Abstract

Unlike Trygve Haavelmo’s seminal contributions to econometrics, his research program in macroeconomic theory is not widely known. In this paper we present his short-run macro model for an economy with deregulated financial markets and a policy determined interest rate path. Driven by a mismatch between the marginal return to capital and the rate of return required by capital owners, a Wicksellian heritage, Haavelmo’s model generates cycles. This highlights how today’s standard equilibrium models may have left out an important characteristic of how the economy functions. It further implies that care should be taken when conducting monetary policy. Adopting a strict nominal anchor as the main objective of monetary policy might generate disequilibrium, or imbalances, in the capital market.

Keywords: investments, business cycles, monetary policy.

JEL classification: E22, E32, E44, E52

The importance of the interest rate for continued economic expansion is not determined by whether it is high or low, whether it is adjusted upwards or downwards etc, the whole point is to keep the inequality in favor of the marginal productivity of capital.

Haavelmo, 1969, p.153, the authors’ translation.
1 Introduction

During the past twenty years, monetary policy has become much more central for macroeconomic stabilisation policy than it used to be in the first decades after World War II. For example, a number of countries have imposed inflation targeting where the central bank (CB) publishes projected interest rate paths that are consistent with the inflation forecast reaching the target in a future period. The interest rate, and more specifically the interest rate path, is the policy instrument. During the same period, the models that are used to aid monetary policy have developed to become dynamic stochastic general equilibrium (DSGE) models.\(^1\) As the name suggests, these models are genuine equilibrium models, and despite short-run frictions, the economy is never far away from equilibrium over the policy horizon. Because of the inherent dynamic stability of the standard models they are not well calibrated to real world disequilibrium dynamics, recently exemplified by the Great Recession of 2007-2009.\(^2\) This observation indicates that there may be deeper forces set in motion by interest rate setting policies than smooth adjustment of prices, and that the potential of disequilibrium deserves more attention than hitherto in “the science of monetary policy”.\(^3\)

In the history of economics, many leading economists have analysed the potential and limitations of monetary policy in their work. John M. Keynes’ ”General Theory” is perhaps the most important single work. In this paper, we want to bring attention to a theory developed by the Norwegian economist Trygve Haavelmo (1911-1999). Not only was he a pioneer in the development of econometrics, for which he was awarded the Nobel Memorial Prize in Economic Sciences in 1989, but he made important contributions to macroeconomics, monetary theory and business cycle theory under influence of Frisch, Keynes and, not least, Wicksell. A recurrent theme in Haavelmo’s theoretical contributions was the interaction between financial markets, capital markets, and the rest of the real economy, and that the ’likely’ outcome of this interaction may be disequilibrium rather than equilibrium dynamics.

Haavelmo wrote at the high tide of Keynesian fiscal policy activism and he lived in a country known for economic planning and regulated markets where sudden falls in the activity level, unemployment, and other business cycle phenomena were thought to be plagues of the past. Given this, it may seem surprising to claim that Haavelmo wrote anything of interest for today’s economists. The solution to this paradox is that Haavelmo studied the role of monetary policy in models where markets were assumed to be completely liberalised and where firms and households in important respects behaved in accordance with the classical theoretical paradigm. Thus, Haavelmo formulated theories that may have seemed far-fetched and of little relevance for the practically oriented economists of his day. The course of history has changed this and Haavelmo’s macroeconomic theory now represents a perspective that seems surprisingly fresh and with many useful insights.

Haavelmo’s understanding of the linkages between the real economy and the financial markets was inspired by the writings of Wicksell (1898, 1906), and his analysis of monetary theory can be seen as complementary to the arguments of Wicksell that led

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\(^1\)A standard reference is Smets and Wouters (2003).

\(^2\)For recent critique of such models, see e.g. De Grauwe (2010a).

\(^3\)This label is from Clarida et al. (1999).
to his famous cumulative process. This is concisely presented in Chapter 33 of the book “A Study in the Theory of Investment” (Haavelmo, 1960). There he outlines how a fundamental overdeterminacy arises in standard models if the authorities choose to use the rate of interest as a policy instrument. This overdeterminacy is due to the properties of standard arbitrage conditions for the agents’ portfolio decisions. Equilibrium in the financial market gives a relationship between the equilibrium real interest rate and the rate of return on capital. Since the rate of return is determined by the real economy, an exogenously set interest rate will make the model logically inconsistent (overdetermined).

Macroeconomic equilibrium, both in the classical and modern sense, is based on a model which is logically consistent, so when overdeterminacy occurs one of the main premises for smooth equilibrating dynamics is lost. In this situation, one important task for macroeconomic theorising is to present models of how the economy realistically functions when the equilibrium model no longer applies. Below, we explain how Haavelmo took up the challenge, and how he arrived at a model with non-linear dynamics and endogenous cycles. These model properties are interesting in themselves, and they mark a stark contrast to the predictions of the modern DSGE models used to guide monetary policy. As noted, Haavelmo had studied Wicksell and he pointed out that adding a dynamic element in the form of a cumulative inflation process is another way to make the model consistent. However, in Haavelmo’s own short-run macro model it is the quantitative variables (‘the level of economic activity’) that bears the bulk of the disequilibrium dynamics. This means that there is a definitive Keynesian flavour to Haavelmo’s model.

