

Austrian Economics: Application on Norwegian Business Cycles

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Abstract

This paper reviews the key elements of Austrian macroeconomics and aims to find out whether the Austrian business cycle theory can explain causes to Norwegian business cycles between 1979 and 2009. The Austrian school suggests that monetary interventions disturb the term structure of interest rates. This causes the capital structure to change which accounts for fluctuations of the business cycle. Credit-induced expansions with unchanged time-preferences create unsustainable growth which inevitably turns the economy into recession. Quarterly time series data of base money supply, interest rates, investment and private consumption expenditure, employment, prices, and aggregate output are analysed in order to find relationships with assumptions of causality. Empirical evidence show that Austrian business cycle theory can help explain fluctuations in aggregate output for Norway.

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*“The difficulty lies not so much in developing new ideas as in
escaping from old ones”*

John Maynard Keynes

1 Introduction

We have recently seen the “2007-2010 financial crisis” develop into the worst global economic crisis in peace time since The Great Depression of the 1930s. In the 2008 Republican presidential race in the USA, we familiarised ourselves with the candidate Ron Paul and his economic advisor Peter Schiff. These two Republican libertarians claim to have predicted the recent economic crisis.¹ At the core of their explanations of the crisis is the Federal Reserve’s inflationary monetary policy. Paul and Schiff can be seen as figure heads of the Austrian economics in American media.

Austrian economics is today a heterodox body of economic theory, but was previously one of the mainstream schools.² Its most influential period was in the late 19th and early 20th century. Austrian business cycle theory (ABCT), the part of the school focusing on an economy’s recurring and fluctuating levels of economic activity, states that credit created through expansionary central bank policies leads to unsustainable economic growth which is inevitably followed by a recession. According to the Nobel Prize Committee, Friedrich von Hayek, one of the most famous theorists of Austrian economics, “was one of the few economists who gave warning of the possibility of a major economic crisis before the great crash came in the autumn of 1929”.³

Discussing the second half of the 20th century, David Simpson of the David Hume Institute stated that “our intellectual understanding of the periodic fluctuations which characterise advanced market economies, the cycle of “boom and bust,” has scarcely improved at all during this period”.⁴ Thus, we ask ourselves if Austrian economics needs renewed attention in academia.

Key Questions

The aim of this thesis is to examine the Austrian school’s view on macroeconomics and analyse whether Austrian theory can give explanations to business cycles in Norway between 1979 and 2009. The reason for focusing on the last 30 years is due to lack of relevant quarterly or monthly data prior to 1979. Business cycles in Norway are measured by fluctuations in gross domestic product (GDP). We focus time series for Norway mainland and do not look at potential differences between the mainland economy and Norway as a whole. To limit the scope of this thesis, we will not enter the

¹ Sjølie 2009

² Thesaurus (2010a) defines “heterodox” as “characterised by departure from accepted beliefs or standards”

³ Nobel Prize Committee 1974

⁴ Simpson 2002

topic of fiscal policy, nor will we perform a normative analysis of the Austrian school. The key questions are:

1. *What are the key elements of Austrian macroeconomics and the Austrian business cycle theory?*
2. *Can Austrian business cycle theory help explain reasons to Norwegian business cycles between 1979 and 2009?*

Outline and Methodology

The thesis is arranged as follows:

First, we present a historical background of Austrian economics in order to enable general understanding of this school of thought. This section gives a chronological overview of the most important economic contributions including the central concepts and methodologies.

Second, we answer the first part of the key question by describing and presenting the unique aspects of Austrian macroeconomics and the Austrian business cycle theory.

Third, to enable easier analysis of the second part of the key question, we use an analytical approach to divide it into more specific hypotheses. In this part, we also describe the data that we use.

Fourth, we make the time series stationary which enables us to perform an analysis of reasons to Norwegian business cycles with help of Austrian business cycle theory. To test the hypotheses we make use of methodologies such as correlation, Granger causality, and multiple linear regression.

2 Austrian Economics: Background

In order to successfully understand the Austrian business cycle theory, it is important to look at the historical background of the Austrian school and to be introduced to the main methodologies and concepts of Austrian economics.

2.1 Origin

Austrian economics (also called the Austrian school, the Psychological school and the Vienna school) has its early origin in the 15th century and the followers of Thomas Aquinas. Over a couple of hundred years, these “late scholastics”⁵ elaborated models on supply and demand, explained causes of inflation, and described foreign exchange rates and the subjective nature of economic value. They also defended property rights and the freedom to trade while combating taxes, price controls, and regulations restraining firms.⁶

However, it was not until the late 19th century with Carl Menger, considered the founder of Austrian school, that Austrian economics really took form. He brought life back to the thoughts of the scholastics and took a big step forward with his *Principles of Economics* (1871). Menger was a methodological individualist believing in deductive logic as the basis for the science of economics. His book is most famous for the theory of “diminishing marginal return” which is the idea that growth in the consumer’s utility becomes lower and lower with higher disposable quantity: “(...) satisfaction (...) for food (...) diminishing according to the degree of satisfaction already attained.”⁷ This marginal utility for a product or a service therefore determined the value and thereby the price. This Austrian concept is called the “subjective theory of value” and is in contrast to classicism, which believes that price is determined by the costs of production and the neoclassical school which bases the prices on the equilibrium of supply and demand.⁸ This revolutionary approach by Menger gave the Austrian school its name by splitting with the mainstream German Historical school of economics.

⁵ Thesaurus 2010b, defines “scholasticism” as the “system of philosophy dominant in medieval Europe; based on Aristotle and the Church Fathers”

⁶ According to Ludwig von Mises Institute (2010a), Joseph Schumpeter described this group as the first real economists, Ludwig von Mises Institute 2010a

⁷ Menger 1976, p. 127

⁸ Singh 2010

2.2 Austrian Economists: First to Second Generation

Eugen von Böhm-Bawerk, greatly influenced by Menger, published *History and Critique of Interest Theories* in 1884 and *Positive Theory of Capital* in 1889. In these books, he defended the idea of the interest rate as a natural part of the market and as a result of people's preference to satisfaction of wants sooner rather than later (i.e. "time-preferences of money"). Böhm-Bawerk showed that capital and production are "heterogeneous" by having an intricate structure with a time dimension. He was finance minister three different times working for balanced state budgets, use of the gold standard, free trade, restrictions on monopolies, and the cancellation of export subsidies.

Ludwig von Mises is probably one of the most important contributors to the Austrian school. He showed how Menger's theory of marginal utility applies to money in his book *Theory of Money and Credit* (1912). Using, among other concepts, Böhm-Bawerk's theory of structure of production and capital, Mises presented the outlines of the ABCT. In his "regression theorem", he demonstrated that money always originates in the market. Central to Mises and Austrian economics is the importance of individuals always acting rationally and out of self-interest. Therefore, the only way of arriving at a valid economic theory is to obtain it logically from fundamental principles of human action. This is what is called methodological individualism: Analyzing human behaviour through the perspective of individual agents. It is described in Mises' *Human Action* which "remains the economic treatise that defines the school".⁹

Much of the Austrian economics' success came to an end when the Austro-Hungarian Empire collapsed in 1918 and Nazism took over in the 1930s. The important Wieser and Böhm-Bawerk were gone, Schumpeter joined other theorists, and the remaining members were dispersed over Europe and USA. This led to a deviation in research efforts from the Austrian core. However, Mises' famous "Privatseminar" in Vienna managed to train the third generation of the Austrian school, including Hayek.

2.3 Austrian Economists: Third Generation

Friedrich von Hayek was a classic liberalist defending the laissez-faire approach which argues for an economy with the least state intervention possible. Hayek claimed intervention by the government distorted relative prices and therefore wiped out valuable information. He thought that the government is not naturally led by price

⁹ Mises [1949] 1966, Ludwig von Mises Institute 2010a

signals and hence should not steer the market. This is also linked to Austrians' belief in Say's law and a decentralised, free market economy. Say's law says that supply creates its own demand due to a sufficient level of real income to purchase all output.¹⁰ Therefore, there is no need for government intervention. In 1974, Hayek received the award for economics by the Nobel Prize Committee.¹¹ He shared the prize with Gunnar Myrdal "for their pioneering work in the theory of money and economic fluctuations and for their penetrating analysis of the interdependence of economic, social and institutional phenomena".¹²

After the financial crash in 1929, Austrian theory took a more macroeconomic turn with Knut Wicksell and Hayek as main contributors. Hayek developed the "Hayekian triangle", a time-consuming multi-stage capital structure, which added an analytical and monetary aspect to Mises' theory on business cycles. His macroeconomic theories were also built on Böhm-Bawerk's and thereby Menger's work. Hayek showed that credit policy pursued by a central monetary authority can be a source of economy-wide distortions in the inter-temporal allocation of resources and hence an important cause of business cycles. According to the Nobel Prize Committee, Hayek "was one of the few economists who gave warning of the possibility of a major economic crisis before the great crash came in the autumn of 1929".¹³ The development of the Austrian capital theory was basically over with his *Pure Theory of Capital* in 1941.¹⁴

According to Hayek, the most important function of the market is to communicate aggregated information about (future) demand, (planned) production, and similar variables. However, Austrian theory sees aggregation as problematic since information comes from economic coordination at the microeconomic level. Howitz claims: "However, recognising that micro issues are the fundamental ones does not deny a role for distinctly macroeconomic analysis".¹⁵ This is why the function of the market price (which is natural) and its exchange of information are fundamental features of the economy. Austrian economics claims that the natural price is the market-based price, which to the Austrian school is the only correct aggregation methodology. The market price represents utility functions from the micro economy and is hence aligned with human action. Austrians deny other aggregate utility functions like the Keynesian aggregation, which uses shortcuts and oversimplifications, and the

¹⁰ The American Heritage Dictionary of Business Terms 2010

¹¹ The Nobel Prize Committee (1974) quotes the prize's real name as "The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel"

¹² Nobel Prize Committee 1974

¹³ Nobel Prize Committee 1974

¹⁴ Hayek 1994

¹⁵ Howitz 1996, p. 287

aggregation based on representative agents in the neoclassical research tradition.¹⁶ This is just one example of how the Austrian school criticised other schools and was criticised itself.

