

**A Sequence Analysis of Money, Savings, and Investments under
Negative Interest Rates**

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Abstract

Money, savings, and investments interact, giving rise to a Wicksell-Keynes disequilibrium when the natural and market rates of interest differ. Wicksell, Mises, and Schumpeter all reject the notion of commodity money in favor of credit money and define the value of money with its purchasing power. Keynes considers the demand for money as a demand for purchasing power and adds credit money explicitly. Wicksell's cumulative process occurs when the natural and market rates of interest differ causing investments to deviate from savings. Lundberg develops sequence analysis, as member of the Stockholm School, whose chief characteristic is *ex ante* disequilibrium of savings and investments reflecting a wedge between natural and market rates of interest, but still allows the supply of savings to have a constraining role on investments in a boom, an intermediate position between Keynes and Hayek. This paper outlines a sequence analysis to consider how money, savings, and investments interact within the context of the Great Recession rather than the Great Depression, addressing negative interest rates.

Keywords: Sequence analysis, money, investment, savings, negative interest rates

1. INTRODUCTION

Eichengreen (2015) compares the Great Depression of the 1930s with the Great Recession of 2008-09, the recent financial crisis, in particular pointing out the lessons learnt from the former when addressing the latter, such as cutting interest rates and injecting liquidity. He provides several examples how our understanding of the Great Depression has improved by the Great Recession: the tendency to extrapolate stability into the future, to rationalize large lending flows, the temptation to use simple policy rules, the danger of distortion rather than illumination when trying to learn from history. Eichengreen points out that the more recent memory of high inflation of the 1970s was stronger than the more distant memory of deep deflation of the 1930s, causing concern among central bankers about lowering interest rates and injecting liquidity as inflationary, an unwarranted concern as the current period of low, and even negative interest rates illustrate. This paper modifies the sequence analysis, based upon the disequilibrium macrodynamic approach of the Stockholm School, as developed by Lundberg (1937), thus addressing the Great Depression of 1930s, in order to address the Great Recession and negative interest rates, both being deflation crisis.

In May 1981, Lundberg ([1981] 1996) delivers his *Raffaele Mattioli Lectures* at Università Commerciale Luigi Bocconi, actually pointing out the problems of the approaches of the Stockholm School and Keynes to address the inflation crisis of the 1970s. He compares the Swedish and Keynesian approaches to macroeconomics and points out there was a Stockholm Circus as well as a Cambridge Circus in the 1930s, in particular he compares the Stockholm School with Keynes. The latter derives its origin to Knut Wicksell and includes as its senior scholars – Erik Lindahl, Bertil Ohlin, and Gunnar Myrdal – and some younger scholars, including Dag Hammarskjöld, Alf Johansson, Ingvar Svennilson, and Erik Lundberg himself. Lundberg stresses the Wicksellian heritage with a clear distinction between statics and comparative statics, on the one hand, and sequence analysis, on the other hand, a

macroeconomic approach used by its senior members already in the early 1920s. Analyzing the disequilibrium approach of the Stockholm school, Lundberg identifies three types:

- (i) Disequilibrium between the natural rate of interest, the efficiency of capital, and the nominal market rate of interest;
- (ii) Disequilibrium between savings and investments *ex ante*, but not *ex post*;
- (iii) Disequilibrium in the labor market, stressing the sequence of disequilibrium periods rather than the comparative statics of Keynes.

Hence, Lundberg (1937) takes an intermediate position between Keynes and Hayek. The Stockholm School worked simultaneously with and independently of Keynes, but suggested similar policies, on the one hand, while Lundberg's sequence analysis involves money and time, like Hayek's ([1929] 1976/2016; [1931] 1976/2016) business cycle theory. Lundberg's starting point is Wicksell's (1898) cumulative process as a sequence due to the fact that the natural and market rates of interest differ, which causes savings and investments to be in disequilibrium. Wicksell ([1906] 1966), Mises ([1912] 1924), and Schumpeter (1917-18, 1970) stress that money is credit money and define its value as its purchasing power. Keynes (1930a) states that the demand for money is actually a demand for purchasing power and he adds bank money explicitly, and explains how the banking system cause the price-level to rise (fall), as it lets the rate of investments exceed (fall behind) the rate of saving. Hence, Lundberg consider savings and investments as independent, along the lines of a Wicksell-Keynes savings-investments disequilibrium, in contrast to Hayek's savings-investments equilibrium. This paper argues that the essential difference is due to their views of money as either credit money or commodity money, money as endogenous or exogenous. Based on Wicksell's pure credit economy with endogenous money, this paper outlines a sequence analysis to consider how money, savings, and investments interact within the context of the Great Recession rather than the Great Depression, addressing negative interest rates.

