in η_1

decreases with η_1. Thus when η_1 rises, the vertical intercept increases, slope decreases and at the same time the horizontal intercept remains unchanged. So due to a rise in η_1, the $\dot{\Omega} = 0$ isocline pivots around the horizontal intercept clockwise.

Consider point B**:** Here $P < 0$, $Q > 0$, $M > 0$, $N < 0$. So from equation (5.34) we get $\frac{\partial \lambda}{\partial \eta_1} = \frac{\lambda Q}{(NP - MQ)} > 0$ and from equation (5.35) we can say $\frac{\partial \Omega}{\partial \eta_1} = \frac{-\lambda P}{(NP - MQ)} > 0$.

Thus as η_1 increases, both the equilibrium values $\lambda^\star$ and $\Omega^\star$ rise and when η_1 decreases, both the equilibrium values $\lambda^\star$ and $\Omega^\star$ fall. See Figure 5.4(b) for the diagram. The impact of a rise in η_1 on the equilibrium rate of capital accumulation under the profit-led or a weak wage-led growth regime is ambiguous which follows from

$$\frac{dg^\star}{d\eta_1} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_1}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{-} \overbrace{\frac{\partial \Omega}{\partial \eta_1}}^{+} \right\} \gtreqless 0. \tag{5.37}$$

Nonetheless, under a strong wage-led growth regime a rise in η_1 has an unambiguously negative effect on the long run equilibrium rate of capital accumulation.

<u>Case 1.3:</u>

Consider point D**:** As $P < 0$, $Q < 0$, $M > 0$, $N < 0$ near steady state D, from equation (5.34) we get $\frac{\partial \lambda}{\partial \eta_1} = \frac{\lambda Q}{(NP - MQ)} < 0$ and from equation (5.35) we get $\frac{\partial \Omega}{\partial \eta_1} = \frac{-\lambda P}{(NP - MQ)} > 0$. Thus as η_1 increases, the equilibrium value $\lambda^\star$ decreases and $\Omega^\star$ rises (see Figure 5.4(c)) and when η_1 decreases, the opposite happens. A rise in η_1 on the equilibrium rate of capital accumulation has same effect as at point A of *case 1.1*.

Note that if η_1 decreases, the two equilibria C and D come closer and for a sufficient fall in η_1, both the equilibria converge to a unique saddle-node equilibrium G. See Figure 5.4(d) for the diagrammatic exposition.

Summary of the above analysis of *case 1.3* yields the following proposition.

Proposition 19. *Suppose the economy is in the stable steady state D of case 1.3. Then a fall in η_1 leads to a rise in $\lambda^\star$ and a fall in $\Omega^\star$ and for a sufficient fall in η_0, no stable steady state exists in the economy.*

Case 2.1:

Here $\frac{1}{\eta_2} > \frac{\partial g^\star}{\partial \Omega} > 0$. The analysis is similar to *case 1.1*. However, when $\frac{\partial g^\star}{\partial \lambda} > 0$, a rise in η_1 has an ambiguous effect on the equilibrium rate of capital accumulation at point A which is shown by

$$\frac{dg^\star}{d\eta_1} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_1}}^{-} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \eta_1}}^{+} \right\} \gtreqless 0 \tag{5.38}$$

However, when $\frac{\partial g^\star}{\partial \lambda} < 0$, the effect of a rise in η_1 on the long run equilibrium rate of capital accumulation is unambiguously positive.

On the other hand, at point B, when $\frac{\partial g^\star}{\partial \lambda} > 0$, a rise in η_1 has an unambiguously positive effect on the equilibrium rate of capital accumulation (which is shown by equation (5.39)) while in a strong wage-led growth regime η_1 has an ambiguous effect on the long run $g^\star$.

$$\frac{dg^\star}{d\eta_1} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_1}}^{+} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \eta_1}}^{+} \right\} > 0 \tag{5.39}$$

We get a similar kind of result for *case 2.2*.

Case 2.3:

The analysis is same as *case 1.3* except that at point D, when $\frac{\partial g^\star}{\partial \lambda} > 0$, the impact of a rise in η_1 on the equilibrium rate of capital accumulation is ambiguous, while in the strong wage-led growth regime, the impact of a rise in η_1 on the equilibrium rate of capital accumulation is unambiguously positive.