2.4 Controversies

Austrian economics has always been a controversial school of thought. Originally, there was a fundamental debate with the German Historical school. Between the 1890s and the 1940s, the Austrians and the Marxian and Socialist school debated each other in the so-called Socialist/Economic Calculation Debate. The most frequent topics were the role of governments and price systems. These issues have also been debated in more recent times, e.g. with Jeffrey Sachs' criticism of the Austrian school and particularly Hayek for the laissez-faire viewpoint. Sachs wrote that "a generous social-welfare state is not a road to serfdom (as Hayek meant) but rather to fairness, economic equality and international competitiveness".¹⁷ Furthermore, the ABCT has met sharp criticism from famous economists like Milton Friedman and Paul Krugman.¹⁸ However, the most intense dispute has been with Keynesianism and is the most important conceptual debate for ABCT today.

Keynes and the Austrians argued over a range of subjects, but the most important issues were the role of the government and business cycles. A strong Austrian divergence from Keynesianism is the belief in Say's law and the ABCT. While the Austrians claim that a recession is necessary for the economy to restore "proper" economic relationships,¹⁹ Say's law provides ABCT a reminder that there cannot be a recession without a distortion of the fundamentals of the economy.²⁰ Keynesian theory states that aggregate demand can become too low and thereby leading to recession. Keynes claimed that it is not the interest rate which ultimately decides the level of investments, but investors' changes in trend and mood (i.e. animal spirits etc.). Austrian theory sees lower interest rate and increased government spending as tools that will make the situation even worse whereas Keynesianism favours these measures in recessions. An analytical comparison with the Keynesian school will be done in chapter 4.5 "Keynesian Recession in an Austrian Framework".

On the methodological level the Austrian school has also been very controversial. The Austrian school refuses conventional methodological approaches of testability on

¹⁶ Garrison 2001

¹⁷ Sachs 2006

¹⁸ Friedman 1964, Krugman 1998

¹⁹ See ch. 4 "Austrian Business Cycle Theory"

²⁰ Anderson 2009

economics. As it is difficult to mathematically model human behaviour and as the market, relative prices, and utility functions are based on subjective values, the economy can simply not be analysed “in a laboratory”. Additionally important are the use of the falsification principle and the rejection of verification of theory due to only empirical support. Therefore, the Austrian school often rejects regression analysis and other econometrically and mathematically based approaches.

The Austrian school believes it is possible to solve complicated economic issues with “thought experiments”, i.e. deductive reasoning.²¹ Deduction, drawing conclusions by reasoning, is used on self-evident (to the Austrians) axioms. These undeniable axioms build on and are closely related to Mises’ methodological individualism. This process is called “praxeology” or, again, deductive reasoning.²² This methodological framework can be seen in contrast to neoclassicism which has been criticised for relying too much on mathematics, but also to other economic schools that make use of mathematical modelling and methodology.

2.5 Recent Times

The dispute between Keynesianism and the Austrians ended in Keynes's favour. After the Great Depression in the 30s, the idea that markets were self-adjusting was abandoned. Even some of Hayek’s students joined the Keynesian revolution. The New Deal policies in the USA were aligned with Keynesian theory and Keynes himself was present in Bretton Woods in 1944 to reshape the world economic system. Hayek's effort in 1941, *The Pure Theory of Capital*, to restate the Austrian capital theory and macroeconomic ideas failed. Keynesianism was very popular and was the most influential macroeconomic theory until the early 1970s. The world experienced high growth in the 1950s and 60s which was seen as a result of Keynesian policies. Time Magazine wrote that “Now Keynes and his ideas (...) have been so widely accepted that they constitute both the new orthodoxy in the universities and the touchstone of economic management in Washington”.²³

Two of the most recent contributors to Austrian economics have been Murray Rothbard and Roger W. Garrison. Rothbard defended a capitalistic social order and the laissez-faire system in *Man, Economy, and State*.²⁴ He also investigated the Great

²¹ Singh 2010

²² Thesaurus (2010c) defines “praxeology” as the “study of human behaviour and conduct”

²³ Time Magazine 1965

²⁴ Rothbard 1962

Depression, applying ABCT to show that the financial crash in 1929 and economic recession were due to an earlier bank credit expansion.²⁵

In *Time and Money*, Garrison wanted to show that the Hayekian triangle is the best starting point for development of a capital-based macroeconomics.²⁶ Garrison claims that modern macroeconomics fails by overemphasising expectations in modern theory. The Austrians think that the “mainstream lack” of real-coupling of the short- and long-term is closely linked to their lack of focus on the inter-temporal capital structure of the economy. The combination of short- and long-run in analysing the economy’s behaviour is hence at the core of Austrian economics. As Garrison puts it: “If Keynes focused on the short-run picture, and the classical economists focused on the long-run picture, then the Austrian economists, and particularly Friedrich A. Hayek, focused on the “real coupling” between the two pictures.”²⁷

Moreover, Garrison criticised Keynes's *General Theory*, defended Say’s law, and put Jean-Baptiste Say and his works back into a “central place in Austrian macroeconomic theory”.²⁸

Today, the most active Austrian environment is the Ludwig von Mises Institute which was established in 1982. The private institution is an academic libertarian organisation located in Alabama in the USA.

2.6 Background for Austrian Economics

Austrian economics emphasises the principle of “laissez-faire”, the marginal subjective theory of value, and the coordinative role of the market prices. Its macroeconomic theory also includes the concept of time-preference of money and coupling of short- and long-run to explain the central theory of the time-consuming multi-stage capital structure. Austrian economics is a controversial school which is particularly opposed to Keynesianism. The Austrians reject the Keynesian way of aggregation, defends Say’s law, and refuse use of mathematical models. Moreover, the Austrian school claims that deductive reasoning through methodological individualism is the only accepted general methodology for the field of economics. The most important contributors to Austrian economics were probably Carl Menger, Ludwig von Mises, and Friedrich von Hayek. The macroeconomic concepts will be presented more in detail in the next chapter.

²⁵ Ludwig von Mises Institute 2010

²⁶ Garrison 2001

²⁷ Garrison 2001, p. 4

²⁸ Ludwig von Mises Institute 2010

3 Austrian Macroeconomics

The inter-temporal structure of capital is a cornerstone in the Austrian framework of macroeconomics. Austrian capital theory, as envisioned by Hayek in the 1930's, deals with allocation of capital and production between early and late stages of production during the business cycle. Investors and other economic agents act upon the information available on prices, wages, and interest rates. Collectively, they also affect the same variables and allocate capital. If real relative prices of capital, more specifically the interest rates, are “wrong”, it follows by the Austrian school that the capital structure will be structured in an unsustainable way. This creates a mismatch between future supply and future demand which will cause an inevitable correction. Hence, a change in monetary policy is unsustainable. However, a potential change in time-preferences of consumers is sustainable. In this chapter, we will go over the basics and building blocks of Austrian macroeconomics.²⁹

3.1 Elements of Capital-Based Macroeconomics

Austrian capital-based macroeconomics has three main building blocks that serve as a graphical disposition and elementary framework. These three elements are:

1. The loanable funds market (LFM)
2. The production possibility frontier (PPF)
3. The inter-temporal structure of production (Hayekian triangle)

The first two should be known to most macroeconomists. However, the production structure is mostly ignored by modern macroeconomic theory, which generally rests upon the Keynesian and Neo-Keynesian framework. With the help of these three models, we will be able to analyse and deal with Austrian subjects like secular growth, capital structure, technology changes, changes in preferences, and the expansion and recession of the business cycle.

3.1.1 Loanable Funds Market (LFM)

In Austrian economic theory, the market for loanable funds looks at all disposable income that is not used for immediate consumption. It includes investments in equity shares and retained corporate profits. In a broad macroeconomic sense, the market for loanable funds can be seen as the market for “investable funds”. Here, supply is all

²⁹ The majority of the Austrian theory in this chapter is based on the work of Roger W. Garrison's *Time and Money* (2001)

funds made available for investment in real economic capital and accumulation of capital. The demand is the investor's need for resources. The compensation and "price" for borrowing these funds is the natural interest rate. Garrison points out that this is consistent with that of Keynes: "[According to the classical theory], investment represents the demand for investable resources and saving represents the supply, whilst the rate of interest is the 'price' of investable resources at which the two are equated."³⁰

The market for loanable funds is pictured in Figure 3.1. We see the equilibrium solution intersecting the demand and supply for loanable funds, where interest rate i_{eq} is the price response.