In addition to his 1960-book, the best source to Haavelmo’s macroeconomic model is perhaps “Orientering i makro-økonomisk teori” (“A Study in Macroeconomic Theory”), Haavelmo (1969), henceforth referred to as SMT. A main topic of the book is how to design a logical system for understanding and managing a complex decentralised market economy, consisting of agents pursuing individual, and often conflicting, goals. This book was on the reading list for several generations of Norwegian economists, but was never completed as a textbook in English.

Moene and Rødseth (1991) provide an excellent presentation of Haavelmo’s contributions to econometrics and economics. Our paper supplements theirs by focusing on the aspects of Haavelmo’s theories that are relevant for monetary policy and for understanding the business cycle. Unlike Wicksell’s cumulative process, Haavelmo’s contribution to macroeconomics is largely unknown among contemporary economists. This also holds for his interpretation of the cumulative process as a force potentially created by the fundamental overdeterminacy. Hence our goal is to make some of his ideas better known to a broader audience.

The rest of the paper is organised as follows: We start out in Section 2 by presenting Haavelmo’s law of indifference in the capital markets. In Section 3 it is shown how this implies a fundamental overdeterminacy in a macroeconomic model where the monetary authority sets the interest rate. Disequilibrium will be an intrinsic feature of such mod-

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4Haavelmo stressed that the model would then be unable to reach a stable stationary equilibrium.

5Morgan (1990) is the first academic appraisal of Haavelmo’s Probability Approach to Econometrics, see Bjerkholt (2005, 2007) for a recent contribution. The reader is referred to Nerlove (1990) for a more critical appreciation of Haavelmo.

6Andvig (1993) also discusses some of these issues. Further, in an article written in Norwegian, Bårdsen and Nymoen (2001) make use Haavelmo’s conceptual framework to aid the interpretation of their macroeconometric model of inflation targeting.
els, and we explain how Haavelmo translated the overdeterminacy into dynamic forces by utilising the desire to purchase new or get rid of existing capital equipment. His endogenous regime-switching business cycle model is explained in Section 4, whereas the scope of his ideas today are discussed in Section 5. Section 6 concludes.

2 The Law of Indifference in the Capital Market

A line of thought characterising many of Haavelmo’s writings is what impact an unregulated capital market will have on the economy, and the implications for private investment activity. Like in other Western economies, the Norwegian capital market remained heavily regulated for a long period of time after the Second World War. Even long before full deregulation had taken place, Haavelmo outlined a monetary theory and its policy implications within a deregulated and decentralised context. Of special interest was his proposition that a fundamental overdeterminacy might be inherent in models where a monetary authority imposes additional constraints on the money market rate of interest. To see more closely what Haavelmo had in mind when he referred to this fundamental overdeterminacy, we present a “skeleton” model that was typical for his approach to almost any issue.

To illustrate the basic concepts, let us first abstract from modeling the real economy, and take it as given. Consider a closed economy where we distinguish between the private sector and the monetary authorities (representing the entire banking industry as well as the CB). The private sector consists of households and capital owners renting real capital to producing firms. At any point in time, the private sector has a given nominal wealth, $W$, which can be held in cash (as deposits in the banking sector, denoted $M$) and in real capital, with a nominal value $pK$. In the short run, the stock of capital available in the economy can be regarded as fixed. The banking sector’s balance sheet reminds us that deposits ($M$) are the counterpart to loans ($L$) to the private sector in this setting. Therefore, the following relations have to hold in this economy:

$$W = pK + M - L$$

$$M = L$$

We consider the private sector as one agent with well-defined preferences over different portfolio compositions. Real capital earns a return $r_K$ when capital owners are renting equipment to private firms. Money holdings in the form of deposits give a return equal to the money market rate of interest, $i$. Here we introduce real money holdings (or deposits) along with an aggregate measure of the general level of activity in the economy, $Y$, which can be interpreted as a measure of GDP. The preference function is assumed to be:

$$V \left( K, \frac{M}{p}, \frac{L}{p}, \frac{W}{p}, r_K, i, Y \right)$$

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7 For a description of the deregulation process in Norway, see Krogh (2010).
8 The model presented in this section is based on Chapter 23 of SMT.
9 $K$ is a physical measure of the stock of real capital at some point in time, $p$ is the price level.
where the choice variables are \( (K, M, L) \), with exogenous parameters given by \( \left( \frac{W}{p}, r_K, i, Y \right) \).\(^{10}\)