The rest of the paper proceeds as follows. Section two considers the interaction of money, savings, and investments in Lundberg's sequence analysis. Section three outlines modifications to consider the context of the Great Recession rather than the Great Depression. Section four uses this modified version to analyze negative interest rates. Section five gives the conclusions.

2. LUNDBERG'S SEQUENCE ANALYSIS AND THE INTERACTION OF MONEY, SAVINGS, AND INVESTMENTS

Lundberg points out that the method of sequence analysis, developed by Lindahl, involves disequilibrium *ex ante* that gives partially unpredictable outcomes *ex post* inducing revised expectations with *ex ante* disequilibria giving new *ex post* outcomes, while Lundberg's (1937) own sequence analysis involves investments determined by the acceleration principle and consumption in a sequence of periods. There, Lundberg brings in credit money.

Lundberg (1937) develops sequence analysis, using Wicksell's cumulative process as a starting point, arguing that the velocity of circulation of money has the same effect as an increase in money. He points out that in a well-developed credit system, bank clearing reduces the quantity of money required, so that the purchase and sale of goods in process takes place simultaneously in the beginning of each period with an arbitrarily small quantity of money. While Amendola and Gaffard (1988) use Lundberg's sequence analysis as a starting point, they turn to Hicks's (1973) and his distinction between a construction phase and a utilization phase, to analyze the economic dynamics of innovation, considering both a human constraint and a financial constraint, Lachmann ([1956] 1978) understands an enterprise as a sequence, involving three structures: the Plan structure, based on technological complementarities, the Control structure, based on the gear of the company's capital, and the Portfolio structure, based on people's asset preferences, all integrated into the overall Asset

structure. He explains that when an enterprise starts, all the operating assets are money, which gradually is exchanged for inputs, capital goods and factor services, that form the plan structure, and when the enterprise finally is liquidated, its operating assets other than reserve assets are turned into money, which is distributed to the holders of the securities (p. 92).

However, Lundberg (1937) follows the Wicksell-Mises-Schumpeter trajectory (Wicksell, [1906] 1966; Mises, [1912] 1924; Schumpeter, 1917-18, 1970), according to which money is regarded as a social institution rather than a commodity, thus involving a credit economy, such as settlement of bills of exchange, comparable with Keynes's (1930a,b) stress on bank money. Money, as social institution, is a clearing mechanism.

Lundberg (1937) goes back to the model sequence of Wicksell's (1898) cumulative process for a fixed production time, involving fixed capital and working capital, as well as a constant flow of credit money to meet the constant flow of goods with fixed technology. He finds the origin of dynamic change in a difference between the natural and market rates of interest. As Lundberg points out, Wicksell starts with an equilibrium system that involves total income, savings, investments, interest rate, and production, in which savings and investments would be in equilibrium only if the market interest rate is equal to the natural interest rate, but Wicksell focuses upon the cumulative process as a sequence because the natural and market rates of interest differ, which causes savings and investments to be in disequilibrium, giving increases in the price level.

Lundberg (1937) criticizes Hayek's business cycle theory for fusing savings and investments with real capital, point out that savings and investments cannot be seen as supply and demand for capital, but an analysis of the interaction of savings and investments with income, production, and consumption is required. According to Lundberg, Hayek provides a static equilibrium explanation of business cycles, while Lundberg considers an expanding economy, which requires a deviation from a savings-investments equilibrium.

Hayek ([1929] 1976/2016) underlines the crucial role money plays for business cycles and that any monetary disturbance may upset any equilibrium and he concurs with Röpke (1926) that even when turning the cheese cover of stable prices upside down upon the capitalistic economic process, business cycles cannot be eliminated. Hayek sees credit as a monetary cause of business cycles. In his business cycle theory, Hayek ([1931] 1976/2016) has the equilibrium between consumption goods and production means as a starting point and sees how changes in savings and money supply through credit change the length of production time, thus altering the proportion of consumption goods and means of production. He points out the crucial difference changes in savings and in money supply, the latter not being induced by changes of consumer preferences, so it causes investments to exceed saving.

This difference of opinion can be attributed to the distinction between endogenous credit money and exogenous commodity money, the former characterizing Lundberg and the latter Hayek. Moore's (1998) concept of endogenous money, means that money is demand-driven, such as credit money. Indeed, as Festré (2006) correctly points out, Wicksell's pure credit economy implies purely endogenous money. Kaldor (1982) argues that credit supply is infinitely elastic at the exogenously set interest rate, while Amendola and Gaffard (1992) claim that true endogenization requires that money becomes a sequential process, like production, involving sequential interaction between real choices and financial decisions. A production process involving qualitative change is complex. Amendola and Gaffard (2014) point out the dissociation of costs from proceeds, implying coordination issues to be addressed over time.