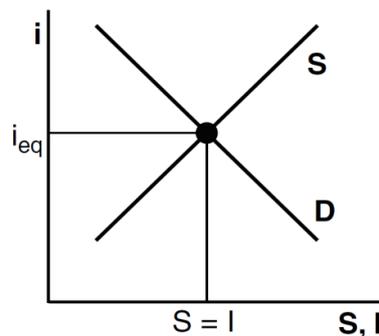


Figure 3.1 – The market for loanable funds (or for investable resources). Source: Garrison 2001

3.1.2 Production Possibility Frontier (PPF)

The PPF is an important graphical tool in the Austrian school.

I: All investments in real capital over a year

C: All consumption in a year

S: Savings over a year

These variables, which are similar to the ones in the framework used by Keynesian theories (C, I, S), can be combined to show the loanable funds market. The PPF shows the trade-offs in any given year, but can be expanded to show growth.

Figure 3.2 shows the national level of consumer goods versus investment goods for Japan and the U.S. in the post-war period. At this time, Japan sacrificed a lot of current consumption and saved a big proportion of their income. Austrians believe this to be the explanation for high investments and higher growth in Japan than in the U.S.

³⁰ Garrison 2001, Keynes 1937, p. 175

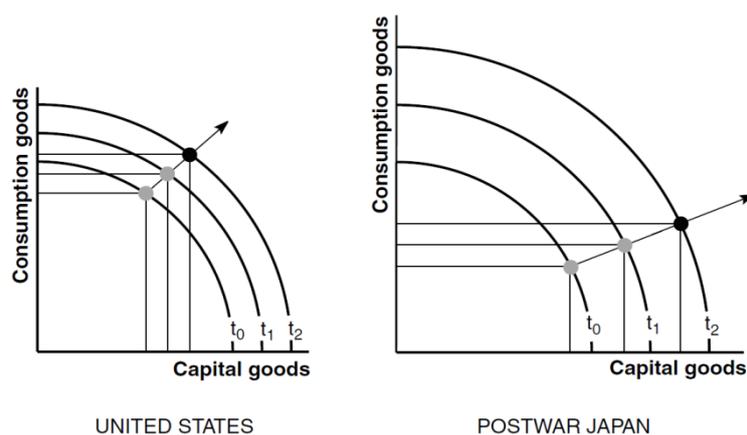


Figure 3.2 – Capital and growth (United States and Post-war Japan). Source: Garrison 2001

Figure 3.3 shows the three different states of an economy: contracting, stationary, and expanding. A stationary state means that investments are equal to depreciation of existing capital, so that net capital value stays the same.

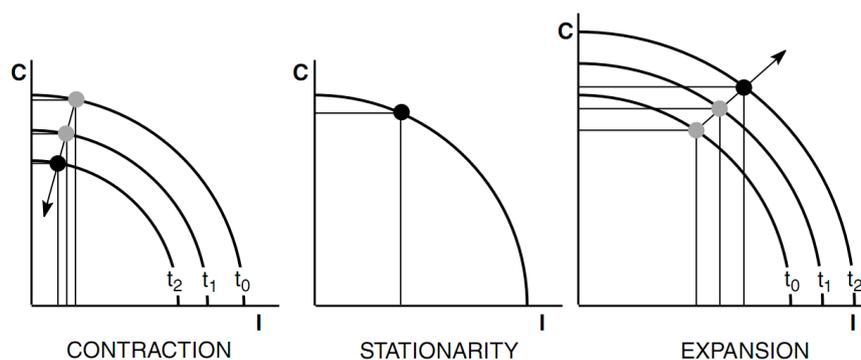


Figure 3.3 – Gross investment and growth (contraction, stationary, and expansion). Source: Garrison 2001

The PPF model entails a number of equilibrium combinations between consumption and investment. This means that outside of the PPF line there is unsustainably low unemployment while inside of the curve means higher than natural unemployment. An equilibrium at the frontier curve represents full employment which equals the natural rate of unemployment. When inside the frontier (as a classical Keynesian unemployment scenario), one can increase both consumption and investment. The trade-off is not between investment and consumption, but between employing resources and idleness.

The boundary of the PPF can be broken when consumption and investment move outwards together. However, the Austrians assume this to be unsustainable. Austrians believe that the long-term trend of C and I are correlated. What separates Austrian economics from modern macroeconomic theories is their belief in higher saving and lower consumption as prerequisite for higher growth. Lower current

consumption will make more funds available for innovators, so investments will increase, and finally future consumption will increase.

The Austrians do not believe that *real* growth can be “created” by public policies or by monetary means. Given low real economic growth, central banks might lower the interest rate (i.e. below its natural rate in Austrian theory) or increase spending.³¹ This will increase both investment and consumption under normal conditions. The Austrian school claims that a lower interest rate than the natural one creates unsustainable growth, since the consumers have not changed their time-preferences to meet future supply. Increased investments mean increased future supply of final output. By increasing consumption now, they will consume less in the future, thereby creating a mismatch in need of correction (i.e. recession).

3.1.3 Inter-temporal Structure of Capital (Hayekian Triangle)

The focus on the inter-temporal structure and stages of capital is almost solely addressed by the Austrians. Capital-based macroeconomics focuses both on the value dimension of the output of different production stages and the time dimension of production.³²

The Hayekian triangle is used in the Austrian theory to include the capital structure into macroeconomics. The model is not intended to give exact values for calculus purposes, but to provide a framework that can show changes in the inter-temporal capital structure. Figure 3.4 shows the Hayekian triangle with five stages of production. The choice of *five* stages is only for illustrative purposes (enough division). The actual unobservable division between stages will differ for each sector and product categories.

The hypotenuse represents the product value which is related to the horizontal time axis with its double interpretation. First, it can be seen as the production process from input to final consumer goods. Second, it can be regarded as stages of production which coexist in the present but operate at different stages.

³¹ See ch. 4.3 Monetary Policy and Expansion

³² Even though the classical interpretation of the model entails an industrial production scenario where there is a linear path from capital goods to consumer goods, the model applies generally well to most business processes, even those that might not be linear, have feedback loops or have multiple purposes

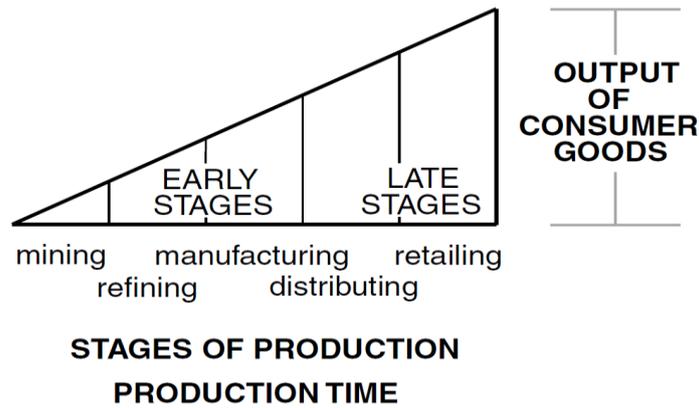


Figure 3.4 – The structure of production (continuous-input/point-output). Source: Garrison 2001

3.1.4 Synthesis

The three separate elements presented in previous subchapters form together capital-based macroeconomics. The models can be combined in a three-part quadrant that makes an organised, illustrative, and educational framework with strong explanatory power. Figure 3.5 shows how the graphs relate to each other.

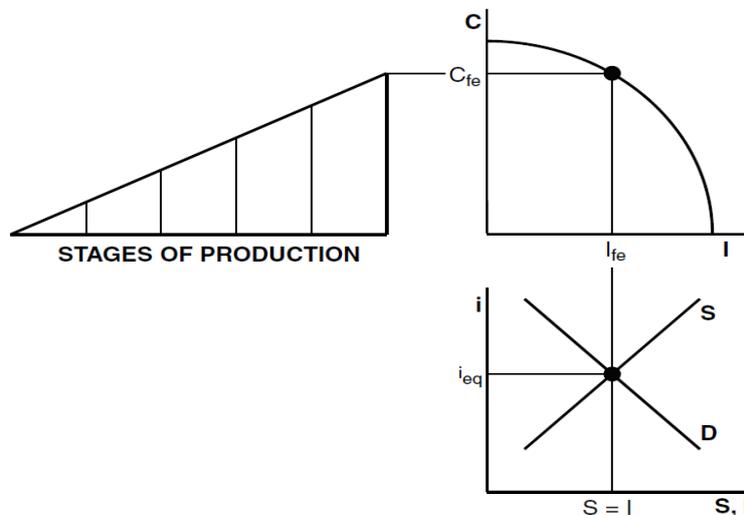


Figure 3.5 – The macroeconomics of capital structure. Source: Garrison 2001

Figure 3.5 represents a fully employed and mixed economy with natural unemployment at the point where government spending equals taxes ($G=T$). A mixed economy implies that there is both a private and a governmental sector. The interest rate created in this equilibrium is the “natural” rate of interest. This rate represents consumers’ time-preferences in terms of present consumption relative to future consumption. It is a no-growth economy where the investment (I_{fe}) is just enough to account for the depreciation among consumers and the heterogeneous capital at the different stages of production. C_{fe} is the corresponding level of consumption.

