

The Dynamic of Business Cycle in Kalecki's Theory: Duality in the Nature of Investment

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Abstract

Periodic crises have been the iconic feature of the capitalist economy since the 19th century. Although periodic crises do not appear as predictable mechanical oscillations, the term “business cycle” has been used to refer to the iterative (and sometimes extreme) fluctuations in the level of output, investment and employment. Various explanations and theories have been given in terms of the origin of the cycles.

There are many reasons (some of them ideological) why different schools of thought have not been able to compromise on the immediate cause(s) of the cycles but beyond all ratiocinations some people tried to find the resemblance between them and put it in a dynamic model. Michal Kalecki was one of them. He is one of the main contributors to the analysis of macroeconomic dynamics, in which different variables in a model are defined at different periods of time. This was in contrast to the orthodox economy of the time which used timeless static models to analyse equilibrium solution(s).

Kalecki's theory of business cycle is one of the most neglected theories, which exhibits an intrinsic dynamic instability of the capitalist economy in the long run as a result of the dual character of investment. He tried to show how the system moves towards cycle when a time lag between “investment decision” and “investment output” is introduced. There are four different versions of his theory on business cycle. In the quantitative versions (1935, 1949) he employs correlation analysis and mixed difference-differential calculus analysis and in the descriptive versions (mainly 1937) he tries to go through the short term and long term equilibrium analysis.

This paper will try to shed light on the quantitative version of his theory, which deserves a new reflection, through combination of mathematical formulation and its solution with Kalecki's intuitive interpretation of the dynamic process of the cycle in his 1937 descriptive version. Finally, we will consider the on-going relevance of Kalecki's model, examining the insight it provides into the analysis of contemporary capitalism.

1. Introduction

Between 1929 and 1931 Kalecki published three articles in the Research Institute of Business Cycle and Prices (RIBCP) in Warsaw. In those essays he followed the orthodoxy theory about the determination of investment by savings but some years later he changed his mind and argued that “investments (together with capitalist consumption) determine profits and hence also the savings that they require, and not the reverse ... from this point of view Kalecki's proposition of 1933, that ‘investment finance themselves’, separates him not only from the economic theory of the time but also from his own first theoretical studies” (editorial notes of Osiatynski, Kalecki 1990, p.424).

This turnover was a significant step into his theory of business cycles which he wrote in 1933 in Polish and then published in English in 1935. In his theory, which he assumes it is “justifiable” to start with a closed economy, there are three crucial elements: consumption, investment and profit. Consumption expenditure in the national accounts exhibits a certain stability but as Kalecki focuses on social classes rather than individuals, he differentiates between workers’ consumption (C_w) and capitalists’ consumption (C_c). The first is thought to be equal to the wage because he assumes workers “do not save” and spend what they earn but the capitalists’ consumption is thought to be that part of their profit which is not invested, that is $B = C_c + I$, where B is the profit of the capitalists, or as Kalecki says “real gross profit ... (which is) the total real income of capitalists” (Kalecki, 1935, p327) and I is the investment or “gross accumulation [which is] the sum of the production of capital goods and of the increment of stocks of all kinds.” (Kalecki, 1935, p328)¹

The reason that Kalecki brings the consumption expenditure and the differentiation between workers’ consumption and capitalists’ consumption into his analysis of the business cycle is to give an idea about his interpretation of the national income. In his intuitive article of the business cycle (published in 1937) he describes the national income as “the sum of capitalists’ and workers’ income”. He then adds “it is easy to see that the national income is equal to the sum of the value of the output of all enterprises minus the value of the output of raw materials. But, hence, it follows that the national income is equal to the value of consumption, purchases of fixed capital equipment, and increase of stocks”. (Kalecki, 1937, p77)

In his analysis of the national income he does not include the trade and the government sectors; not just for the sake of simplicity but he believes that the investment process in the capitalist system is inherently causing the business cycles and this is not associated to any policy chosen by a government to reach full employment before an election, which is called “political or politically-based business cycle” and is wrongly attributed to Kalecki.