Lundberg (1937) also points out that savings play no independent role in Keynes's equilibrium system, where savings and investments are equal to net sales minus consumption expenditures. He points out that the quantity of money changes with independent variations of savings and investments, while the quantity of capital changes with investments, so any

difference between savings and investments changes the quantity of money, thus disrupting so the equilibrium system, and regarding coordination as sequential, a process in time. In his *General Theory*, Keynes ([1936] 1973) himself argues that savings by necessity equals investment, because both are equal to the excess of income over consumption. In his *Treatise on Money*, Keynes (1930a) considers the deviation of savings from investments, but their equality would reflect equilibrium between consumers' expenditure and producers' output, so that excess investment over saving would mean expenditure above available output, causing the price level to rise. This echoes Wicksell's (1898) cumulative process, where the natural rate of interest being higher than the market rate of interest, causes investments to exceed savings, causing the price level to increase. Keynes (1930a) shows, using his banana parable, that excess saving over investment decreases the price of bananas, causing a transfer from producers to consumers, or more generally producers make a profit when investments exceeds savings and losses when the opposite is the case, as in the banana parable. Keynes acknowledges Wicksell explicitly, defining the natural interest rate to be the rate at which savings equal investments and arguing that the market interest rate can only be lower as long as there is a continuous increase of bank money, but Keynes also puts himself close to what he labels the neo-Wicksell school in Germany and Austria, mentioning Mises and Hayek.

In his *General Theory*, Keynes ([1936] 1973) criticizes his own analysis in the *Treatise on Money*, arguing that saving and investment are equal and even investments funded by bank credit will increase income and thereby savings. According to Moore (2006), savings and investment are always identical *ex post* as an accounting identity, defining savings as a change in net worth in a national balance sheet, where net investment is the change of intangible assets equal to net worth as net saving. Moore points out that credit means adds a non-volitional element to savings, but also that planned saving is never equal to planned investment in complex adaptive systems. Lundberg ([1981] 1996) argues the equality of

savings and investments *ex post* does not prevent savings from restricting investments during a boom, bringing in the relation between savings and profits.

In his own sequence analysis, Lundberg (1937) points out how Keynes (1930a) develops Wicksell's cumulative process, bringing greater realism, but losing the dynamics of Wicksell, who wants to show the consequences of changes in one year for the following year, by having a constant rate of expansion, yet capturing how the production period captures the duration of the boom, having the interval between wage payments as unit-period and a corresponding holding of cash, where voluntary saving is equal to investment in fixed capital and credit finances investment in working capital. For a treatment of transitions between periods, Lundberg turns to Hammarskjöld (1933), who considers a transfer of profits between periods, so that anticipated profits give rise to changes in savings, involving finite cumulative processes, as an increase in purchasing power is subject to a successive reduction during a series of periods, where the unit-period is defined by the interval between profit-registrations, during which stocks may change.

Lundberg (1937) finds both the view of Keynes that savings are a passive factor, the residual between income and consumption, and the view of Hayek that savings are an active form of demand for capital goods to be one-sided, because the former discriminates between the varying effects of different forms of savings on investments, while the latter excludes the attainment of equilibrium, as savings only under certain conditions can be transformed into demand for capital. Instead, he argues that we should distinguish between savings in the form of increased cash balances and the purchase of new securities, where saving in the form of retentions and new equity shares constitute active demand for capital, while bank deposits constitute passive savings. As crucial factor, he sees the speed by which savings are transformed to investments, comparing the duration of time before income becomes income again via demand for consumption goods with the period of income-generating investments,

so that mere transfer may be the case, but also transfer from consumption goods to capital goods. Lundberg argues that the introduction of time means that investment has both active and passive elements, active investment (passive saving) through increase in volume and passive investment (active saving) through cash holding or bank deposits, unused income, where the choice of being active or passive depends upon entrepreneurial expectations, so the choice of unit-period becomes crucial for savings and investment being active or passive.

In his own model sequences, Lundberg (1937), the savings-investments equilibrium is disrupted and investments are explained casually, starting with inequality between receipts and payments of costs as well as a variety of ways of producers to respond to an increase in consumers' expenses. Hence, there is heterogeneity among producers. As unit-period, Lundberg uses as reaction interval corresponding to the average distance between the rise in demand and the subsequent increase in production, representing producers' inertia to changes in receipts and profits. In his first model sequence, having constant investment, Lundberg arrives at something resembling the multiplier, the equilibrium towards which the process ends. In the second one, involving investment in working capital, he observes cyclical variation, asymptotically reaching equilibrium. In the third one, involving investment in fixed capital, he finds initially expansion, when the difference between gross investments and planned gross savings is positive, followed by contraction when that difference becomes negative, because new investments depend on consumers' demand, so every swing upward leads to a downward development. This resembles Hayek's boom-bust cycle.