3.2 Relative Prices

Figure 3.5 is different from other conventional macroeconomic frameworks. For example is the IS/LM and the AS/AD different in the sense that capital-based macroeconomics does not account for a money market, nor do the Austrians believe it exists. Austrian economics stresses money merely as a medium of exchange due to the nature of the barter system. The economic system in its purest theoretical way is just about goods being traded for other goods. In that respect, money is on every axis (e.g. the consumption axis) in the Austrian framework. Furthermore, the general price level is accounted for differently than in AS/AD cross-curves. An important point is that Austrians believe that it is the relative interest rates that affect the capital structure and the relative price level. This is illustrated in Table 3-1.

Table 3-1 – Effects of relative price changes on economic profit

Stage:	0 years (natural resource owner)	1 year	2 years	3 years	4 years (final output)
Price with 10% interest rate	\$100	\$110	\$121	\$133.10	\$146.41
Prices with 8% interest rates	\$107.61	\$116.22	\$125.52	\$135.56	\$146.41
Rate of Economic Profit	7.61%	5.66%	3.74%	1.85%	0%

Source: Cwik 2005

In this Austrian model, Cwik assumes rational profit-maximising agents and sticky prices for the final output. Then, a reduction from ten to eight percent interest rate increases the economic profit for all stages except the final stage, where early-stage increases relatively more. We see that the changing interest rate affects the agents' profit rates in dissimilar ways in the different stages since their alternative profit rate is risk lending to the bank. Suppliers in all stages must now accept increases in prices as long as there is a minimum profit rate of eight percent equal to its alternative risk-free alternative. Low interest rates therefore favour early stage production and should shift resources from late to early production.

3.3 Secular Growth

We have shown how the PPF contracts, is stationary, or expands, depending on saving and investment in relation to the capital stock. In a stationary economy, savings and investment are equal to capital depreciation. Figure 3.6 illustrates a hypothetical path for an economy. The first two periods depicts an economy with no growth. After the second period, the economy saves more than capital depreciation. This leads to less

consumption in the nearest future, but increases as the ongoing investments are starting to yield at an increased rate. In this figure, consumers have to forego current consumption from period two and can enjoy more consumption from period seven.

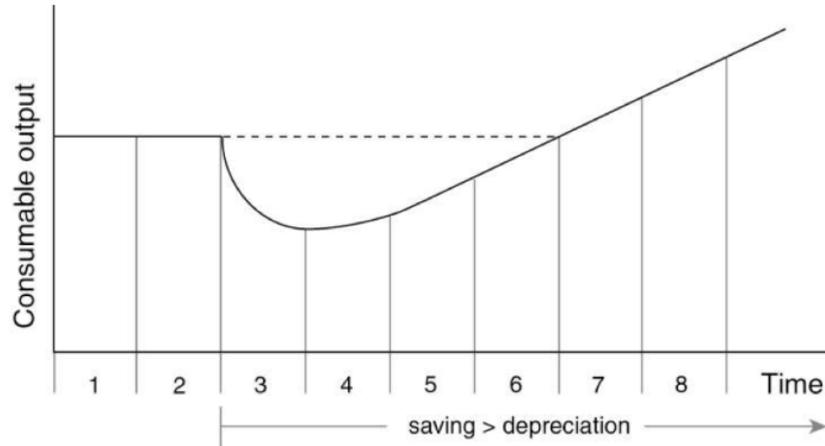


Figure 3.6 – A hypothetical path of consumption. Source: *Snowdon and Vane 2005*

The consumption path requires a capital restructuring that can be shown in Figure 3.7. The steepest line shows the capital structure before a change in savings, period one and two. The new shape from period three illustrates the capital restructuring; resources are bid away from late stages to early stages of production. Since more capital goes to early stages of production, the triangle forms a new shape that is flatter and more time-consuming. This restructuring of capital stock is a necessity to transform the economy from a stationary (no-growth) to expanding state.

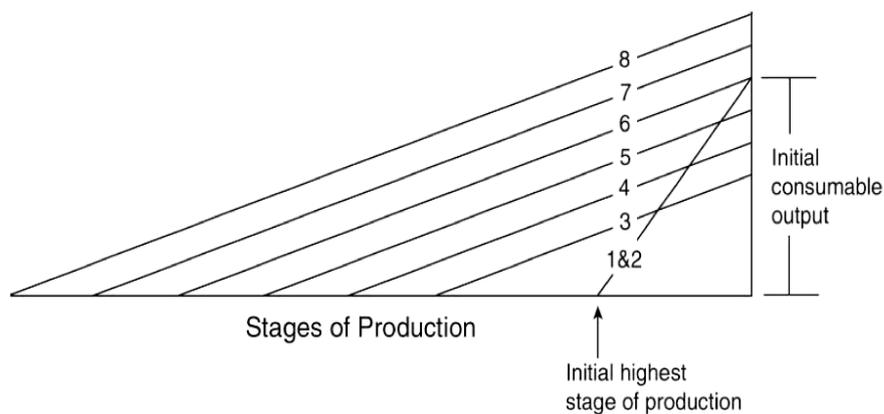


Figure 3.7 – Capital restructuring and changes in savings. *Snowdon & Vane 2005*

The economy expands from period six, purely driven by savings and capital accumulation. This is referred to as secular growth in Austrian economics. The expansion is shown by the shift to the right in PPF in Figure 3.8. The long-run

consequence from increased savings in the past is benefiting the economy as the earlier investments are starting to yield positive returns, shifting the PPF to the right.³³

Figure 3.8 illustrates all the effects together. The Hayekian triangle experiences outward shifts as the level of investment increases and capital stock gets bigger. As income increases, an increased pool of savings is supplied, causing the supply curve to shift to the right. As capital accumulates, firms have to demand more funds to maintain a larger capital stock, causing the demand curve to shift to the right. In this figure, it is assumed that supply and demand shift with equal magnitudes making the interest rate to stay at the same level. Empirically, however, it has been shown that an increase in income decreases the time-preference and that supply outpaces demand. This would lead to a decrease in the interest rate.³⁴ As the model depicts, it is consistent with the conventional consumption function (i.e. that C and I move positively outwards).

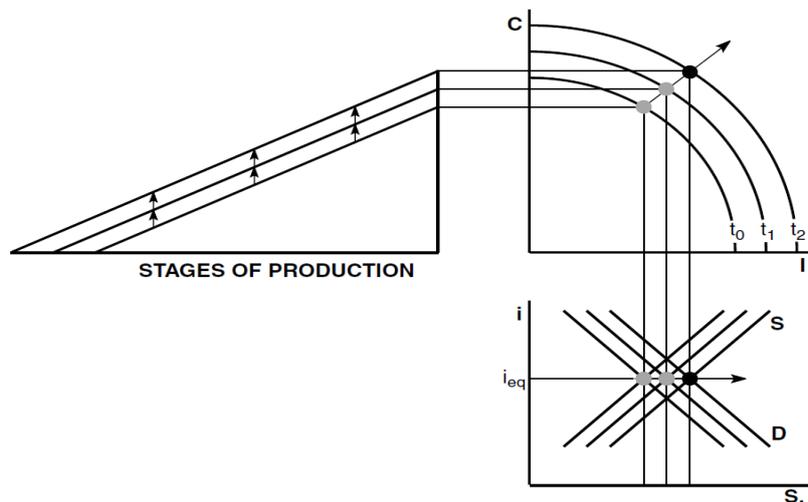


Figure 3.8 – Secular growth (with assumed interest-rate neutrality). Source: Garrison 2001

The process of secular growth illustrated in this framework has been heavily criticised by different authors.³⁵ They argue that without a technology shock or/and falling time-preferences as the capital stock is increasing, long-term growth described is not likely and unsustainable.

The case of secular growth is not likely from a neo-classical perspective: Even if the savings is proportional to income (time-preference held constant),³⁶ sustainable

³³ On the basis of the framework from previous sub-chapters, Garrison 2001, p. 54 claims that, “the ongoing gross investment is sufficient for both capital maintenance and capital accumulation.”

³⁴ Garrison 2001

³⁵ Salerno 2001

³⁶ Mankiw 2007, p. 189: This is illustrated in Macroeconomics in the Solow Growth model where savings is a constant proportion of income, and investment is equal to savings. Proof: (1) Demand for goods derives

secular growth will not happen. Secular growth will not take place due to the assumption of the Cobb-Douglas production function:³⁷

$$Y = AK^\alpha L^{1-\alpha} \quad (1)$$

Marginal productivity of capital is positive:

$$\frac{\partial Y}{\partial K} = \alpha AK^{\alpha-1} L^{1-\alpha} > 0 \quad (2)$$

And marginal productivity of capital is decreasing:

$$\frac{\partial^2 Y}{\partial K^2} = (\alpha - 1)\alpha AK^{\alpha-2} L^{1-\alpha} < 0 \quad (3)$$

If investment is equal to savings, an increase in investment will have decreasing effects on Y due to increasing capital stock and diminishing returns. The falling marginal productivity of capital will also make the interest rate fall.

Even though secular growth theory is inconsistent with exogenous neo-classical growth theory, it provides a bridge between Austrian and endogenous growth theory.³⁸ “Hayek explicitly excludes technological change from the discussion of changes in the time structure of production, (and) this embraces technological change as the output of intangible investments and, therefore, a capital-based engine of sustainable secular growth”.³⁹

No matter the differences on growth theory among different schools, the focus in this paper is not the secular growth theory itself, but the Austrian business cycle theory.