In fact, what Kalecki says in his mid-1940s works, is about the role and the knowledge of government in stimulating the economic activities to reach to the level of full employment at the cost of budget deficit but he also believes that capitalist system needs unemployed ‘working class’ people because without that “the system would exasperate the underlying social and political tensions resulting in problems of discipline and instability” (Kriesler and Harcourt, 2010, p17), due to the growing of “self-assurance and class-consciousness”². Knowing these facts, governments play a political game with the issue of unemployment before the election to increase the chance of being re-elected. “Joan Robinson reinterpreted Kalecki’s analysis as providing the basis of a model of the political business cycle” (Kriesler and Harcourt, 2010, p17) but the fact is that his theory of business cycle is purely related to the process of investment, which is an interaction between investment (including investment

¹ His notation for investment in his 1935 article was A which changed to I in 1937.

² In fact, Kalecki’s observations about capitalist economy made him to believe that “the reserve of capital equipment and the reserve army of unemployed are typical features of capitalist economy, at least throughout a considerable part of the cycle.” (Kalecki, *Collected Works* vol. 2, hereafter CWII, p.311)

orders, production of capital goods and deliveries of them), profit and stock of capital equipment.³

2. Short-period Equilibrium and the Dynamic Process

In an attempt to analyse the investment process in a capitalist economy, Kalecki's 1937 article introduces two concepts:

A) '*Short-period Equilibrium*', in which he follows a basic profit maximization rule for every enterprise with a given capital equipment to find the level of output and employment⁴. He then explains how the level of spending by capitalists for consumption and investment determines the short-period equilibrium; where the amount of their spending $C_c + I$ determines the level of their income $C_c + S$ and eventually the equality between them $I = S$ (with a causality direction from I to S) can be interpreted as "the investment of some capitalists create a saved income of an equal amount for others". (Kalecki, 1937, p79)

He argues that in the short-period with a given capital equipment the amount of investment is the only indeterminate factor which "determines ... almost entirely the short-period equilibrium". (Kalecki, 1937, p80)

B) '*Dynamic Process as a Chain of Short-period Equilibria*', in which he intellectually introduces a time-lag between investment decisions (investment orders) and investment output (finished form of the orders). He calls this time-lag as "gestation period", which is "the average time required for the completion of investment decisions". (Kalecki, 1937, p 81)

Kalecki's initiation of introducing this new concept made a significant difference between his and Keynes work on the investment process. Keynes perception of investment is timeless and consequently static as he does not differentiate between investment orders and investment production but the gestation period in Kalecki's model exhibits the investment as a dynamic process.

In the short-period, Kalecki takes the rate of investment as given but in a dynamic process he believes there is a bi-direction relationship between investment and profit and "the rate of investment is proportionate to the value of the stock of uncompleted orders" (Kalecki, 1937, p82). In fact, in his formulation the amount of real gross profit B depends mostly on investment but on the other hand, "prospective rate of profit", which can be estimated through the "gross profitability of existing plants" (B/K), changes the decision of capitalists to invest. Therefore, the rate of investment is not constant and varies with the expected rate of profit.

³ In his 1937 article, he explicitly says: "in the last section I show that the investment processes necessarily create a business cycle". (Kalecki, p77)

⁴ According to the profit maximisations rule each enterprise employs workers up to the point that its marginal revenue is equal to the marginal cost. Kalecki subtracts the price of raw materials from the price of output and the cost of production to obtain 'value added' and 'labour' costs respectively. So, an enterprise produces at the point where its marginal value added is equal to its marginal labour cost.

3. What does induce the capitalists to invest?

Without any idea about the determination of the investment decision, the business cycle theory cannot be understood. Kalecki himself believes that “there is continues search for new solutions in the theory of investment decisions”. (Kalecki, 1971, p viii)

In his 1937 paper he criticized Keynes for his idea about the determination of the rate of current investment by the gap between the marginal efficiency of various assets and the interest rate. Keynes believed that “it is obvious that the actual rate of current investment will be pushed to the point where there is no longer any class of capital of which the marginal efficiency exceeds the current rate of interest” (quoted by Kalecki 1937 from the General Theory). In other word, “the investment [...] will rise until the increase of the prices of investment goods, [...] reduce the marginal efficiency of all assets to the level of the rate of interest”. (Kalecki, 1937, p 84)

But according to Kalecki, Keynes’s conception has two problems; first it does not show the change in the rate of investment decisions when entrepreneurs are faced with a given prices of investment goods. It merely shows how “disequilibrium changes into equilibrium”; secondly, is there any change in the rate of investment after reaching to the equilibrium? In fact, he believes that the increase of investment does not increase only the price of capital goods but all prices, which shifts up the marginal revenue of all enterprises and motivate them to employ more workers and this, in turn, will improve the entrepreneurs’ expectations about the state of the economy which leads to a new gap between the marginal efficiency of assets and the interest rate and this means that “equilibrium is not reached and the investment continuous to rise.... [so] the rise of investment does not lead to equilibrium at all ... [at least] not to immediate equilibrium” (Ibid, p 84)