Case 3.2/3.3:

Consider point F: Here $P < 0$, $Q < 0$, $M > 0$, $N > 0$. So from equation (5.34) we get $\frac{\partial \lambda}{\partial \eta_1} = \frac{\lambda Q}{(NP - MQ)} < 0$ and from equation (5.35) we can say $\frac{\partial \Omega}{\partial \eta_1} = \frac{-\lambda P}{(NP - MQ)} > 0$. Thus as η_1 increases, the equilibrium value $\lambda^\star$ decreases and $\Omega^\star$ rises and when η_1 decreases, the opposite happens. Here, under the profit-led or a weak wage-led growth regime the impact of a rise in η_1 on the equilibrium rate of capital accumulation is ambiguous and shown by

$$\frac{dg^\star}{d\eta_1} = \left\{ \overbrace{\frac{\partial g^\star}{\partial \lambda}}^{+} \overbrace{\frac{\partial \lambda}{\partial \eta_1}}^{-} + \overbrace{\frac{\partial g^\star}{\partial \Omega}}^{+} \overbrace{\frac{\partial \Omega}{\partial \eta_1}}^{+} \right\} \gtreqless 0. \tag{5.40}$$

However, under the strong wage-led growth regime there is a positive effect of a rise in η_1 on the long run equilibrium rate of capital accumulation.

As demonstrated in Figure 5.4(e), a fall in η_1 causes the equilibria E and F to come closer and a sufficient fall in η_1 leads to the convergence of those two equilibria to the single saddle-node steady state H.

5.6 *Effect of a change in* η_2

Setting equations (3.2) and (3.10) to zero and differentiating partially w.r.t. η_2 we get,

$$P\frac{\partial \lambda}{\partial \eta_2} + Q\frac{\partial \Omega}{\partial \eta_2} = 0 \tag{5.41}$$

$$M\frac{\partial \lambda}{\partial \eta_2} + N\frac{\partial \Omega}{\partial \eta_2} = -g \tag{5.42}$$

where $P = \left(\xi_1 \frac{\partial g}{\partial \lambda} - \xi_3 \frac{\partial \pi}{\partial \lambda} - 1\right)$; $Q = \left[\xi_1 \frac{\partial g}{\partial \Omega} + \xi_2(\zeta - 2\Omega) - \xi_3 \frac{\partial \pi}{\partial \Omega}\right]$; $M = \left[\eta_1 + \eta_2 \frac{\partial g}{\partial \lambda}\right]$; $N = \left[\eta_2 \frac{\partial g}{\partial \Omega} - 1\right]$

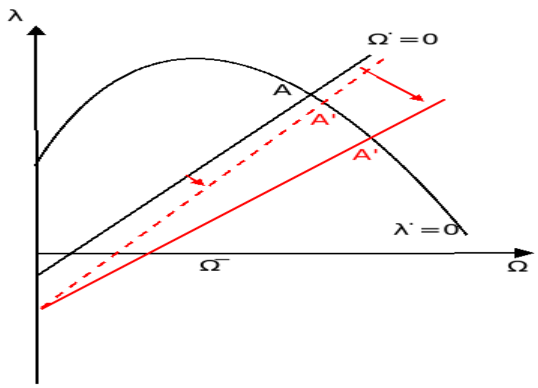
Rewriting equations (5.41) & (5.42) in matrix form we get,

$$\begin{pmatrix} P & Q \\ M & N \end{pmatrix} \begin{pmatrix} \frac{\partial \lambda}{\partial \eta_2} \\ \frac{\partial \Omega}{\partial \eta_2} \end{pmatrix} = \begin{pmatrix} 0 \\ -g \end{pmatrix} \tag{5.43}$$

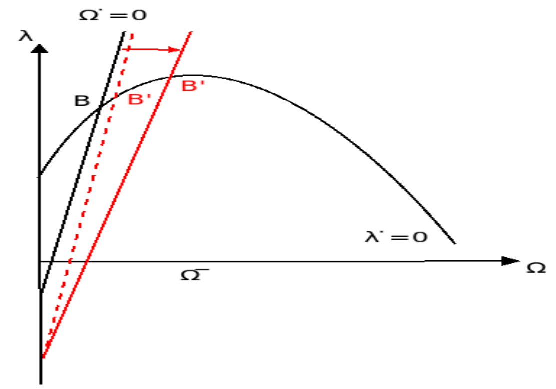
$$\text{So, } \frac{\partial \lambda}{\partial \eta_2} = \frac{gQ}{(NP - MQ)} \tag{5.44}$$

$$\text{and } \frac{\partial \Omega}{\partial \eta_2} = \frac{-gP}{(NP - MQ)} \tag{5.45}$$