3.4 Money and Prices

Garrison claims that Austrians regard money as a “loose joint” in the economic system.⁴⁰ Hayek indicated early on: “The task of monetary theory [is] nothing less than to cover a second time the whole field which is treated by pure theory under the assumption of barter”.⁴¹ It should be noted that Austrians do not disregard monetary considerations. The ABCT focuses on the created disequilibrium due to policy-induced actions. By affecting relative interest rates with monetary shocks, the capital structure

from consumption and investment: $Y = C + I$. (2) Savings is an exogenous variable and constant share of income: $C = Y - sY = (1 - s)Y$. Putting (1) and (2) together gives us: $Y = (1 - s)Y + I \rightarrow Y - Y + sY = I \rightarrow sY = I$

³⁷ Y is total income, K is capital stock, and L is labour force

³⁸ Endogenous growth theory attempts to develop models that explain technological advance

³⁹ Young 2007, p. 19

⁴⁰ Garrison 2001

⁴¹ Hayek [1935] 1967, p. 127

changes, and mismatch is created. In this regard, ABCT is under the category of monetary theory.

Monetary theories were popularised by Milton Friedman in the 1960s. The long-run relationship between money and inflation is today no longer an unconventional thought and well supported by empirical studies. Though Monetarism and the Austrian school share a common belief in that monetary effects cause the business cycle, they differ in a significant way: Monetarists blame the central bank for the bust due to contraction of money supply, while Austrians blame the central bank for creating the boom with credit expansion leading to the inevitable bust.

The well-known money relationship reintroduced by Friedman can be applied by the exchange function:

$$MV = PQ \quad (4)$$

For a given money supply (M) and velocity (V), an increase in consumption and investment (Q) must be followed by a price deflation (P). The deflationary consequences of secular growth should not be confused with the deflation caused by reduced money supply or increase in demand. The secular growth deflation does not equal monetary disequilibrium. In fact, the Austrians believe that equilibrium can be characterised by lower prices and wages. This was the case in most Western countries during the industrial revolution and can also be seen in certain modern technological sectors like IT and electronics. Today however, one rarely finds deflation on a national level since most central banks have explicit inflation targets.⁴²

One important factor in Austrian economics is the focus and decomposition of Q. Both Keynesians and monetarists focus on the relationship between the variables, but not on the sub aggregates that sum up to Q. Aggregate output can be decomposed to $Q = Q_c + Q_i$ where Q_c is consumption goods and Q_i is investment goods. The exchange function can be rewritten as:

$$MV = P(Q_c + Q_i) \quad (5)$$

Further more, investment goods can be disaggregated to many different goods to include the Hayekian triangle in this function. The equation becomes:

$$MV = P(Q_c + Q_2 + Q_3 + \dots + Q_t) \quad (6)$$

⁴² For example, Norges Bank sets the target rate based on the following *loss equation*:

$L_t = E_t \sum_{k=0}^{\infty} \delta [(\pi_{t+k} - \pi^*)^2 + \lambda(y - y^*)^2_{t+k}]$ where π is inflation, π^* is the inflation target, y is production, y^* is the production potential, and E_t is a expectation operator

To avoid double counting, all the Q variables are reckoned as final goods. The sum of Q will therefore be equal to total output. While Keynesians and monetarists focus on the aggregate Q, the Austrians' emphasis is on relative movements among different kinds of goods as well as the total amount of goods. Why the Austrians disaggregate will be dealt with in ch. 4.2.1 "Labour Demand and Time-Discount".

4 Austrian Business Cycle Theory (ABCT)

The secular growth illustrated in the previous chapter describes an economy that saves and invests more than capital is depreciated. This chapter will focus on growth and business cycles impacted by technology shocks, inter-temporal preferences, and monetary policy. Changes in technology and inter-temporal preferences are sustainable while a change in monetary policy is not.⁴³ Moreover, ABCT is an endogenous approach.⁴⁴ Low interest rates induce investment which creates the business cycles. Recent business cycle theories tend to focus on shocks and exogenous causes of the business cycles and neglect the endogenous mechanisms.⁴⁵

4.1 Changes in Technology

ABCT claims that an advance in technology has a direct effect on the LFM and the PPF. A technology shock typically occurs in one particular market, but through resource allocation, it can increase the potential production in several markets. This has several implications in the model: The production frontier shifts outward in all sectors, and since business firms now want to exploit the new technological possibilities, the demand for funds shifts upward from D to D' . As the economy is able to produce more with the new technology, the higher income will increase supply of savings, which causes the supply curve in the LFM to shift to the right from S to S' . This is shown in Figure 4.1.

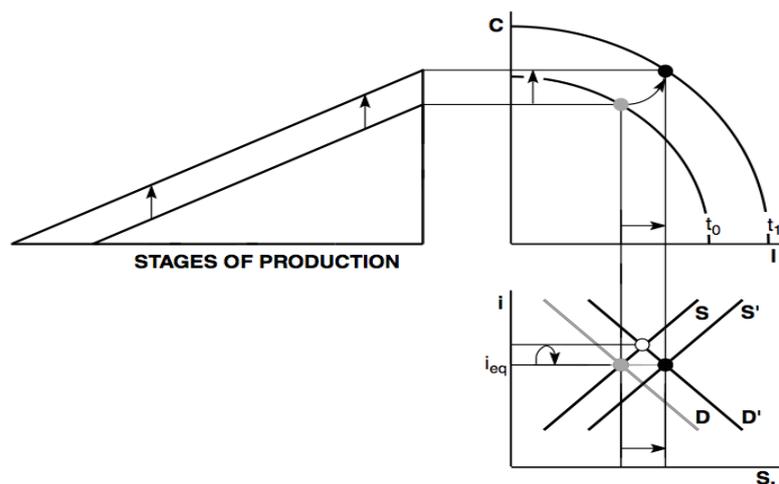


Figure 4.1 – Technology shock and growth. Source: Garrison 2001

⁴³ Garrison 2001

⁴⁴ Garrison 2001, see also ch. 4.6 “Austrian Economics in Perspective”

⁴⁵ Zarnowitz 1999, 82–83

The direction of the interest rate is ambiguous. The interest rate is dependent on the magnitudes of the shifts in the demand and the supply curve in the LFM. Initially, the interest rate will rise as the economy is adjusting to the technological shock. It is not given that the new equilibrium interest rate will settle above the equilibrium interest rate established prior to the technological shock. However, this result is not a fundamental issue in the model. The ambiguity derives from the fact that a technological shock can be realised today and in the future by greater consumption. We can identify two main technological shocks:

1. The technological shock affects the whole economy and affects all stages of production. Resource allocation is not necessary.
2. The technological shock affects only one stage in the production process. Due to resource allocation, the shock has an immediate impact on current consumption.

In the first scenario, the interest rate will not necessarily increase. Since the economy, as a whole, is able to produce more in all sectors, income, consumption, investment, and savings will all increase without putting pressure on the interest rate either way. In the second scenario, which is the most likely scenario, the demand for funds will shift first since businesses take advantage of the new technology in their stage of production. For simplicity, Garrison assumes that this happens in the early stage of production.⁴⁶ The increase in investment will shift demand for funds from D to D' . The interest rate rises to the point where new demand intersects with supply of funds, indicated by the hollow circle in Figure 4.1. Since the shock is in the early stage of production, consumption will not increase immediately. Income will increase due to increased investment spending, consumption will increase later on due to resource allocation, and savings will eventually increase. Supply of funds will ultimately shift to the right from S to S' causing the interest rate to move back to its initial level.

Even though a technological shock is considered to be interest neutral in ABCT, the Austrians see the possibility that the interest rate can move from one equilibrium to another. Unlike scenario two, where the rise in interest rate is transitory, the technological shock may tie up resources to the extent that allocating resources to the late stages of production will be limited. This increased demand in funds may then have a dominating effect on the interest rate for quite some time. The Austrians do not claim that the interest rate necessarily has to be at the same level as before. This is dependent on the nature of the technology shock and the ability of the economy to reallocate resources.

⁴⁶ Garrison 2001

4.2 Changes in Inter-Temporal Preferences

Changes in inter-temporal preferences are referred to as changes in consumption and saving plans.⁴⁷ Like changes in technology, ABCT claims that an increase in savings over consumption leads to sustainable growth.⁴⁸

Figure 4.2 illustrates a situation where people decide to save more. The supply curve in the LFM shifts to the right from S to S' . The increase in the supply of funds means that people decide to consume less today and more in the future. The increased savings implies lower interest rate in the LFM, shown by the dark point. A lower interest rate results in more borrowing by firms. The corresponding dark point in the PPF shows that lower consumption is substituted by higher investment. There are two important features of changes in preferences:

1. The movement is *along* the PPF curve rather than a movement *off* the curve.
2. There is *no* income effect on the supply of funds.⁴⁹ Since the increase in investment is offset by less consumption, income is the same. If investment did not increase with decreasing consumption, income would go down. Hence supply of savings would decline even more causing the equilibrium interest rate to actually rise. ABCT implies that people's decision to consume less today implies more spending in the future. A higher savings rate is an accelerator for higher growth.