But what Kalecki proposed instead was a combination and an interaction between different elements, such as profit, capital stock, income and the growth rate of income. In fact, he developed different versions of the theory of investment decisions. In his article in The Review of Economic Studies (1949-1950) he acknowledges that “the most controversial of the assumptions underlying [business cycle] models are those concerning the determinants of investment decisions. The rate of investment decisions is assumed in some theories to be determined by the rate of change in income (or output) and in some by the level of income. Indeed the problem of determinants of investment belongs probably to the least explored subjects of modern economics”. (Kalecki, 1949-50, p 57)

In this article Kalecki makes no assumption about the determinants of investment decisions but he assumes there is an interrelation between investment and income, based on the relation between income and saving and the equality of saving and investment in a closed economy. He then applies a “correlation analysis”, which leads him to the conclusion that “no business cycle theory should neglect, provided our assumptions correct, the level of income as a determinant of the rate of investment decisions. On this basis any theory of business cycle based on the pure acceleration principle, which makes investment decisions dependent on the rate of change in income only should be rejected ... better approximation is obtained if

investment decisions are considered an increasing function, both of the level and of the rate of change in income, than of the level of income only. (ibid, p 61)

His final equation for the investment decision in that article is as following:

$$D_t = \alpha S_t + \beta Y'_t - \gamma K'_t \quad (A)$$

Where D_t , S_t , Y'_t and K'_t are respectively, investment decision, saving, rate of change of income (or output) and the change in the volume of capital stock all per unit of time.

This is not the only version of Kalecki's investment decision theory. "Steindl (1981) identifies three different versions of the theory of investment in Kalecki's writings. The analytical core is made up two key variables: profits and the capital stock", (Trigg, p 94). But, indeed, what Kalecki said about "two determinants of the business decisions" in his 1935 and 1937 articles was that "the rate of investment decisions is an increasing function of the difference between the prospective rate of profit and the rate of interest" (Kalecki, 1937, p 86), that is:

$$D = \varphi \left(\frac{B}{K} - r \right) \quad \varphi'_{B/K} > 0, \varphi'_r < 0 \quad (B)$$

Where, $\frac{B}{K}$ as mentioned before, is the gross profitability of existing plants, by which the prospective rate of profit is calculated and r represents the interest rate. "However, such variables, in Kalecki's opinion, do not influence the absolute level of investment but rather its level relative to the capital stock that is the ratio $\frac{D}{K}$. In fact, when B and K increase in the same proportion, so that the ratio $\frac{B}{K}$ remains unchanged, D probably rises", (Gandolfo, 1996, p559). Thus we have:

$$\frac{D}{K} = f \left(\frac{B}{K} - r \right) \quad (C)$$

This version is quite different to the Steindl's interpretation because from Kalecki's point of view the prospective rate of profit is nothing but another name for the "prospective current return of assets", which is also a measure for the marginal efficiency of assets and it is affected by the present economic situation and the entrepreneur's expectation about that.

After this formulation, Kalecki goes further and explains that the determinants of the prospective rate of profits are the long-term expectations of returns and the prices of investment goods. But, these expectations depend on the present "state of affairs"; therefore, it is the short-period equilibrium again, which determines the prospective rate of profits. Bear in mind he already stated that, with a given capital equipment, the short-period equilibrium is a function of the investment I .

On the other hand, he asserts that under certain assumptions “the rate of interest can also be represented as a function of investment”, (Kalecki, 1937, p 86). His reasoning in this case shows that he had a clear idea (or perhaps theory) about the demand and supply for money; something very similar to the Keynes’s theory of liquidity preference; but Kalecki had reached to this idea in his 1933 article before Keynes.

In his 1937 article he argues that why interest rate (r) should be a positive and then negative and finally again positive function of the investment (I), which is in contrary to what is being taught in macroeconomics textbooks.