The private sector is assumed to maximise (3) subject to a wealth constraint (1). For a given set of exogenous parameters, the optimisation will result in standard “demand functions” like those in (4) - (6) below, where the star indicates an optimised value:

\[
K^* = k \left( \frac{W}{p}, r_K, i, Y \right) \tag{4}
\]

\[
\left( \frac{L}{p} \right)^* = l \left( \frac{W}{p}, r_K, i, Y \right) \tag{5}
\]

\[
\left( \frac{M}{p} \right)^* = m \left( \frac{W}{p}, r_K, i, Y \right) \tag{6}
\]

In equilibrium, with \( Y \) and \( p \) given in the short run, and (1) and (2) satisfied, we automatically have \( pK = W \). Hence, we end up with a single equilibrium condition, which can be expressed as:

\[
m(K, r_K, i, Y) = l(K, r_K, i, Y) \tag{7}
\]

This condition defines an equilibrium relationship between the two rates of interest. Haavelmo refers to it as the law of indifference in the capital markets. The interpretation of (7) is the following. Consider first the case of an endogenous money market rate of interest \( i \), which Haavelmo called passive monetary policy. In this case (7) determines \( i \), since \( r_K \) is determined by the marginal return to capital derived from the macro production function. Next we have the case of active monetary policy, i.e. when \( i \) is used as an instrument and is set by the CB. In this case (7) defines what we denote \( r^* \): the rate of return that the capital owners require so as to be willing to keep the given stock of real capital. This regime is what we will focus at in the following. It is then practical to write (7) for the case of an exogenous interest rate \( i \) as

\[
r^* = f(i; K, Y) \tag{8}
\]

### 3 Fundamental Overdeterminacy

Will we in a regime with active monetary policy have a required rate of return \( r^* \) compatible with macroeconomic stability, for example as a stable flow of private investments, smooth private consumption and a high employment ratio? To realise that the answer is “No” is crucial to the understanding of Haavelmo ideas. The heart of the matter is how various interest rates are determined. When considering a classical model where agents make portfolio decisions according to the description above, Haavelmo focuses on a simple, yet crucial point. Equilibrium in the asset market requires (7) to hold. At the same time, capital equipment \( (K) \) is owned by households and rented by firms to produce output according to an aggregate production function \( \phi(K, N) \), where \( N \) is aggregate employment. With depreciation being proportional to capital in use, profits are given by \( \phi(K, N) - \delta K \), and the marginal return to capital is given by \( \phi'_K(K, N) - \delta \). Given this

\(^{10}\)Patinkin (1956) formalised similar preferences by incorporating real money balances in the preference function. We might say that (3) captures the Pigou and Fisher effects, as discussed by Tobin (1980).
When we instead consider the case when the interest rate is used as a policy instrument, the required rate of return $r^*$ is given by (8), and at the outset there is no reason to expect $r^*$ to coincide with the marginal return to capital $\phi'_K(K, N) - \delta$. This causes capital owners to receive either more or less from renting out capital than what is required for equilibrium in the asset market. If we put on ourselves the restriction that an economic explanation should be based on a determined mathematical model, we see that we now have a puzzle: The model that we have formulated cannot explain how the economy functions in the case of active monetary policy—the model is fundamentally overdetermined.

One way of reading this result is that it is an argument against active monetary policy, perhaps of the inflation targeting type. This would be to take the logic too far though. The overdeterminancy is only a feature of an economic model, not of the real world. Hence, the only mistake we can do as economists is to use a wrong or irrelevant model to aid monetary policy. Specifically, models that implicitly or explicitly assume that the capital markets are in joint equilibrium have low relevance for monetary policy in Haavelmo’s view:12

It is obvious what an actual economy does under such circumstances: It operates under a different model that does have a solution. Why, then, should we take even the slightest interest in an overdetermined model? If we do, the only acceptable reason would seem to be that we believe that, somehow, the economy first “tries out” the hopeless model, and then derives a practicable alternative in a way which could be predicted by studying the overdetermined model.

Haavelmo pointed out that one possible solution would be to add a Wicksellian cumulative process, as noted in the introduction, but he did not pursue that possibility himself.13 Instead, he presented a complementary suggestion, namely to exclude $\phi'_K(K, N) - \delta = r^*$ as a condition in the model, and at the same time sketch a theory of investment behavior outside of the ”classical” equilibrium (which requires this equality to hold). This is a natural way to attack the issue since a state of disequilibrium plays an important role in explaining investment behavior in his 1960-treatise.14 A point he stressed was that in a classical model there is no way to derive the demand for investment from the first-order condition with respect to capital. The theorist therefore has to look for other reasons than the classical profit motive in order to get a formal theory of investment, this being for instance supply side constraints or time-lags in the production of capital goods.15 The way to avoid an overdetermined model that Haavelmo presents in SMT can be viewed as a short-cut to the more complicated job of modeling supply side constraints.