Lundberg's (1937) model sequence at constant investment

Variables

R : total receipts in consumptions goods production = consumer outlays

a : increase in consumers' expenditure

C : calculated costs of consumption goods production; $C = E + N$

E : income-generating costs = total income (wages, interest, dividends)

N : non-income-generating costs (amortization, purchase of inputs, expected profit)

S : savings; $S = \Lambda E$

Equations

$$C_{t+1} = R_t = C_t + a$$

$$C_t = E_t + N_t; C_{t+1} = E_{t+1} + N_{t+1}$$

$$\text{Constant demand for replacement: } R_t = (1 - \Lambda)E_t + C$$

$$\text{Limitation in free competition: } N_t = aE_t$$

$$\text{Reaction equation: } (1 - \Lambda)E_t + C = (1 + a)E_{t+1}$$

$$\text{Condition for continued expansion: } C \geq (a + \Lambda)E_t$$

Stable path to long-run equilibrium:

$$\lim_{x \rightarrow \infty} E_{t+x} = \frac{C}{a + \Lambda}$$

Lundberg's (1937) model sequence with investments in working capital

Variables

R : total receipts in consumption goods production = consumer outlays

a : increase in consumers' expenditure

C : calculated costs of consumption goods production; $C = E + N$

E : income-generating costs (wages, interest, dividends); $E = E' + E''$

E' : income-generating cost of consumption goods production

E'' : income-generating investment costs

N : non-income-generating costs (amortization, purchase of inputs, expected profit)

S : savings; $S = AE$

K : working capital

I : investments

k : "normal" relation of working capital to production

Equations

$$I_t = kC_t - K_{t-1} = (1 + a)E''_t$$

$$R_t = (1 - \Lambda)(E'_t + E''_t) + C$$

$$R_t = \frac{1 - \Lambda}{1 + a}R_{t-1} + \frac{(1 - \Lambda)(1 + k)}{1 + a}(R_{t-1} - R_{t-2}) + C$$

Cyclic variation giving a successive, asymptotic path towards the equilibrium:

$$R_t = \frac{C(1 + a)}{a + \Lambda}$$

Lundberg's (1937) model sequence with investments in fixed capital

Investments in residential houses

Variables

$1/\sigma$: fixed proportion of rents in consumption

R : total receipts in consumptions goods production = consumer outlays

a : increase in consumers' expenditure

$D^{(h)}$: effective demand for housing = total sum paid in rents

C : calculated costs of consumption goods production

E' : income-generating cost of consumption goods production

E^h : income from "running" houses (rents)

h : fixed portion of consumer expenditures not becoming income next period

S : savings; $S = AE$

$S_t^{(B)}$: planned gross savings

I : investments

$I_t^{(B)}$: planned gross investments

Equations

$$R_t = E'_t + I_t - S_t + C$$

$$I_t = \mu \left(D_{t-1}^{(h)} - D_{t-2}^{(h)} \right) = \frac{\mu}{\sigma} (R_{t-1} - R_{t-2})$$

$$E'_t = \frac{R_{t-1}}{1+a} = R_{t-1}(1-b)$$

The rents R_t/σ are not transformed into income in the same way as other income.

$$E_t^{(h)} = \frac{R_{t-1}}{\sigma} (1-h)$$

$$E'_t = \left(R_{t-1} - \frac{R_{t-1}}{\sigma} \right) (1-b)$$

Assume $h > b$:

$$E_t = \left(R_{t-1} - \frac{R_{t-1}}{\sigma} \right) (1-b) + \frac{R_{t-1}}{\sigma} (1-h) + \frac{\mu}{\sigma} (R_{t-1} - R_{t-2})$$

$$R_t - R_{t-1} = \frac{\mu(1-\Lambda)}{\sigma} (R_t - R_{t-1}) - \left[1 - (1-\Lambda) \left(1 - b - \frac{h-b}{\sigma} \right) \right] R_{t-1} + C$$

$$S_t^{(B)} = S_t + \left[R_{t-1} - \left(E'_t + E_t^{(h)} \right) \right] \text{ and } I_t^{(B)} = I_t + C$$

Expansion $(I_t^{(B)} - S_t^{(B)}) > 0$, is followed by contraction $(I_t^{(B)} - S_t^{(B)}) < 0$.

The excess saving over investment of contraction Hayek ([1929] 1976/2016) refers to as forced saving, but that notion presupposes an underlying savings-investment equilibrium. Using Moore's (2006) notions of volitional and non-volitional savings, Hayek considers savings as essential volitional, implying a causality from savings to investments, while Moore has the reverse causality. Hicks (1967) points out that Hayek's ([1931] 1976/2016) theory is one about how the economy adjusts to changes in saving. Lundberg (1937) see this adjustment in expansion, where savings drive investment during expansion, while he finds savings-investment equality *ex post* non-informative, because it does not explain the shift from a positive to a negative difference between investments and savings. As Hicks (1967) argues, Keynes (1930a) indeed considers the difference between investments and savings, stressing that Keynes considers sectoral disequilibrium prices. For Keynes (1930), profits are the difference between investments and savings, $Q = I - S$, and equilibrium requires zero-profits, while expansion requires profits to be positive.