He explains that “the rise of I causes a rise of Y [income], while the increased employment pushes nominal wages to a higher level. The greater the money income [nominal income] Y the greater is the demand for cash for transactions, which, with a constant amount of money in circulation, must cause the rate of interest to increase. ... however, the investment I ... determines (with a given capital equipment) the short-period equilibrium and thus the general state of affairs. But the better this state of affairs the greater is the lender’s confidence and therefore, through this channel the rise of investment has a tendency to lower the rate of interest ... but after passing a minimum the rate will begin to rise when investment further increases.

At a low level of investment I , and thus of income Y , the elasticity of supply of money is high, while an improvement in business much affects the lender’s confidence, and thus the rate of interest is likely to fall with the rise of investment. But at a high level of investment and income, as the supply of money has become more inelastic and the lender’s confidence is less sensible to a further rise in business activity, the increase of investment will rather cause the rate of interest to rise”. (Kalecki, 1937, p 87)⁵

So, according to what Kalecki says in his 1933 and 1937 articles, two determinants of the investment decisions (the prospective rate of profit and the interest rate) are both function of the investment. That is:

$$D = \emptyset(I) \quad (D)$$

So, investment again is the main determinant of the investment decision in the long period, but its effect comes through a dynamic process.

Kalecki uses the linear form of this model to explain the long-term business cycles, which will be explained in the next section.

⁵ This is the essence of what Minsky says later in 1992 in his paper: “The financial instability hypothesis”. He believes the level of profit is the key determinant of the system behaviour. Banks (or any intermediaries) look for profitable business activities to finance them. Expectation of profits depends on future investment and realized profits are determined by previous investment. In this case, validation of liabilities depends on investment. Minsky believes that after a long period of economic growth, financial fragility is inevitable as the economy transits from the financial relations that contribute to the stable system to those that push the system to unstable situation He also believes as the expansion develops, optimism increases, and conventions about the proper level of debt and risk begin to change. For more information see his paper or Wolfson, Martin H, 2002, “*Minsky's theory of financial crises in a global context*”, journal of Economic Issue, electronic page.

4. The Model and its Solution⁶

As mentioned earlier Kalecki model starts with some assumptions; some of them for simplification and some others for the way he looks at the problem. According to his 1935 paper these assumptions are as following:

- a. The economic system is closed with no government involvement.
- b. The economic system is free of a secular trend, which means the system has a periodic behaviour.
- c. Workers do not save and they spend all their income. As a result, the real gross profit of capitalists is their real income, which consists of two parts; capitalist consumption expenditure (C_c) and investment (I), so

$$B = C_c + I \quad (1)$$

There is another way to obtain the above identity. According to Kalecki's argument the national income consists of profits of entrepreneurs and wages of workers. If we denote them respectively by Y, B and W , then

$$Y = B + W \quad (2)$$

and on the other hand national income can be written as

$$Y = C_c + C_w + I \quad (3)$$

where C_c and C_w are the consumption expenditure of capitalists and workers respectively. As Kalecki assumes workers spend all their earnings, ($W = C_w$), so comparing (2) and (3) leads us exactly to (1).

- d. Personal consumption of capitalists is not very elastic and it is linear and proportionate to their income (real gross profit). This linear relationship can be shown as

$$C_c = C_1 + \delta B \quad (4)$$

Comparing (1) and (4) we get:

$$B = \frac{C_1 + I}{1 - \delta} \quad (5)$$

⁶ The modelling and the solution in this part of the article are inspired from different sources, mostly from Kalecki's articles and "Economic Dynamics" by Giancarlo Gandolfo. But, at the end I have not followed Kalecki's solution and instead, a new method of solution is introduced.

In the equation (5) the profit of capitalists is expressed as a function of their investment “since capitalists can choose how much to invest, but not how much they can earn”. (Trigg, 1994, p93)

- e. During the cycle, total volume of stocks does not show any cyclical behaviour so it can be assumed that it remains constant; therefore, any increase in the gross accumulation I will be the outcome of an increase in the production of capital goods.
- f. “Gestation period”, θ , which is a time lag between investment output (deliveries of finished goods) and investment decisions (investment orders) is constant. In reality, θ , is variable for different projects but for simplicity Kalecki takes an average for all investment projects.

The model starts by distinguishing three different stages of investment; decision to invest, production of capital goods and delivery of finished capital goods, respectively. In the beginning of the process (stage I), entrepreneurs have some investment decisions (or investment orders), which takes time (θ) to be done and delivered. This can be shown by $D(t)$.