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11This level corresponds to what Wicksell (1898) called the normal rate of interest.
12Haavelmo (1960, pp.200–201)
13To see examples of how Haavelmo presented the cumulative process in his lectures in Oslo during the 1950s, see Thalberg (1952, 1955).
14See Boianovsky (2002) for comments on how this influenced, and was influenced by, the unemployment theories of Don Patinkin.
15Several authors have recognised these insights, see e.g. Nickell (1978, p. 12).
To see the point, focus on the source of the "problem", namely that the exogenously determined interest rate level interferes with equilibrium in the capital market. When the law of indifference in (8) gives a required rate of return corresponding to the actual rate of return, the households (which are the investors) have an implicit demand for investment, passively investing their savings. But we also need to know how they will react when \( r^* \) fails to match the marginal productivity of capital. A simple theory is:

\[
\text{Investment demand} = \begin{cases} 
\infty & \text{if } \phi'_K(K, N) - \delta > r^* \\
\text{Passive} & \text{if } \phi'_K(K, N) - \delta = r^* \\
0 & \text{if } \phi'_K(K, N) - \delta < r^*
\end{cases}
\]

This is only a formal way of saying that when the interest rate is set too low, investors will try to purchase as much capital equipment as possible. When it is too high, they will not invest at all.

Clearly, infinite demand cannot be be an equilibrium outcome. Since there is no capital price in this one sector economy, there is no way for investors to signal their desire for more capital, and no reason for consumers to cut back on consumption to make a larger piece of the pie available for investments.

Since the theory of optimising behavior cannot be applied to figure out how total production will be distributed between consumption and investment, Haavelmo imposed rationing of investors. This meant that a state with demand exceeding supply had to be allowed in the solution of the macro model. Given this, Haavelmo argued briefly that for simplicity he would let consumption have priority to the domestic product. This will make maximum supply of capital goods constrained to equal GDP at full employment net of consumption.

We next follow Haavelmo and show how these different theory elements can be used to formulate a short-run macro model which is logically consistent, regime dependent, and implies interesting dynamics.

### 4 A Business Cycle Model

In Part VI of SMT, the implications of overdeterminacy and the possible investment responses are taken into a macrodynamic model. It is a Keynesian type macro model for a closed economy, where the investment response of firms in the economy plays a fundamental role. Haavelmo included a brief presentation of this model in his article on business cycles in the International Encyclopedia of the Social Sciences, see Haavelmo (1968). But the only full-fledged presentation is found in SMT.

#### 4.1 Momentary equilibrium

We assume that there is a representative firm producing aggregate output \( (Y) \) at every instant according to a standard macro production function:

\[
Y(t) = \phi(N(t), K(t))
\]
where $N(t)$ denotes labour input and $K(t)$ is capital input. As noted above, in any period $t$ the capital stock is a predetermined variable. The firm can hire one unit of labour or capital at prices $w(t)$ and $r_K(t)$, respectively.

The labour market is modeled by assuming that the entire labour force, $H(t)$, is willing to work as long the wage they receive exceeds some reservation level $\overline{w}$. During periods of unemployment, competition on the supply side drives the wage down to the reservation level. Under full employment, competition on the demand side will push the wage up to the marginal productivity of labour. We therefore have the following conditions for the labour market:

$$N(t) \leq H(t)$$

(10)

$$w(t) = \begin{cases} \frac{\partial \phi}{\partial N} & \text{when } N(t) = H(t) \\ w(t) & \text{when } N(t) < H(t) \end{cases}$$

(11a, 11b)

It is assumed that $\overline{w}(t)$ corresponds to a minimum wage set by the government at a “reasonable” level.

As explained above, the household sector seeks to hold an optimal portfolio, investing its wealth either in capital or deposits. For an exogenously set money market interest rate we find the investors’ required rate of return from the law of indifference on the capital markets. Taking (8) and simplifying by setting $f'_Y = f'_K = 0$, we get it in its crudest form:

$$r^*(t) = f(i(t))$$

(12)

This model therefore applies for a regime where the interest rate $i$ is used as a policy instrument.

The household sector is willing to hold the existing capital stock as long as the return from doing so does not fall below $r^*$ in (12). The actual return to capital, $r_K$, is found from the firm’s optimisation problem:

$$r_K = \phi_K(K, N) - \delta$$

(13)

If $r_K > r^*$, the household sector earns more from holding capital than what they require, given the money market rate of interest, $i$. They will invest as much as possible in order to increase their stock of capital, but rationing implies that investments are limited to full capacity GDP minus consumption. When $r_K < r^*$ we are in the opposite situation – they are not getting their required return and would, if they could, get rid of capital. Of course, gross investments cannot be lower than zero, but this will at least result in a negative net investment given sufficient depreciation. This yields the following discontinuous relation for private investments, $I_p$:

$$I_p(t) = \begin{cases} \phi(H(t), K(t)) - g(R(t)) - C_g(t) - I_g & \text{when } r_K(t) \geq r^*(t) \\ 0 & \text{when } r_K(t) < r^*(t) \end{cases}$$

(14a, 14b)

16 The function in (9) is assumed to be constant returns to scale, strictly increasing and concave in both arguments. This implies that the inputs are technical complementarities.