The essential point is that production takes time. Amendola and Gaffard (1992, 2014) stress that when production takes time, involving qualitative change, we are out of equilibrium and money matters, as inputs coming before outputs indeed require money, so our analytical focus has to be *ex ante* rather than *ex post*. This is consistent with Lundberg (1937), who acknowledges that production takes time and he addresses the difference between costs of production during a period and consumer outlays, explicitly stating that for a given day they are far from identical, and that the discrepancy is higher with a shorter period. Hence, that savings equal investments *ex post* becomes uninteresting when studying the production process.

Here, there is a clear affinity between Lundberg and Hayek. Concerning production time, Hayek ([1931] 1976/2016) consider the flow of money from factors of production to consumption goods in stages of production, involving intermediate goods, to analyze

qualitative changes of production. This is simplified as the Hayekian triangle. Lundberg (1937) points out that the production process is not given, because it takes time and requires some circulating capital, but also that the value of the product increases towards the final stage, though the way remains unknown, but for simplicity can be assumed uniform and represented by a triangle with the base representing output and the height production time for each consumption good. Hence, Lundberg uses the Hayekian triangle, but he considers a range of such triangles from zero production time, when production and consumption coincide to, relatively long production time, where the height, the production time, varies for different consumption goods.

Concerning money, the affinity between Lundberg and Lachmann warrants our attention. Lachmann ([1956] 1978) stresses that entrepreneurs make regroupings of heterogeneous capital goods to bring in some complementarity in the production plan, but every enterprise starts with homogenous money capital, 'free capital' to be collected from owners and creditors, preceding the making of the production plan, while investment means dehomogenization of money into heterogeneous capital. Similarly, Lundberg (1937) observes a sequence of payments in time, expressed in the velocity of circulation of money, which is derived from the existence of expenditure time. Amendola and Gaffard (1992) argue for a sequential approach to finance as well as production to consider endogenous money. Lachmann ([1956] 1978) considers how cash reserves are required to overcome inconsistent reshuffling of capital among firms, while Lundberg (1973) considers how capital can be increased either through increasing liabilities or decreasing liquid balances.

Lachmann's asset structure opens for a sequential approach to money. He makes a distinction between operating assets - capital goods and money complementary to them – and securities – titles embodying the control of production, giving rise to two spheres of the market economy: one where the asset preferences of the holders of titles shape production, the

other where technological exigencies of production planning shape the asset holdings.

Lachmann ([1956] 1978) distinguishes between three types of operating assets:

- (i) *First-line assets*: capital goods used in production from the start;
- (ii) *Second-line assets*: spare parts and money planned to be used during the production period;
- (iii) *Reserve assets*: cash reserves and reserve stocks kept for unexpected contingencies, being supplementary to first- and second-line assets; a measure of success and failure of plans, success if they are not used, failure if they are used, extreme failure if exhausted.

Among securities Lachmann makes a standard distinction, which gives the control structure:

- (i) *Debt*: the right to a specific income in currency units;
- (ii) *Equity*: the right to participate in control and to residual income.

Finally, the operating assets and securities give, according to Lachmann, rise to three interdependent kinds of structure, each one having its own foundation:

- (i) *Plan structure*: technical complementarities;
- (ii) *Control structure*: high or low gear of capital, the leverage;
- (iii) *Portfolio structure*: asset preferences.

He describes the interdependence of these structures in terms of the viability of a production plan, which depends upon the willingness of people to hold the securities necessary to its realization, and the offer of such securities.

Lachmann attributes an essential role to capital gains and losses, since they reflect within the portfolio structure the success or failure of production plans, and see how they alter the relative values of the securities in the portfolio, thus causing reshuffling among them and thereby changing the portfolio structure. Nevertheless, to him securities represent operating assets, so the portfolio structure essentially reflects the plan structure. Instead, Lachmann

stresses money flows and how success and failure of plans give rise to flows of money, thus affecting cash reserves, while capital gains and losses reflect such occurrences elsewhere.

Capital gains and losses will influence the market net capital value.

However, Lundberg (1937) considers net capital value, using a simple balance sheet, according to which fixed and working capital may increase through an increase in net capital value that to some extent offsets any increase in total liabilities or decrease in cash balances to fund investments, thus reflecting money flows generated by the investments. He later equates net capital value to amortization and profits at book value and includes them in non-income-generating costs. The profits would tend to increase wages and dividends, thus indirectly increasing income-generating costs and thereby receipts, although the proportion of these two types of production costs may change, but this implies that consumption and thereby receipts are directly increased by household income from increasing asset prices.