⁴⁷ In reality, these changes depend on lots of factors, such as pension benefits, education system, and social security. The main point in this chapter is not why people change their inter-temporal preferences, but that a change in spending and savings patterns of an economy has a long-run growth effect

⁴⁸ This requires a positive, and not a negative, development in technology and inter-temporal preferences

⁴⁹ Investopedia 2010 defines "the income effect" as "the change in an individual's or economy's income and how that change will impact the quantity demanded of a good or service. The relationship between income and the quantity demanded is a positive one, as income increases, so does the quantity of goods and services demanded." Note that the income effect would have a negative effect on the supply of funds if consumption goes down, *ceteris paribus*

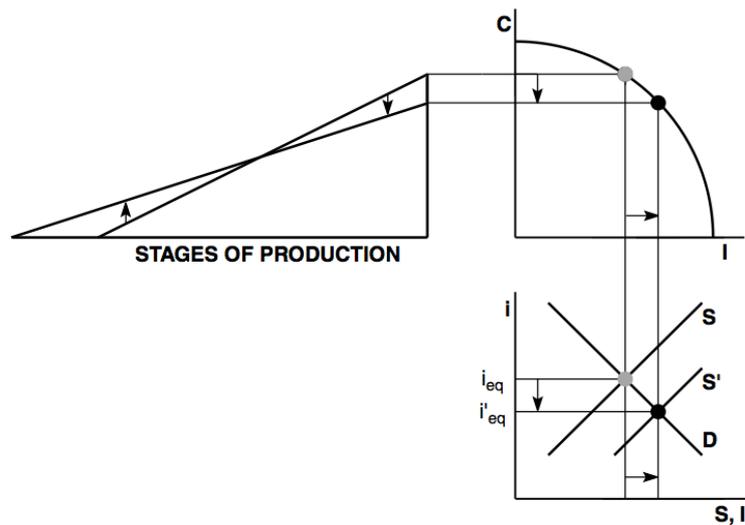


Figure 4.2 – Change in time-preferences. Source: Garrison 2001

In Austrian capital-based macroeconomics, lower consumption allows investment to increase due to a lower interest rate. To understand how the markets clear, we have to focus on the Hayekian triangle. The new shape of the triangle reflects how the new investment is used. Resources are bid away from late stages of production, due to lower demand of consumption goods, into long-term investments in the early stages of production, where demand is high due to the lower interest rate. Figure 4.2 implies a fall in consumption and does not show the next period's increase in output as a result of increased investment. To show the increasing growth rate after the increased savings, we have to look at Figure 3.8 that shows an economy with secular growth. An increased investment today means that the PPF will shift outwards more than it will without the increased savings.

4.2.1 Labour Demand and Time-Discount

Increased savings will have two different effects on labour demand:

1. *The derived demand effect:* Labour demand is a derived demand from output. Increased savings means lower consumption today. Lower demand for consumption goods means lower demand for labour that produces consumption goods. The stages of production close to final output will therefore demand less labour.
2. *The time-discount effect:* Assuming a project being financed by borrowed money, a reduction in the interest rate leads to lower capital costs. This increases demand for labour as firms want to increase production due to higher profitability. The effect is bigger for early-stage production as this sector is more capital-intensive and time-consuming than late stages of production.

The two effects result in opposite outcomes for labour demand. The first effect pulls labour demand down while the second effect pulls labour demand up. Since labour demand is a derived demand from output, we can illustrate the effect at a microeconomic level from the equation in Figure 4.3. Goods and labour demanded will be lower in the late stages, while it increases in the early stages.⁵⁰

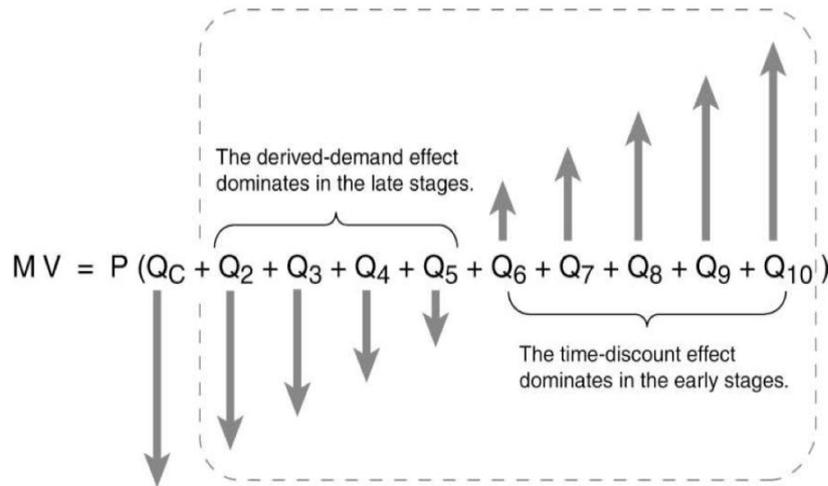


Figure 4.3 – Derived demand and discount effect on labour. Source: Snowdon & Vane 2005

Together, they form the shape of the Hayekian triangle. The two hypotenuses in the triangle show the capital structure before and after the change in inter-temporal preferences. The more horizontal curve shows the result after the restructuring. The intersection of the two hypotenuses shows the point where effect (1) and (2) just offset each other.

Below the Hayekian triangle in Figure 4.4, it is illustrated how the labour market adjusts to the new changes. Labour demand increases in early stages of production until the stage at the intersection and decreases in stages of production thereafter. This is shown by a shift in labour demand from D to D' in the two graphs. Initially, after the changes in labour demand, wages in early stage of production increases while wages in late stages fall. This is marked by the hollow circles. Later, as labour is adjusting to the new market conditions, wages will go back to their initial levels. Supply of labour will shift from S to S' , and the dark points in the figure represent the new wages.⁵¹

⁵⁰ In the traditional exchange function, this effect would not be illustrated. Quantity produced at an aggregated level would be the same. The Hayekian triangle and the capital structure are essential in Austrian economics to focus on the underlying fluctuations in aggregate demand instead of focusing on total aggregate demand itself

⁵¹ Further comments can be made on the assumption that wage rate reverts to its initial level. A change in wages after a change in interest rate is backed by perceptions about where the labour is employed, if it's concentrated in early or late stages of production. In Austrian perspective, labour is not concentrated in any

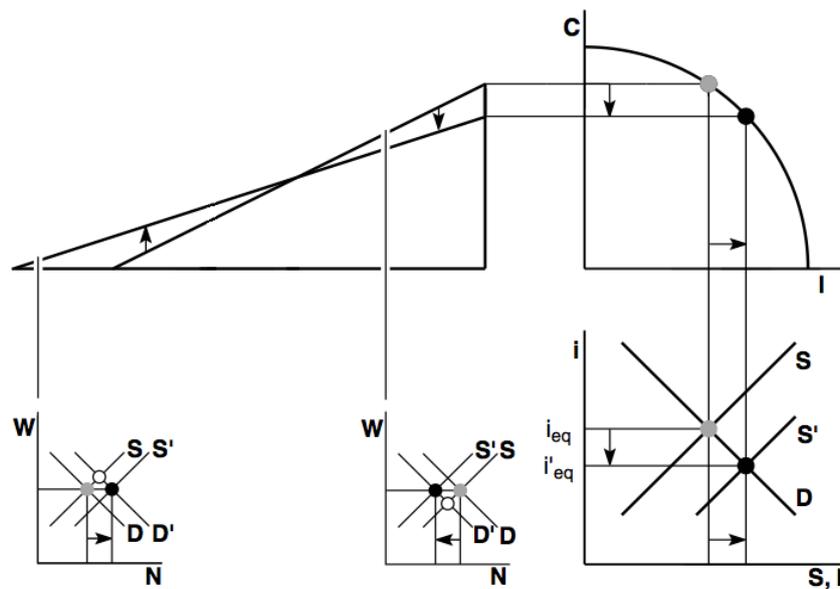


Figure 4.4 – Change in inter-temporal preferences with labour market clearing. Source: Garrison 2001

Austrian economics treats labour as a nonspecific factor of production which has to be induced with higher wages to move from one sector to another. Labour with specific skills can be considered as human capital. Specific skilled labour will not move from one stage to another, but will experience a wage increase/decrease depending on location of employment at the stage of production. Movements of nonspecific labour can also include capital movements. Capital would move from one stage to another through the time-discounting effect. Capital that was used in the final stage of production could have fled to early stages of production as a result of lower discount rate.

To sum up, in case of a change in inter-temporal preferences, nonspecific factors of production will experience a quantity adjustment, while specific factors will experience a price adjustment. The treatment of labour is important to illustrate the relative wage effects that adjust to the change in preferences and capital restructuring through the derived demand and time-discount effect.

4.2.2 Changes in Inter-Temporal Preferences and Keynes' Theory of Thrift

Let us compare the conclusion about savings in the Austrian perspective to mainstream paradigms about savings: Keynes' paradox of thrift states that if people try to save more, the economy will go into recession and aggregate demand will decline

stages of production. However, the Austrians recognise the possibility that labour is not equally distributed in the stages of production. If we take this effect into account, then we also have to modify the labour markets in Figure 4.4

further.⁵² The diverging result is due to the fact that Keynesians only focus on derived demand while the Austrians focus on *both* derived demand and the time-discount.