The delivery of the finished capital goods at time t , which can be denoted by $L(t)$, requires an investment (or as Kalecki says: the “production of capital goods”) at stage II. The amount of investment at time t can be shown by $I(t)$.

The relation between the stages (I) and (III) can be written as

$$\begin{aligned} D(t) &= L(t + \theta), \text{ or} \\ D(t - \theta) &= L(t) \end{aligned} \tag{6}$$

To find the relation between the stages (I) and (II) it is needed to find the total volume of the decisions made during the period $(t - \theta, t)$. If $W(t)$ represents this total, we have:

$$W(t) = \int_{t-\theta}^t D(\tau) d\tau \tag{7}$$

As each investment decision needs the gestation period θ to be filled, the actual amount of investment would be $1/\theta$ of the total volume of the decisions (orders), that is:

$$I(t) = \frac{W(t)}{\theta} = \frac{1}{\theta} \int_{t-\theta}^t D(\tau) d\tau \tag{8}$$

The meaning of (8) is that, the production of capital goods at time t is equal to an average of investment decisions made during the period $(t - \theta, t)$.

Now, let us call $K'(t)$ the rate of change in the volume of the existing capital goods at time t and U as the demand for restoration of these goods, which represent physical depreciation. We get:

$$K'(t) = L(t) - U \tag{9}$$

Kalecki assumes that the new equipment is young and their rates of mortality are low, as their life time is much longer than the duration of cycle, so, the physical depreciation remains law and constant during the cycle and can be ignored.

To close the model, Kalecki employs the investment decision function (C), which is:

$$\frac{D}{K} = f\left(\frac{B}{K} - r\right) \quad (10)$$

As it is mentioned before, Kalecki assumes that prospective rate of profit represents the general state of economy and the “lender’s confidence”; so, in the absence of any financial panic (“the so-called crises of confidence”), the interest rate varies with the “general business conditions”. In this case he assumes that the interest rate is an increasing function of $\frac{B}{K}$.

Therefore, we get:

$$\frac{D}{K} = \phi\left(\frac{B}{K}\right) \quad (11)$$

Substituting (5) into (11), and because B is proportionate to $C_1 + I$, we get:

$$\frac{D}{K} = \phi\left(\frac{C_1 + I}{K}\right) \quad , \quad (\phi' > 0) \quad (12)$$

which is another representation of the equation (D). Kalecki assumes that (12) is a linear function; that is:

$$\frac{D}{K} = m \frac{C_1 + I}{K} - n \quad , \quad (m, n > 0) \quad (13)$$

By multiplying both sides of (13) by K , the investment decision (investment order) function can be written as a linear function of investment I and capital stock K . That is:

$$D = m(C_1 + I) - nK \quad , \quad \text{or}$$

$$D(t) = m[C_1 + I(t)] - nK(t) \quad (14)$$

The equation (14) will not be solved unless there is a way to change all the variables into one, using their interrelations. To start, let us list all of the important equations in the model with their associated numbers as following:

$$D(t - \theta) = L(t) \quad (6)$$

$$I(t) = \frac{W(t)}{\theta} = \frac{1}{\theta} \int_{t-\theta}^t D(\tau) . d\tau \quad (8)$$

$$K'(t) = L(t) - U \quad (9)$$

$$D(t) = m[C_1 + I(t)] - nK(t) \quad (14)$$

Differentiating (14) and (8) with respect to t , we get:

$$D'(t) = m I'(t) - nK'(t) \quad (15)$$

and

$$I'(t) = \frac{D(t) - D(t - \theta)}{\theta} \quad (16)$$

$$\text{Also from (6) and (9):} \quad K'(t) = D(t - \theta) - U \quad (17)$$

By substitution of (16) and (17) into (15), we get:

$$D'(t) = \frac{m}{\theta} [D(t) - D(t - \theta)] - n[D(t - \theta) - U] \quad (18)$$

For simplification let us call

$$J(t) = D(t) - U \quad (19)$$

as the net level of investment. Therefore, (18) can be transformed into:

$$J'(t) = \frac{m}{\theta} [J(t) - J(t - \theta)] - nJ(t - \theta) , \text{ or}$$

$$(m + n\theta)J(t - \theta) = mJ(t) - \theta J'(t) \quad (20)$$

which is a mixed linear differential-difference equation with constant coefficients. The solution of this equation will be an investment decision function, expressed in terms of t and other parameters in the model, which under certain conditions behaves cyclically.