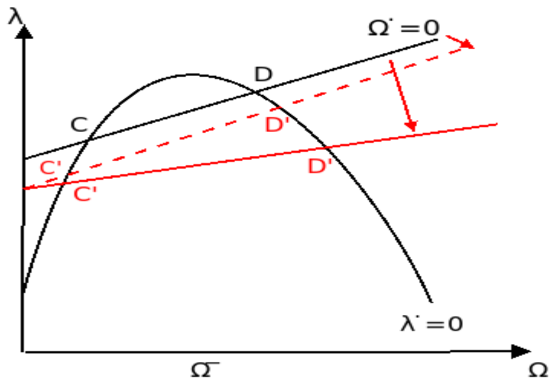
Note that the vertical intercept of the $\dot{\Omega} = 0$ curve is $\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0} = \frac{\eta_0 - \eta_2 g(0)}{\eta_1}$. So partially differentiating it with respect to η_2 yields $\frac{\partial\left(\lambda\Big|_{\dot{\Omega}=0}^{\Omega=0}\right)}{\partial \eta_2} = -\frac{g(0)}{\eta_1} < 0$. The horizontal intercept for the $\dot{\Omega} = 0$ isocline is $\Omega\Big|_{\dot{\Omega}=0}^{\lambda=0} = \eta_2 g(\lambda = 0) - \eta_0$.



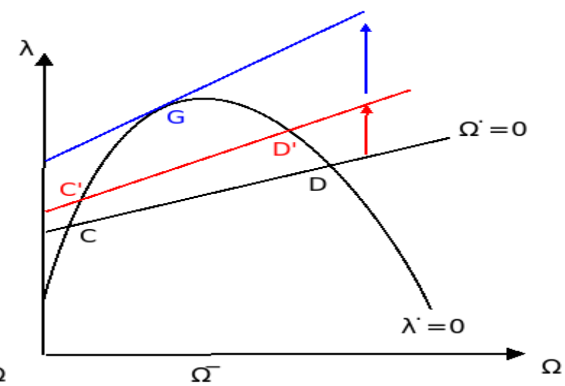
(a) *Case 1.1:* a rise in η_2 (when the economy starts from point A where $\Omega > \bar{\Omega}$)



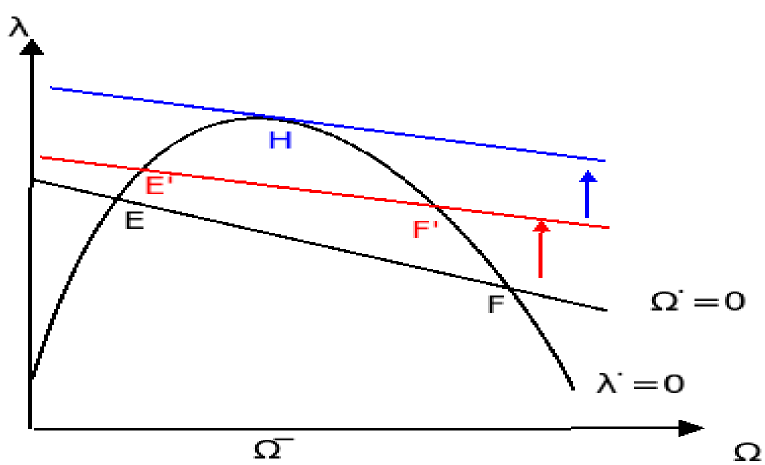
(b) *Case 1.1:* a rise in η_2 (when the economy starts from point B where $\Omega < \bar{\Omega}$)



(c) *Case 1.3:* a rise in η_2



(d) *Case 1.3:* a fall in η_2



(e) *Case 1.1:* a fall in η_2

Figure 5.5: Effect of a change in η_2

So partially differentiating it with respect to η_2 yields $\frac{\partial\left(\Omega\Big|_{\dot{\Omega}=0}^{\lambda=0}\right)}{\partial\eta_2} = g(0) > 0$. Slope of the $\dot{\Omega} = 0$ isocline is $\frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0} = \frac{1-\eta_2\frac{\partial g}{\partial\Omega}}{\eta_1+\eta_2\frac{\partial g}{\partial\lambda}}$ and so the change in slope is ambiguous with respect to the change in η_2 (as $\frac{\partial\left(\frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0}\right)}{\partial\eta_2} = \frac{-\left(\eta_1\frac{\partial g}{\partial\Omega}+\frac{\partial g}{\partial\lambda}\right)}{\left(\eta_1+\eta_2\frac{\partial g}{\partial\lambda}\right)^2} \gtrless 0$). Thus, finally we can conclude that when η_2 rises, the $\dot{\Omega} = 0$ isocline shifts toward rightward direction (although the shift may not be parallel). See Figure 5.5 for the diagram. Solid red lines show the shift in the $\dot{\Omega} = 0$ isocline when the slope of the $\dot{\Omega} = 0$ isocline decreases with η_2 (i.e. $\frac{\partial\left(\frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0}\right)}{\partial\eta_2} < 0$) and the dotted red lines show the shift in the $\dot{\Omega} = 0$ isocline when $\frac{\partial\left(\frac{d\lambda}{d\Omega}\Big|_{\dot{\Omega}=0}\right)}{\partial\eta_2}$ is positive. Note that the comparative static results for a change in η_2 is qualitatively opposite to that of a change in η_0 and similar to that of a change in η_1. So we are not discussing it further.