17 It should be noted that these labour-market assumptions are not identical to those in SMT, but rather a special case of equation (26.8), where the only wage-requirement is that the entire labour force is always willing to work for a wage not exceeding the marginal return of the representative firm.
where the first case represents maximum investments and the second one the minimum case.

To complete the description of the demand side, we assume that private consumption, \( C_p \), is given by some consumption function \( g(R) \), where \( R \) is net-of-tax income.\(^{18}\) Government consumption, \( C_g \), and investments, \( I_g \), are taken to be exogenous. We have the following definitions of aggregate consumption, investments, income, and condition for clearing of the goods market:

\[
\begin{align*}
C(t) &= g(R(t)) + C_g(t) & (15) \\
I(t) &= I_p(t) + I_g(t) & (16) \\
R(t) &= Y(t) - \delta K(t) - T(t) & (17) \\
Y(t) &= C(t) + I(t) & (18)
\end{align*}
\]

where \( T \) is the amount of taxes collected by the government.

### 4.1.1 Multiple regimes

Equations (9) - (14) gives the model of momentary equilibrium. At first sight it seems like we have too many conditions – 8 endogenous variables and 9 equations. However, by inspecting the equations more carefully we observe that not all will bind simultaneously. If \( r_K \geq r^* \), (14) coincides with (18), while (10) is binding and (11) determines the wage rate. In the opposite case, \( r_K < r^* \), equations (18) and (14) represent independent relationships, while (10) can be ignored. Hence the model does not have one single momentary equilibrium. Instead there are two possible equilibria, or regimes.

The prevailing equilibrium will depend on aggregate investment activity in the following way: If the effective return to capital is above \( r^* \), capital owners’ response will be to invest as much as possible, making demand for labour increase to a point such that \( N(t) = H(t) \). However, if the marginal return to capital is less than \( r^* \), aggregate investments will be determined only by \( I_g \), since private investments will drop to zero in such a case. Demand for labour will follow accordingly. This can be summarised as follows, using A and B to label the two regimes:

**Regime A:** A “high activity” state (boom), characterised by capacity constraints on the supply side. This occurs when investments are given by (14a) – as much as possible is invested. The result is full employment with (10) binding and (11a) determining the wage.

**Regime B:** A “low activity” state (bust) which is demand constrained. This occurs when investment is given by (14b) – as little as possible is invested. The result is unemployment [(10) is not binding] and wages are fixed at the level in (11b). Employment, \( N(t) \), follows from (9).\(^{19}\)

Two factors are important in determining which regime that will prevail: The initial situation – including ”initial” employment – and the current rate of interest \( i \). Let \( \bar{N} \) be

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\(^{18}\)The marginal propensity to consume, \( g'(R) \), is positive but less than one.

\(^{19}\)With fully flexible wages, the drop in output would be smaller, but it would have no qualitative effects.
the level of employment arising under regime B (whereas $H$ is the level under regime A), and define $\bar{i} = f^{-1}(\partial\phi(H,K)/\partial K - \delta)$ and $\bar{i} = f^{-1}(\partial\phi(N,K)/\partial K - \delta)$ which are, as we will see, two critical levels of the interest rate. Figure 1 indicates how the momentary equilibrium is determined.

To first clarify the importance of the initial situation, suppose we start out with some interest rate $i \in [\hat{i}, \bar{i}]$ and initial employment at a level $N$ such that the marginal productivity of capital corresponds to a point like $a$ in Figure 1. In this situation, capital owners will recognise that the marginal return to capital is higher than the required return $r^*$, and their response will be to invest as much as possible. Employment jumps to $H$ and as a result of that the actual return to capital jumps to its regime A level. What if employment had started at a lower level, making the marginal return to capital correspond to point $b$? In this case, capital owners would want to invest as little as possible, and employment would fall to $N$ while $r$ would jump down to $\partial\phi(N,K)/\partial K - \delta$. Hence neither $a$ nor $b$ can constitute equilibrium combinations of the marginal productivity of capital and employment – equilibrium employment is either $H$ or $N$.

The effect of monetary policy therefore depends on the initial situation. If employment is at $H$ and the interest rate at any level $i \in [\hat{i}, \bar{i}]$, the economy remains in a high activity state. However, if the interest rate is increased to a level marginally above $\bar{i}$, investments will immediately fall to its minimum level and the economy enters a recession. Employment falls to $N$, causing the marginal productivity of capital to drop further below $r^*$, and we enter regime B.