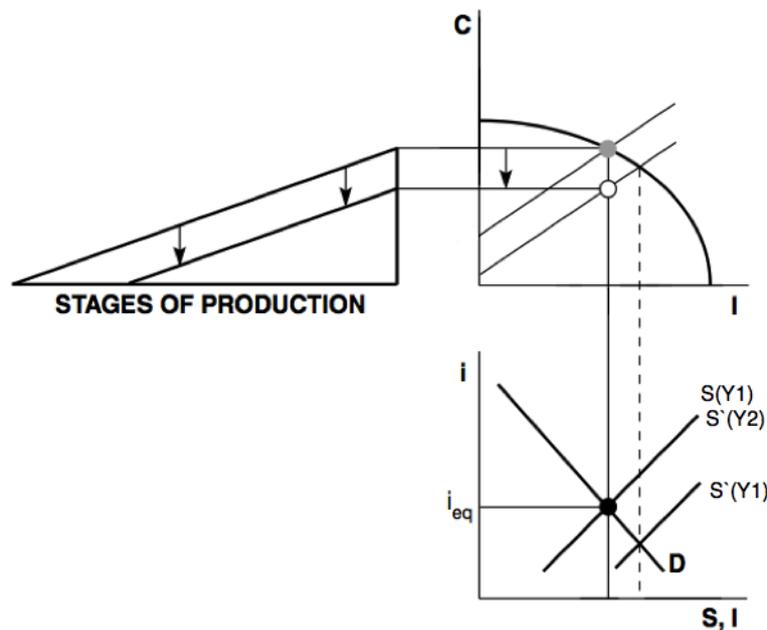


Figure 4.5 – Change in inter-temporal preferences and Keynes' theory of thrift. Source: Snowdon & Vane 2005 and drawings by author

The Austrian explanation is shown in Figure 4.5 which can be compared to Figure 4.2. Both figures assume employment to be equal to the natural rate of employment. Initial savings is labelled $S(Y1)$ to emphasise that people save from an initial disposable income. Increased savings shift the supply of funds from $S(Y1)$ to $S'(Y1)$ and the demand constraint in PPF moves downwards.⁵³ With more savings, interest rate is pushed downwards.

In the Keynesian perspective, however, the income effect dominates and the equilibrating relationship between savings and investment is cut short.⁵⁴ More savings means less consumption. This results in lower aggregate demand which causes income to decrease in multiple turns. Lower income leads to less savings causing the supply curve to shift back from $S'(Y1)$ to $S'(Y2)$ where $Y2 < Y1$. The negative income effect fully offsets the positive change in the inter-temporal preference effect. Since income is lower, the economy faces a situation where it has less to spend on consumption and investment, causing the PPF to shift inwards indicated by the hollow

⁵² Snowdon & Vane 2005, ch. 9

⁵³ The parameters of the upward sloping demand constraint will be dealt with later in ch. 4.5 "Keynesian Recession in an Austrian Framework"

⁵⁴ See Mankiw 2007, p. 468 for more detailed explanation of the income effect

circle. The economy cannot simply move along its production possibilities frontier, and savers who push in that direction will cause the economy to sink into recession.⁵⁵

Another fundamental difference is that the Hayekian triangle does not change its shape as in Figure 4.2, but is instead shifting inwards. This means that the time-discount effect is not accounted for. The capital is not reallocated in the different stages, and the economy demands less labour and capital goods causing the triangle to change its size.

To Keynesians, the paradox of thrift is an unavoidable and unfavourable outcome of the market process,⁵⁶ but it is a situation that the Austrians consider as unlikely. To analyse effects of savings, the Austrians emphasise the effects it has on the capital structure and disaggregation of goods produced.⁵⁷

4.3 Monetary Policy and Expansion

Austrian economics distinguishes between real sustainable growth and “artificial” unsustainable growth where the main differences derive from real savings and monetary policy. Austrians believe that an increase in real savings causes sustainable growth while any attempt from monetary authorities to “manipulate” the loanable funds causes unsustainable development of the business cycle.

According to Garrison, Ragnar Frisch’ work on business cycles has features that can be attributed to ABCT.⁵⁸ Frisch focuses on an impulse that triggers the business cycle and on the propagation mechanism that allows the business cycle to play itself out. In ABCT, the trigger is increased money supply. The propagation mechanism is the relative resource and price changes within the inter-temporal structure of production after the credit expansion.

4.3.1 Effects on Nominal Prices

In Figure 4.2 we illustrated an economy where people change their time-preferences and decide to save more. New equilibriums are shaped without any monetary policy involvement, but changes in price levels were never illustrated.⁵⁹ Nevertheless, prices

⁵⁵ Snowdon & Vane 2005, ch. 9

⁵⁶ Keynes 1936, p. 84: “Every such attempt to save more by reducing consumption will so affect incomes that the attempt necessarily defeats itself”

⁵⁷ According to Garrison, this is what Hayek (1931) had in mind when he said, “Mr. Keynes’s aggregates conceal the most fundamental mechanisms of change.”

⁵⁸ Garrison 2001, Frisch 1933

⁵⁹ ABCT does not take absolute price changes into account as the standard AS-AD analysis does in the Keynesian framework

are an important factor in the ABCT and should have one of two following developments:

1. Money supply is held constant. A growing economy will therefore experience a declining price level.
2. Monetary injections are in symmetry with real output growth. Price level will therefore be constant, and money injections will not cause inflation pressure.⁶⁰

The Austrian school does not focus on quantity of money supply and the consequent actual and expected changes in the general price level. Rather, they focus on *new* money created and the following *relative* price changes that govern the allocation of resources over time. New money is referred to as a situation where the central bank expands reserves and currency held by the public which are directly controlled by the central bank.⁶¹

4.3.2 Effects on the Loanable Funds Market

Figure 4.6 illustrates an economy with expansionary monetary policy with subsequent credit expansion. Inter-temporal preferences are assumed unchanged. Money supply includes savings from the public and funds from the central bank. Changes in money supply can be implemented in the following ways:

1. Open market operations: For instance, the central bank can lend to the financial market or to the government by acquiring securities issued by the Treasury.
2. Set a central bank interest target and discount rates in the financial markets.
3. Change the reserve ratio imposed on commercial banks.

These tools differ from one to another in terms of frequency and efficiency. How the authorities conduct the monetary policy will not be treated in this paper.

⁶⁰ Recall the money exchange function: $MV = PY$. Assuming velocity (V) is constant, an increase in Y has to be accompanied by a change in M or/and P . If M is held constant as in scenario (1), we can see from the equation that P has to go down if real GDP (Y) increases, causing a deflationary pressure in the economy

⁶¹ Definition of money supply (M) and monetary base (B): $M = C + D$ and $B = C + R$. Where C = currency held by the public, D = demand deposit, R = reserves, and C/D = currency-deposit ratio. Dividing the money

supply with monetary base gives us: $\frac{M}{B} = \frac{C+D}{C+R} = \frac{\frac{C}{D}+1}{\frac{C}{D}+\frac{R}{D}} = \frac{cr+1}{cr+rr} \rightarrow M = \frac{cr+1}{cr+rr}B$. Notice that only B is controlled by the central bank. rr is determined by banks and regulations and cr is determined by households. See Mankiw (2007) "Macroeconomics" for more information about money supply

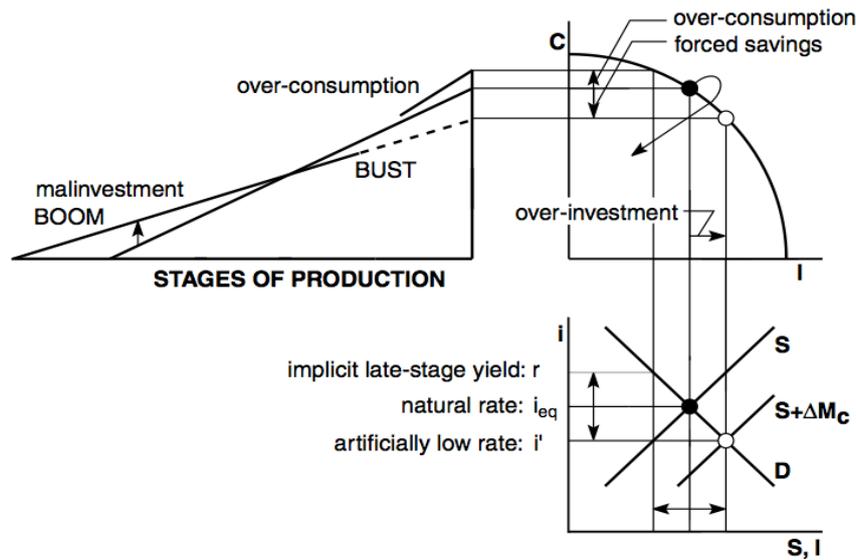


Figure 4.6 – Monetary expansion. Source: Garrison 2001

The injection of new money is labelled ΔM_c and shifts the supply curve from S to $S + \Delta M_c$. The change in real money supply is temporary until the aggregate price level adjusts with assumption of sticky prices.⁶² An increase of funds makes the interest rate drop, and the hollow point shows the new market interest rate. The initial effect on the interest rate is the same for monetary expansion and for expansion induced by change in inter-temporal preferences in Figure 4.4. The fall in interest rate may seem to be permanent as a result of changed time-preference, and people may perceive the lower current rate as a new natural rate. What matters is *why* there is a lower market interest rate in the first place. The interest rate is lower due to credit expansion, but in Figure 4.4, market rate drops due to changes in preferences. This difference is crucial in order to identify if the economy experiences a sustainable or unsustainable expansion.