To solve the equation let us re-write (20) as:

$$J'(t) = aJ(t) - bJ(t - \theta) \quad (21)$$

where $a = \frac{m}{\theta}$ and $b = \frac{m + n\theta}{\theta}$.

The equilibrium state, where there is no change in the net level of investment (or better to say in the level of investment decisions), occurs when $J'(t) = 0$.

From mathematical point of view, (21) is a homogeneous equation, as there is no function such as $\psi(t)$ (constant or a function of t), which satisfies the following equation:

$$J'(t) - aJ(t) + bJ(t - \theta) = \psi(t) \quad (22)$$

Therefore, for a homogeneous equation ($\psi(t) = 0$) such as (21), the following theorem is applicable:

Theorem 1: “If $j_1(t)$ and $j_2(t)$ are two distinct (i.e. linearly independent) solutions of the homogeneous equation ..., then $A_1 j_1(t) + A_2 j_2(t)$ is also a solution for any two constants A_1, A_2 .” (Gandolfo, p 11)

The type of the function, which is a solution for the equation (21) would be an exponential type of function such as $j_1(t) = e^{\lambda t}$. A cyclical behaviour appears in (21) when the characteristic equation

$$\lambda = a - be^{-\lambda\theta} \quad (23)$$

(obtained from substituting the solution into (21)), has a complex solution for the eigenvalues λ . That is:

$$\begin{aligned} \lambda_1 &= x + iy \\ \lambda_2 &= x - iy \end{aligned} \quad (24)$$

This means:

$$x \pm iy = a - be^{-(x \pm iy)\theta} \quad (25)$$

By separating equation (25) into the real and the imaginary parts and using the general form of Euler's formula ($e^{in\theta} = \cos n\theta + i \sin n\theta$), we get:

$$x = a - be^{-\theta x} \cos \theta y \quad (26)$$

$$\text{and} \quad y = be^{-\theta x} \sin \theta y \quad (27)$$

We know that $b > 0$ and $e^{-\theta x} > 0$, now, if $y > 0$, then $be^{-\theta x} \sin \theta y > 0$ and this means that $\sin \theta y > 0$. Therefore, the following inequalities should be satisfied:

$$\begin{aligned} 2k\pi &< \theta y < (2k + 1)\pi \quad \text{or} \\ \frac{2k\pi}{\theta} &< y < \frac{(2k + 1)\pi}{\theta} \end{aligned} \quad (28)$$

Where k belongs to the positive integer set.

Using (26) and (27), two distinct solutions $j_1(t) = e^{\lambda_1 t}$ and $j_2(t) = e^{\lambda_2 t}$ can be found as following:

$$j_1(t) = e^{(a-be^{-\theta x} \cos \theta y + ibe^{-\theta x} \sin \theta y)t}$$

and

$$j_2(t) = e^{(a-be^{-\theta x} \cos \theta y - ibe^{-\theta x} \sin \theta y)t}$$

If $\alpha = (a-be^{-\theta x} \cos \theta y)t$ and $\beta = bte^{-\theta x} \sin \theta y$, then they can be re-written as:

$$j_1(t) = e^{\alpha+i\beta} = e^{\alpha} (\cos \beta + i \sin \beta) \quad (29)$$

and

$$j_2(t) = e^{\alpha-i\beta} = e^{\alpha} (\cos \beta - i \sin \beta) \quad (30)$$

According to the theorem (1), any combination of two distinct solutions would be another solution, so, if $A_1 = A_2 = 1$, the solution $J(t)$ can be a real solution, that is:

$$\begin{aligned} J(t) &= j_1(t) + j_2(t) = 2e^{\alpha} \cos \beta \\ &= 2e^{(a-be^{-\theta x} \cos \theta y)t} \cos(bte^{-\theta x} \sin \theta y) \end{aligned} \quad (31)$$

Kalecki tries to follow Tinbergen's method in his 1935 article to find solutions for equations in (24), but that method does not show the way of obtaining set of different complex numbers. It only assumes the infinite values of x and y are available. In fact, the solutions for x and y cannot be easily obtained through the transcendental equations (26) and (27) but the locus of them can be found if we transform them into something familiar. For example, they can be transformed as following:

$$\begin{aligned} x-a &= -be^{-\theta x} \cos \theta y \\ y &= be^{-\theta x} \sin \theta y \end{aligned} \quad (32)$$