What if $i \in [\hat{i}, \bar{i}]$ and we are in regime B to begin with? Then we can see from Figure 1 that the economy will remain in recession – even if the interest rate is initially very close to $i$ and then reduced to a level just above $\hat{i}$. To initiate a regime shift, the interest rate must be reduced to a level below $\hat{i}$, making it sufficiently profitable to invest in new capital goods. If that happens, employment will jump to $H$ and we switch to regime A.

In sum, two central conclusions may now be drawn: If the economy is initially characterised by the high activity state, then any interest rate below $\bar{i}$ will sustain high activity. However, if the economy is in the low activity state, then any interest rate exceeding $\hat{i}$ will keep the economy in a depression.

![Figure 1: Two alternative regimes – confer Figure (26.12) in SMT](image-url)
4.1.2 ‘Liquidity trap’

Note that there might well be a big discrepancy between the interest rate level required to push the economy out of the low activity state and the interest rate that moves the economy from the high activity state to the low activity state.\textsuperscript{20} The implication of this is that it might be easier to use the interest rate to dampen activity than it is to use monetary stimulus to speed up recovery.

In this spirit, Haavelmo provides an alternative explanation of the situation known as the Keynesian liquidity trap. His point is that it can happen that, as is the case in Figure 2, the actual return to capital in the low activity state is below the required return for any money market interest rate. An activistic monetary policy will by itself not be sufficient to move the economy out of recession. As Haavelmo puts it in SMT:

J.M. Keynes and other macroeconomists have emphasised that an economy might end up in a situation where no positive interest rate level is low enough to move the economy out of a low activity state.\textsuperscript{21}

Even though the prescribed cure is the same as that recommended by Keynes and others, namely supplementing monetary policy by a fiscal expansion, the mechanism is quite different. Consider the case where no investments are carried out by existing firms because the return to capital is less than the required rate from the law of indifference (the lower line in Figure 2). Monetary stimulus is not sufficient to stimulate recovery. However, assume that the government increases public investments by an amount $\Delta I_g$. This fiscal expansion will increase employment in the low activity state, leading to an increase in the marginal productivity of capital due to technical complementarities in production. This is illustrated by shifting the lower line in Figure 2 upwards. If the interest rate is kept low enough (at least lower than $i'$), the combination of expansionary fiscal and monetary policy may be sufficient to push the economy into the high activity state.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{potential_liquidity_trap.png}
\caption{Potential liquidity trap – confer Figure (26.15) in SMT}
\end{figure}

\footnotesize
\textsuperscript{20}The same point is stressed in Haavelmo (1968), where a similar model is very briefly discussed.
\textsuperscript{21}Haavelmo (1969, p.145), the authors’ translation
4.2 Endogenous cycles

In the previous section, we showed how the model operates \textit{at any given moment in time}, and we saw that two possible regimes can prevail. We now consider the dynamic implications of the model. It will become evident that the model has a typical solution with switching between the two regimes, creating \textit{endogenous cycles}.

In a dynamic context we need, in addition to (9)-(14), equations governing how the stocks of labour and capital evolve over time. We therefore define:

\[
\dot{K}(t) = I(t) - \delta K(t) \quad (19)
\]

\[
\dot{H}(t) = \text{Some function of time} \quad (20)
\]

As we saw in the description of the alternative regimes, a central variable in the model is the marginal productivity of capital. When capital and the population evolve over time, so will the marginal productivity of capital. For instance, let us consider the development if we are constantly in regime A. If both the capital and labor stock are growing, for small values of growth in the labour stock the marginal productivity will decrease over time as the capital stock increases. Alternatively, if population growth is high then we might have an increasing marginal productivity if investments are insufficient to stop the capital intensity from decreasing. Figure 3 illustrates two alternative paths; “Low” $\dot{H}$ and “High” $\dot{H}$.

![Figure 3: Marginal return dynamics under regime A – confer Figure (27.11) in SMT](image)

Figure 3: Marginal return dynamics under regime A – confer Figure (27.11) in SMT

Interestingly, what matters is not really the exact time-profiles for marginal productivity, but how they match the path of $r^*$, the required rate of interest, uniquely determined by the path of the policy instrument $i(t)$. In Figure 3 two possible interest rate trajectories are drawn. If the relevant development for $\frac{\partial \phi}{\partial K} - \delta$ is that of “High” $\dot{H}$, we see that the economy is on a sustainable full employment path no matter whether $r^*_1$ or $r^*_2$ is chosen. However, if we consider the case where population growth is low, an interest rate path such as $r^*_1$ will not sustain high activity forever, since as soon as point c is reached we will shift to regime B. This implies that the model can create endogenous switching between the two regimes.

\textsuperscript{22}At least within the horizon shown in the figure.
Assume for simplicity that the interest rate is constant and \( \dot{H} = 0 \). Under appropriate assumptions for values of the various exogenous variables, we will have that:

- Under Regime A, the marginal productivity of capital \( \textit{declines} \) because of positive net investments.
- Under Regime B, the marginal productivity of capital \( \textit{rises} \) since the capital stock shrinks.