6 *Conclusion*

In this chapter we dealt with a post-Kaleckian growth model in which in the long run rate of technological change and the level of financialization evolve endogenously. First, we examined short-run stability and comparative statics. We observed that in the economy, both wage-led and profit-led demand regimes as well as growth regimes are possible. When the consumption propensity of the rentiers is greater than the responsiveness of investment demand to a unit change in distributed profit (which ensures a wage-led demand regime), a higher 'internal finance channel' (i.e. when $\frac{\partial r^R}{\partial\Omega}$ is sufficiently large) is sufficient to ensure an expansionary effect of financialization on aggregate demand provided that it is sufficiently strong compared to the other two channels (i.e. 'preference channel' and 'distribution channel'). Similarly, when rentiers' consumption propensity is smaller than the responsiveness of investment demand to a unit change in distributed profits, financialization has a contractionary effect on aggregate demand. These results are not explicitly mentioned in Hein (2012a). Nonetheless, one can easily derive these results from Hein (2012a) as well.

Consistent with Hein (2012a), we found that the following conditions together ensure the impact of financialization on capital accumulation to be expansionary: (*i*) a low propensity to save out of rentiers' income, (*ii*) weak effects of distributed profits (and hence, internal funds) on firms' investment decisions, (*iii*) comparatively lower importance of the 'preference channel' for firms' investment decisions relative to the 'finance channel', and (*iv*) a high responsiveness of investment to the profit share. Otherwise financialization has a contractionary effect on capital accumulation.

Unlike Hein (2012a), we found that the impact of an improvement in technological change on aggregate demand and on the equilibrium rate of capital accumulation is ambiguous and depends on the particular regime the economy is in.

The main departure of our analysis from the earlier literature, however, lies in the long run, where along with the rate of technological change, we endogenize the financialization level. In the long run, we found richer dynamics than Hein (2012a). Unlike Hein (2012a) (where the equilibrium is unique), in our work we found that multiple equilibria may arise. Because of the incorporation of the financialization dynamics, unlike Hein (2012a), we also found that the interaction between technological change and financialization dynamics can lead to instability in the economy.

We found a few other interesting results as well. First, for a fixed level of financialization, the steady state rate of technological change is stable. On the other hand, in the absence of technological change (or for a fixed value of the rate of technological change), a contractionary effect of financialization on aggregate demand implies a stable steady state level of financialization. However in case of an expansionary effect of financialization on aggregate demand, an unstable equilibrium level of financialization is possible.

Second, for a sufficiently high and expansionary effect of financialization on the equilibrium rate of capital accumulation, under certain conditions, when the speed of adjustment parameter related to technological change is critically low (because of stringent intellectual property rights and so on), the economy loses its stability and gives birth to a limit cycle. So, for ensuring stability in the economy, government (or institutional) intervention for weakening stringent intellectual property rights are desirable. Similarly, under certain conditions, when the speed of of adjustment parameter related to the dynamics of financialization is very high the economy can lose its stability and a limit cycle can emerge. This suggests that more regulated financial markets are desirable for ensuring stability in the economy .

Third, irrespective of whether financialization has a contractionary or an expansionary effect on the equilibrium rate of capital accumulation, the effect of a rise in ξ_0 on the equilibrium level of financialization is always positive. However, when financialization has a strong expansionary effect on the equilibrium rate of capital accumulation (i.e. in *case 3*), a rise in ξ_0 leads to a fall in $\lambda^\star$. A similar kind of result is observed for a change in ξ_1.

Fourth, when the economy is either in *case 1.3* or in *case 2.3* or *in case 3.3*, in the period of stagnation, a decent degree of intra-class conflict among firms (or a decent level of ξ_0) is desirable as it preserves macroeconomic stability. On the contrary, a sufficiently low level of ξ_0 causes instability in the economy.

The analysis in this chapter, however, has limitations. Our model is based on closed economy without a role for government intervention. Open market consideration at the one hand, opens the possibility of imitating foreign technologies. Level of financialization also get enriched on the other hand. Active government intervention through various fiscal and monetary policies also influences the product market, financial market and rate of technological change. This issue is, however, left for future research.

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