Although it makes sense to include capital gains, along the lines of Moore (2006), to use a Hicksian conception of income, the notion of income in Lundberg's sequence analysis is clearly what Hicks (1939) labels *ex ante* income: the maximum value of consumption during a period that keeps expected wealth constant. This income is a continually revised permanent income, as Bromwich *et al.* (2010) point out. Indeed, Lundberg ([1981] 1996) himself explains that income was more seriously considered in Stockholm than in Cambridge during the 1930s and that Lindahl's view of aggregate household income then was close to the later postwar concept of permanent income, but also that the *ex ante* disequilibrium between planned consumption, investment, and prices implied partially unpredictable *ex post* outcomes. Hence, expected capital income would be included in household income, and thus used as a determinant of consumption together with labor income.

3. THE GREAT DEPRESSION, THE GREAT RECESSION, AND SEQUENCE ANALYSIS

Eichengreen (2015) compares two large-scale crises: the Great Depression of the 1930s and the Great Recession of 2008-09, both being deflation crises due to unsustainable booms that were addressed by cutting interest rates and injecting liquidity, in contrast to the inflation crisis of the 1970s. These historical experiences shape our perceptions of the state of the economy. Lundberg ([1981] 1996), who labels himself Keynesian, states that the policy models of the Stockholm School and Keynes had been adequate in the 1930s, but not in the 1970s, causing a shift from demand-side to supply-side policies, but he stresses the importance of a relatively full utilization of capacity for expanding market economies, the crucial role of a sufficient demand pressure, that resources made available by cuts in public spending and increased saving must be used productively in an expanding economy and be matched by increasing aggregate demand.

However, here the composition of demand may be more relevant than aggregate demand. Hicks (1967) argues that Keynes's (1930a) treatment of the natural rate of interest differs from that of Wicksell and finds Myrdal ([1931] 1933) more accurate by focusing on sectional prices levels.¹ We have to consider capital goods as well as consumption goods. This will bring in structure. Hayek ([1931] 1976/2016) considers the time dimension of production explicitly, where there are several stages of capital goods production before the production of consumption goods, and here structure matters, as there may be lengthening and deepening.

¹ Hicks refers to Wicksell and Myrdal, but some differences have been observed. Siven (2006) points out that Myrdal considers savings as income not consumed, so savings-investments equilibrium means equilibrium in the goods market rather than in the capital market, and that the natural rate must be seen as value productivity, for which the unit of account matters to relative prices and which is calculated as the ratio of net return of real capital to its reproduction costs. Siven also finds that Myrdal favors a disequilibrium approach to a temporary equilibrium approach.

Kates (2010) argues for a focus upon the structure of rather than the level of demand, because crises are outcomes of poorly synchronized economy. Lachmann ([1956] 1978) considers heterogenous capital, a capital structure made up of heterogenous capital combinations, stressing the importance of plan complementarity and structural complementarity when entrepreneurs form plans. This involves both the firm and the market. According to Lachmann, the entrepreneur achieves plan complementarity by combining capital goods within one plan, while the market achieves structural complementarity through the interplay of mostly inconsistent entrepreneurial plans. This involves capital reshuffling.

To Lundberg (1937), production takes time and requires circulating capital and there is a range from zero production time, when production and consumption coincide, to relatively long production time, so in terms of a triangle, the height, which measures production time, varies for different consumption goods, giving a range of triangles, which can be arranged according to production and whose sum gives the amount of circulating capital. The length of production of time can be seen as the degree of roundaboutness. As Keynes ([1936] 1973) considers capital, he discusses the selection of the most efficient roundabout processes and to organize production so that goods are produced when consumers expect their effective demand to become effective. Here it is a matter of matching production and consumers' intertemporal preferences.

The idea of production matching consumers' intertemporal preferences is an underlying assumption of the triangle used by Hayek, or Lundberg's range of triangles. Hayek ([1931] 1976/2016) analyzes the conditions for equilibrium between the demand for consumption goods and the demand for means of production, starting with initial production factors, which are allocated at various stages of production to the production of intermediate goods and finally consumption goods, pointing out how money supply could alter the demand for consumption goods, taking account of the velocity of money.

While Hayek expresses concern that the injection of money disturbs the price mechanism that informs about changes in demand of consumption goods relative to intermediate goods, Lundberg (1937) observes a sequence of payments in time, expressed in the velocity of circulation of money, which is derived from the existence of expenditure time, allowing for a variety of velocities depending upon expenditure time, thus introducing heterogeneity. Lachmann ([1956] 1978) considers how an enterprise starts with homogenous money capital, ‘free capital’ to be collected from owners and creditors, precedes the making of the production plan, while investment means dehomogenization of money into heterogeneous capital. In addition, Lundberg considers credit as an extension of money, since a firm may finance expansion by cash balances or bank deposits, sale of liquid assets, use of overdraft facilities, new bank loans, and the issue of stocks or bonds. Nevertheless, an injection of liquidity would alter perceived changes in demand, being nominal rather than real. Injection of liquidity may be harmful.