By squaring both equations and adding together, we get:

$$(x-a)^2 + y^2 = b^2 e^{-2\theta x} \quad (33)$$

The exponential part can be substituted by a polynomial, using Maclaurin series expansion. So;

$$(x-a)^2 + y^2 = b^2 \left[1 - \frac{2\theta x}{1!} + \frac{4(\theta x)^2}{2!} - \dots \right] \quad (34)$$

When $x = 0$; $y = \pm \sqrt{b^2 - a^2}$, but for other values of x , the locus of the solutions could be a circle (depends on how many items in the bracket are used for the approximation of the

solutions, excluding the case where $y = 0$, as in this case the eigenvalues λ are not complex any more).

Kalecki used the data from Germany to evaluate the gestation period and some other parameters of his model. The empirical results show that the gestation period is around 0.6 year and the duration of a cycle is about 8 to 12 years.

5. How does the model work?

Equation (14) shows the interrelation of three important variables in the Kalecki's model:

$$D(t) = m[C_1 + I(t)] - nK(t) \quad (14)$$

investment decision (investment orders), investment (production of capital goods or gross accumulation) and capital stock (volume of the existing industrial equipment). In fact, the positive values of m and n indicate that D is an increasing function of I and decreasing function of K .

To start imagine a good economic conditions where the volume of the investment orders are bigger than the production of capital goods ($I_1 < D_1$), which means that entrepreneurs need to provide credit for the new orders. Part of that credit comes through the previous investments, which form the "realised profit" and improve the expectations and the "lender's confidence". This situation improves the business such that the next period investment I_2 will be bigger than both I_1 and D_1 .

As long as the investment orders are bigger than the demand for restoration of the industrial equipment, the gross accumulation I will continue to rise and the profits of the capitalists are also rising.

At the early stage, capital stock is not increasing as the delivery of capital goods is related to the previous orders (equation (6) and (17)). But when investment orders increase in each period and its volume exceeds the restoration level (U), the capital stock starts to increase (eq. (17)). Increasing K has negative impact on orders (eq. (14)), so, when the capitalists consumption and investment cannot increase as fast as capital stock, the investment orders start to fall and this in turn, causes investment I to fall (eq. (16)).

The decrease continues until the investment orders and investment are not enough to cover the demand for restoration. The drop in the volume of capital stock continues until the new investment orders become bigger than the amount of investment and the system starts the recovery process.

6. Conclusion: Is Kalecki's Theory of Business Cycle Relevant?

This paper has tried to shed light on a theory which tries to explain the dynamic of the investment process in the capitalist economy through the change of its endogenous variables. As it is already mentioned, the idea that Kalecki was a pioneer in the innovation of the theory of "political-based business cycle" is wrongly attributed to him, as he tried to show in different articles that the capitalist system intrinsically causes business cycles.

In his final paragraph of his 1937 article, he perfectly explains why this process happens endogenously: "... the question "what causes the periodical crisis?" could be answered shortly: the fact that the investment is not only produced but also producing. Investment considered as capitalist's spending is the source of prosperity, and every increase of it improves business and stimulates a further rise of spending for investment. But at the same time investment is an addition to the capital equipment and right from birth it competes with the older generation of this equipment. The tragedy of investment is that it calls forth the crisis because it is useful. I do not wonder that many people consider this theory paradoxical. But it is not the theory which is paradoxical but its subject; the capitalist economy". (Kalecki, p 68-69)

There are many innovations in the Kalecki's theory which cannot be ignored. His precise reasoning about the existing of a time lag between different stages of investment process (which is then accompanied by supporting empirical results) introduces dynamic to the process, through bringing different variables into effect at different stages, which is far from the static-type analysis of the cycle.

The bi-direction relationship between investment and profit cannot be seen in a static model, and it is not just this relationship that makes Kalecki's model unique; his reasoning about the role of interest rate and its co-movement with the investment (after passing a minimum level) in the boom period is something which we can find in new theories and it is in contrary with the orthodox rules.

The impact of this interrelationship (between investment decision and expected rate of profit) can be seen in other theories of the business cycle, such as "the financial instability hypothesis" introduced by Minsky. As long as investment decisions are influenced by the prospective rate of profit and profits are gained through capitalists' investments and the volume of capital stock has negative impact on the investment decisions the Kalecki's theory will be referable.

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