Say we start out in regime A at some point in time, \( t_0 \). Firms are investing as much as they are able to with full capacity utilisation at any given point in time. However, as capital is accumulated, the marginal productivity of capital will decrease – this is illustrated in panel (a) of Figure 4. At \( t_1 \), it has fallen to a level equal to \( r^* \), and as soon as it falls below this rate there will be a switch to regime B (corresponding to point c in Figure 3). Firms stop investing, leading to a sudden drop in output and an increase in unemployment. Further, since the stock of capital is unchanged but employment has fallen, the marginal productivity of capital jumps down to a level \( \textit{far below} \ r^* \). These shifts are depicted in the three panels of Figure 4. After the sudden drop, the marginal productivity of capital recovers as the stock of capital is slowly worn out. When we reach \( t_2 \), it has returned to the level \( r^* \), and as soon as it is marginally above \( r^* \) we switch back to regime A. Firms start to invest again, leading to a jump in production and employment. As a result, the marginal productivity of capital jumps up, and a new cycle starts.
Figure 4: Haavelmo’s Business Cycle Model – confer Figure (28.1) in SMT
5 Discussion

The regime-switching process and the distinct boom-recession-boom cycle of Haavelmo’s model are the results of two of his main premises. First, he replaced the notion of a mathematically well behaved (smooth) investment function with the idea about arbitrage-based investment strategies. Second, he showed that in a model that included real capital as one of the assets investors can hold, the money market interest rate cannot be autonomously controlled by the CB without this causing out-of-equilibrium effects. Haavelmo’s logical scheme implies that imbalances between supply and demand for capital and assets may occur. When applied jointly in a macroeconomic model, the two principles implies disequilibrium macrodynamics with endogenous switching between low activity and full employment regimes. Taken at face value, Haavelmo rejected the *Neo Classical Synthesis* macro model which was the standard approach up to the stagflation period that followed in the wake of the two OPEC oil price shocks in the 1970’s.

As a business cycle theory, Haavelmo improved upon the existing models of his time. In particular, he paid attention to Goodwin (1951) which he characterised as weakly founded because it “lacked proper behavioural theory for the producers”, Haavelmo (1969, p 156). Haavelmo found it unsatisfactory that Goodwin’s model rested on *ad hoc* upper and lower bounds of desired capital stocks (that corresponded to full employment and to the low activity level respectively) without any reference to profitability considerations. As we have seen above, Haavelmo improved on this, and he succeeded in modeling the joint dependence between the desired capital stock and the activity level.

In formulating a full-fledged macroeconomic model with endogenous switching between a regime with classical and smooth growth and another with Keynesian unemployment, Haavelmo preceded the disequilibrium or fixed-price macroeconomic models of the 1970s and 1980s; see *e.g.*, Barro and Grossman (1976), Malinvaud (1977), Bénessy (1986, 2002).\(^{*}{23}\) It is interesting to observe that whereas these models first abstracted from investments and capital markets, the main, underlying idea of Haavelmo’s model is that states of disequilibria arise in the interface between asset markets and the real economy.\(^{*}{24}\) The profession seems to a large extent to have lost interest in disequilibrium macroeconomic models around 1990. It will never be known whether or not the perspective adopted by Haavelmo in SMT could have provided a powerful guideline and a different development.

Haavelmo adhered to the principle known as *Occam’s Razor*. His theoretical macro model, (which he often referred to as a ‘ribbed to the bone’model) should include only the essential mechanisms that would survive also in extended versions of the model that would (potentially) bridge the gap between theory and the real world—but no other elements. The following quotation is rather typical.\(^{*}{25}\)

> It is worth reminding the reader that the above conclusions do not represent statements about the development of the real world, rather they are state-

\(^{*}{23}\)In Weintraub (1979), Haavelmo’s impact on subsequent disequilibrium modeling, is fully recognised; see p.84. Some preliminary thoughts on how to analyse issues outside equilibrium were written, in Norwegian, and published in a “Festschrift” to Frederik Zeuthen in 1958, called “What can static equilibrium models tell us?” (Haavelmo, 1958). This note was published in English in Haavelmo (1974).

\(^{*}{24}\)Investment and dynamic disequilibrium issues were later analysed by Malinvaud (1980).

\(^{*}{25}\)Haavelmo (1969, p 155), our translation.

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ments that strictly speaking are valid only within the logic of the model. That said, we would also make clear that the model has not been presented just for the purpose of doing some mathematical deductions and analysis. We have of course tried to formulate a model that represent certain salient features of the real world economic systems that we find in many countries, Norway included.

Haavelmo never undertook a systematic testing of his hypothesis about investment behaviour. Later researchers may have found the investment theory too specific to follow it up closely, and it remains to be seen whether an empirically congruent version of his model can be formulated without watering out the core theoretical ideas too much.