In support of Hayek and the Austrian business cycle theory, according to which credit creates an artificial boom that leads to bust, Horwitz (2010) explains the Great Recession in terms of unintended consequences of intervention in the market process: expansionary monetary policy and artificial reduction of the costs of homeownership; expansionary monetary policy and low interest rates, a state-sponsored push for affordable housing, building up a housing bubble, a policy-induced boom-bust cycle. Gunning (2010) adds to the explanation of the housing bubble another structural dimension by using the notions of incentive divergence among economic agents and of reliance cycle in financial intermediation, in which savers first distrust intermediaries, who respond by building trust, and eventually savers start trusting them and decrease their alertness to explain the housing bubble. From this, we may infer that structure matters.

Now, compare the Great Recession with the Great Depression. Eichengreen (2015) clearly support the preceding periods of monetary expansion in both cases, the effect of the real bills doctrine that credit had to expand to meet the legitimate needs of business in early twentieth century and Ponzi's scheme contributing to a housing bubble in Florida, involving mortgage securitization, during the 1920s as well as a stock market boom in the late 1920s. He mentions the capital flows induced by the interwar gold exchange standard and later the euro. Hence, there were common phenomena. A difference that he notes is the growth of the nonbank financial sector, including hedge funds, money market funds, and special purpose vehicles, making derivative securities important, although more so in the United States than in Europe, still more bank-based, giving a banking crisis due to overleveraged, undercapitalized, and excessively exposed banks. Eichengreen provides a case in point: Ireland had enjoyed a sustained rapid growth becoming the best-performing economy in Europe, but there was a banking boom with credit growing much faster than GDP, house prices increasing rapidly due to cheap mortgages, while banks lent massively to construction, funded by deposits by foreign investors who were attracted by high yields. Here, we may observe a boom in asset prices due to credit expansion, creating a housing bubble, but also a highly connected economy. Kates (2010) mentions unsound policy-induced lending in housing, bundling of mortgages into financial derivatives, erratic monetary policy, plunge in share prices, etc.

Similarly, Moore (2006) considers the Japanese conundrum, an enormous asset bubble created as real long-term interest rates had been reduced below the expected real long-term economic growth rate, since reductions in interest rates create capital gain income due to increasing asset prices and reduces the costs of borrowing, but after the asset bubble burst, the economy no longer responded to a reduction of short-term interest rates. He observes that households saved, while investors in land expected prices to fall.

Consequently, we need to consider investment in housing, where households are house owners, who use mortgage finance, asset prices, being reflected in household debt, involving interest and amortization, and mortgage-backed securities. Households hoard, holding either money or securities. While Wicksell ([1906] 1966) argues that bank lending prevents cash balances from remaining idle and that payments are made through giro transfer from the balance sheet of one customer to the balance sheet of another one, which implies an accounting system of exchange, and develops his pure credit economy, Keynes (1930a) interprets an enormous rise in the price of securities, not being accompanied by any rise in the price of the current output of new fixed capital as an outcome of “bull” investors buying securities and borrowing money via the banking system from “bear” investors due to a difference of opinion concerning the prospects of securities.

This fits well with Great Recession, but also the current situation with increasing asset prices fueled by monetary expansion and low interest rates. Hence, we will extend Lundberg’s model sequence with constant investment (in industrial investments) with creation of credit money in a pure credit economy, where households demand money by bank borrowing to finance part of their consumption loans, but also to invest in financial assets, thus earning capital gains with increasing asset prices.

Variables:

R: total receipts in consumptions goods production = consumer outlays

a: increase in consumers’ expenditure

C: calculated costs of consumption goods production; $C = E + N$

E: income-generating costs = total income (wages, interest, dividends)

G: capital gains

E^G : total income, including capital gains: $E^G = E + G$

M: money supply = total debt

N: non-income-generating costs (amortization, purchase of inputs, expected profit)

S: savings; $S = AE$

d : amortization rate on debt

r : market interest rate

σ : share of household bank borrowing for consumption

$(1-\sigma)$: share of household bank borrowing investment in financial assets

In the credit economy, all money is credit money, so credit creation is equal to money creation. Households borrow $(M_t - M_{t-1})$, dividing the share σ to finance consumptions and $(1-\sigma)$ to finance investment in financial assets, to obtain capital gains, $G_t = g(1 - \sigma)(M_t - M_{t-1})$. As in Lundberg (1937), costs of consumer goods production are covered by consumer outlays in the previous period, $C_{t+1} = R_t = C_t + a$. Costs are income-generating and non-income generating, $C_t = E_t + N_t$, and there is also limitation to free competition, $N_t = aE_t$.

Now the constant demand for replacement changes to:

$$R_t = (1 - \lambda)E_t^G + \sigma(M_t - M_{t-1}) - (d + r)M_t + C$$

This gives the following reaction function:

$$(1 - \lambda)E_t^G + \sigma(M_t - M_{t-1}) + C = (1 + a)E_{t+1}$$

Total income with capital gains becomes:

$$E_{t+1}^G = \frac{(1 - \lambda)}{1 + a}E_t^G + \frac{(\sigma + g(1 - \sigma))(M_t - M_{t-1}) + C - (d + r)M_t}{1 + a}$$

Expansion requires that $C_{t+1} \geq R_{t+1}$. The condition for continued expansion becomes:

$$C \geq (a + \lambda)E_t - \sigma(M_t - M_{t-1}) + (d + r)M_t$$

Here we may observe that credit expansion for consumption decreases the constant demand for replacement required for continuous expansion, while amortization and interest payments on loans do the opposite. The creation of credit money has a positive effect on expansion by lowering the threshold replacement when $\sigma(M_t - M_{t-1}) \geq (d + r)M_t$, giving the following requirement:

$$M_t \geq \frac{\sigma}{\sigma - (d + r)}M_{t-1}$$

As we can see, a zero amortization, zero interest rate policy implies that any increase of credit money would be expansionary, while a higher debt service cost would increase the required monetary expansion. The former will assure capital gains can be enjoyed with more certainty, but the actual

demand for replacement may be far too low when the interest increases. Capital reshuffling may therefore be low.

4. NEGATIVE INTEREST RATES

Hicks (1977) combines Wicksell and Keynes, and referring to the former he points out that to Wicksell, deflation occurs when the market rate of interest does not fall as fast as the natural rate of interest, something characterizing the 1930s, while the market rate of interest did not rise as fast as the natural rate of interest during the Bretton Woods regime, which Hicks characterizes as a big step towards Wicksell's credit economy. Hicks stresses the long-term equilibrium of Wicksell-Myrdal,² in contrast to the short-term equilibrium of Keynes, and makes a Wicksellian interpretation of Keynes's supply curve of output, comparing growth rate and inflation rate in a growth supply curve, which has a point, where growth is considerable, while there is no inflation, below which process fall with increasing productivity, while Bretton Woods economies were above that point. In addition, Hicks allows for heterogeneity, so that the prices in fast industries need to fall relative to those of slow industries, giving rise to disequilibrium. Hicks finds Wicksell to better understand the slow reaction to monetary ease than Keynes. In his own capital theory, Hicks (1973) uses the *Traverse*, as a transition from one stationary state to another one, analyzing the construction and the utilization of a new technique and an old technique.

However, we are concerned with the deflation of large-scale crises, so the growth rate is below the threshold and consumer prices fall. The natural rate of interest was below the market rate of interest. How may central banks try to increase liquidity by having a negative rate of interest? The Wicksellian answer would be that the natural rate of interest is negative.

² Hicks uses the elaboration of Wicksell's analysis done by Myrdal ([1931] 1933), translated as *Monetary Equilibrium*, at the time he expressed as selection of an equilibrium, where money wages moved little with increasing productivity, while flexible consumer prices decreased.

Boianovsky and Trautwein (2006) find that Wicksell considers a negative natural rate of interest when agents expect real income to decrease in the future. In terms of the model outlined above the demand for money decreases, turning capital gains into losses in addition to consumption loans being repaid, thus contracting money supply. Indeed, Laubach and Williams (2016) observe a sharp decrease in the natural rate of interest since the Great Recession.

5. CONCLUSIONS

This paper outlines a sequence analysis to consider how money, savings, and investments interact within the context of the Great Recession rather than the Great Depression, addressing negative interest rates, by modifying Lundberg's (1937) sequence analysis of economic expansion, which represents an intermediate position between Hayek and Keynes. Lundberg pursues a disequilibrium approach to macroeconomics having great affinity with Lachmann's theory of capital structure, while his sequence analysis has its origin in Wicksell's cumulative process and considers a Wicksell-Keynes savings-investment disequilibrium. Based on Wicksell's pure credit economy and monetary thought stressing the role of credit money, following Wicksell, Mises, and Schumpeter, but also Keynes, this paper considers endogenous credit money. It addresses the current situation with credit and money expansion causing increasing asset prices, by letting endogenous credit money finance consumption and investment in financial assets with capital gains. Excess credit yield capital gains that stimulates consumption, but allow for expansion at very low levels of replacement of industrial capital, meaning little reshuffling of capital. Instead, there is an asset price bubble.

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