One way to increase the relevance from the theoretical side is to embed the main idea in a model with two or more sectors. In fact Haavelmo did consider a two sector model in Chapter 31 of Haavelmo (1960). In this model, the level of investment is determined by the relationship between the price of the pre-determined capital (stock), factor costs, and the technology in the production of new capital. As pointed out by Moene and Rødseth (1991), investments are determined from the supply side of the economy, and the implication is that investments are less volatile than in the classical model. Haavelmo did not study the effects of overdeterminacy in his two sector model, but doing so could be an interesting path for future research. This could also set the scene for analysing fascinating price dynamics.26

Moene and Rødseth also point out an interesting parallel to Tobin’s q-theory of investment, see Tobin (1969). The difference is that while Tobin’s theory needed rationalisation in the form of increasing firm adjustment costs to obtain ‘smooth’ investments, as in Hayashi (1982), Haavelmo in his two-sector model obtained a logically sound solution for the investment level with reference to the productive capacity of the macro economy itself. Hence, because of the way investments are determined, Haavelmo’s theory can be said to be supply side oriented in both the two sector version, and in the ‘cruder’ form presented above, where private firms ‘get’ what is left of GDP after consumption has chopped off its share.

It is important to keep in mind that the model we have presented is meant for one specific economic policy regime, namely a country (or economic area) with de-regulated financial markets and with an active interest rate policy aiming at stabilising the macro economy. The position taken by the modern theory of monetary policy is that this form of interest rate setting has lasting and predictable consequences for the nominal path of the economy, but only temporary consequences for the activity level. We have seen that the predictions from Haavelmo’s model are different, and in important ways also richer, than the implications of the standard model today.

Because of its obvious simplifications, there is no reason to believe that the model we have presented is able to completely describe the forces that are set in motion in the real world. It may of course be that the conduct of monetary policy is made easier by these other forces, but that does not seem very likely. We therefore have a paradox, namely that any attempt to use the interest rate as an instrument may lead to a loss of ability to forecast the macro economy, as we might not know which forces that will

26Haavelmo discusses to some extent the issue of price dynamics both in Chapter 31 of Haavelmo (1960) and in Chapter 24 of Haavelmo (1969).
dominte. Clearly, this is the exact opposite conclusion of the macro models that are actually used to guide inflation targeting. In these models, inflation is predictable and depends functionally on the interest rate, see Svensson (1997), and a popular view is that CBs should really aim for inflation forecast targeting. In the light of Haavelmo’s macroeconomic scheme, inflation targeting would seem to be a more daunting task, and that there would be some risks for reacting too slowly to imbalances outside the realm of the inflation rate and the output gap.

6 Final Remarks

As pointed out in the introduction, we believe that the macroeconomic paradigm of today might benefit from supplementing current theory with other insights. In particular, the way in which the capital market should be treated within the macroeconomic models used for analysing the economy should be (re)considered. Our paper explains and discusses a model due to Trygve Haavelmo where the capital market plays a crucial role. The insights from this model seem relevant also for macroeconomic model building today. Being strongly influenced by the Swedish economist Knut Wicksell (1851 - 1926), Haavelmo was in a position to develop Wicksell’s approach into a macroeconomic model that included capital markets.

In this paper, we have presented our interpretation of the core aspects of Haavelmo’s monetary theory of investment and business cycles. A central issue in understanding how a market economy with decentralised portfolio decisions will operate is the problem of overdeterminacy related to the law of indifference in the capital markets. This relationship has interesting implications for the analysis of active monetary policy through interest rate setting. Even though issues related to the law of indifference were known as early as in Haavelmo (1960), the full dynamic implications of this law were not completed or elaborated thoroughly until SMT was first published in 1966. In this treatise he presented a conventional, yet original, macrodynamic disequilibrium model with endogenous business cycles, where the activity level, due to sound economic principles, switched between a full capacity-regime and a low demand-regime.

As a final comment, we should note that Haavelmo also can be found relevant by those who aim to develop macroeconomics in a way that can, over time, become an alternative to the paradigm of rational expectations (RE) and, to some extent, micro-founded macro models. For instance, the strand of behavioural macroeconomics (see De Grauwe (2010b, 2011)) point to the incredible mental abilities required by agents if they behave as assumed by RE models. Specifically, they are assumed to know the entire structure of the economy, how to linearize this system, and finally to form expectations by the use of mathematical expectations. This feature of modern macroeconomics also come also under attack in the literature on imperfect knowledge economics, see Frydman and Goldberg (2007, 2011). Although Haavelmo does not make any particular assumptions regarding how expectations are formed, his model is, and in particular the arguments used to construct the model in SMT, will probably inspire those wanting macro models to be well-founded, but not necessarily micro-founded in the form that has become custom.
References