An important aspect is the relationship between saving and investment. In Figure 4.4, increased savings is matched by equally increased investment. In Figure 4.6, these two aggregates move in *opposite* directions; less saving and more investment. An increase in money supply that is not backed up by real economic growth creates a gap between savings and investment. Since preferences have not changed, savings will decline in response to a lower interest rate. However, investment will increase in response to increase in supply of money and lower interest rate.

⁶² Sticky prices are the case when a variable is resistant to change. For example, nominal wages are said to be sticky in the short-run. New Keynesian economists advocate models with sticky prices and wages. Hence, the assumption of sticky prices in the Austrian framework and the Keynesian framework is the same

4.3.3 Effects on the Production Possibility Frontier (PPF)

The PPF also shows the relationship between savings, consumption, and investment. Less saving means more consumption. The latter should be accompanied by lower investment according to Austrian theory.⁶³ In Figure 4.6, *both* consumption and investment increases. Looking closer at the PPF, it is not given that investment and consumption always are negatively correlated. They increase to a point outside the PPF and therefore exhibit a positive correlation. The PPF only gives the natural rate of employment and *sustainable* combinations of consumption and investment. A monetary injection causes the economy to produce at a level outside the PPF, which is possible but unsustainable in the Austrian perspective.

Figure 4.6 illustrates the initial phase of an expansion after new money is created. Credit expansion makes consumers and investors demand more of both consumer and investment goods. To understand the subsequent phases, one has to understand how new money affects actual production. The Austrians believe that investment is increasing more than consumption in an initial expansion since new money is followed by lower interest rate, and the lower interest rate stimulates investment spending. The arrow from the dark circle in the PPF illustrates this effect. In addition, because of this investment bias, the capital structure changes.

4.3.4 Effects on the Structure of Capital (Hayekian Triangle)

The capital restructuring can be shown in the Hayekian triangle in Figure 4.6. The increased consumption and investment that put the economy outside the PPF pulls the triangle in opposite directions. Expansionary monetary policy makes the hypotenuse flatter from early to intermediate stages of production, while making it steeper from intermediate to final stage of production. Resources are bid away from intermediate stage to early stage since investors find the long-term investments more attractive with lower interest rate. Moreover, resources are bid away from intermediate to late stages since people save less and consume more with lower interest rates.⁶⁴ The Hayekian triangle is pulled in both directions as a result of more investment and higher consumer demand. A resource-drained intermediate stage is a sign of an unsustainable situation. The broken line in the Hayekian triangle illustrates that the restructuring cannot be completed in subsequent periods. The expansion is “artificial”, and the changes in inter-temporal structure of production are unsustainable and cannot last forever.

⁶³ Recall the Austrians’ emphasis on the substitution effect and movement on the PPF

⁶⁴ Mises 1966, p. 559, 567, and 575, attach importance to malinvestment and over-consumption during the expansion

4.4 Recession

Later on, as predicted by ABCT, the credit-induced high business activity reaches its peak. The expansion phase of the cycle creates the conditions for the recession phase.⁶⁵ It is not a necessity that the economy experiences an exogenous shock to convert expansion into recession.⁶⁶

The increased money supply has given firms “wrong” interest rate, prices and wage signals. Thus, firms have invested in production methods that take too long to produce consumer goods. Consumer demand will materialise before the final goods are finished. When this happens, the lack of current consumption goods will put an upward pressure on prices of current consumption goods relative to future consumption goods.⁶⁷ As the aggregate price level increases during the expansion, real money supply (M/P) decreases which corresponds to a rise in interest rate. The interest rate will adjust to its natural rate.⁶⁸

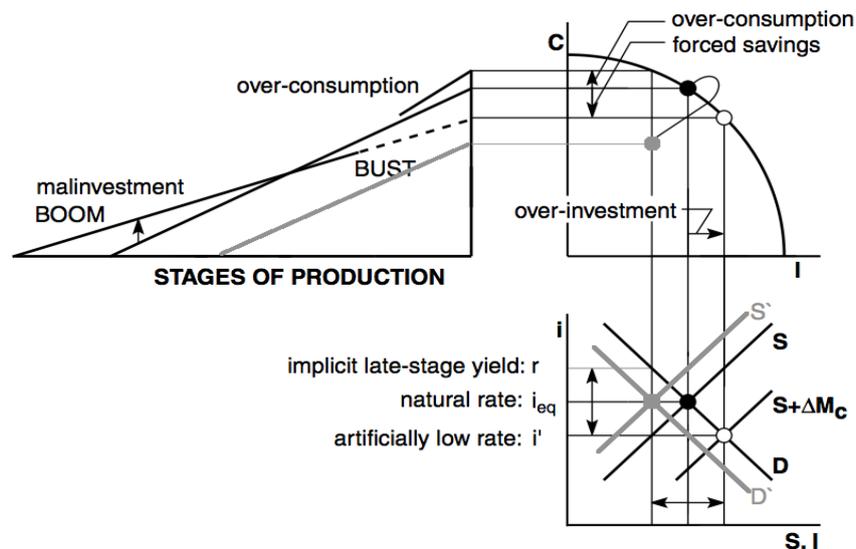


Figure 4.7 – Recession. Source: Garrison 2001 and drawings by author.

The higher interest rate creates problems for the business community. Firms that invested in long-term production goods on the basis of a lower interest rate will now face higher carrying costs and discount rates making the net present value of the projects much smaller than anticipated, or even negative. Profit rates will fall causing

⁶⁵ Hayek [1935] 1967, 54–62

⁶⁶ Another distinctly Austrian concept is the endogenous reversal of the expansion leading to recession, through the Ricardo Effect (Keeler, 2001 p. 334)

⁶⁷ Oppers 2002, p. 6

⁶⁸ Wicksell's cumulative process also explains how the market rate goes back to the natural rate, as the banks respond to an endogenous shortage of currency and reserves, Trautwein (1996, 31-33)

firms to demand less labour, which causes higher unemployment rates and corresponding lower household income and spending. The recession is inevitable.

Firms have to restructure the production and bring capital stock to a structure that corresponds to inter-temporal consumer preferences. Where the economy is heading as it is recovering is not a clear case. However, the Austrians emphasise on the role of investment bias during the initial phase of the boom. Hence, the economy will not likely go back to its initial location on the frontier. It will instead end up *inside* the PPF, indicated by the grey point, which involves more investment relative to consumption. Supply of funds shifts from S to S' as income decreases, and demand for funds shift from D to D' as firms lose confidence and decrease their demand for investment goods. The grey point in the LFM shows that the equilibrium interest rate goes back to its initial level that is consistent with inter-temporal preferences. The Hayekian triangle also experiences a shift inwards as the economy contracts.

The assumption of an economy that ends up *inside* the PPF is quite a controversial one. Nobel Prize winner Paul Krugman calls the ABCT for “The Hangover Theory”.⁶⁹ In capital-based macroeconomics, a recession is the cure of the malinvestment and expansion. In short-run/long-run Philips curve analysis with focus on the labour market, the economy goes back to its natural rate of unemployment. However, the Philips curve does not take capital structure into account. If the economy was experiencing growth above the natural growth rate (natural unemployment) due to expansionary monetary policy, then Austrians see it as almost impossible to return to the initial point on the PPF due to liquidation of malinvestments.

Even though ABCT favours liquidation and recession as a natural consequence for the expansion phase, the recession is not entirely unavoidable. The economy could go back to its initial PPF temporarily. The government could avoid or dampen the recession by preventing an increase in the interest rate. Monetary authorities would have to increase the money supply further and expose the economy for the same forces with malinvestments and eventually upward pressure on the interest rate again. However, this situation is problematic and unsustainable. The central bank will at some point in time be forced to stop inflation and let the interest rate climb making the malinvestments become apparent. This reasoning has strong monetary policy implications. Once the malinvestment has taken place, expansionary monetary policy can only further postpone the recession, but not avoid it. Furthermore, Austrians argue that if such policy actions take place, the future downturn will be even bigger

⁶⁹ Krugman 1998

since the inconsistency between savings and investment increases when liquidity is injected.

Though Austrians consider the downturn as necessary and inevitable to liquidate the malinvestments, they recognise the possibility of a situation where the economy goes to a point deep inside of the PPF. The economy could face a scenario where supply and demand for funds decrease further as savers increase their money holdings and firms lose confidence in the economy. This spiralling downward was described by Hayek as “secondary deflation”. Austrians do not claim that this is desirable. Neither do they see this as a necessary part of the recovery process. They believe that the government should avoid disrupting the market forces, but see the potential benefit with Keynes’ expansionary policies: Keynes’ stimulus policies should avoid the compounding “secondary deflation” situation, but not to avoid the recession itself.⁷⁰

4.5 Keynesian Recession in an Austrian Framework

The aggregation in the Keynesian framework prevents a closer look at inter-temporal structures during business cycles. In other words, the Hayekian triangle is not considered in the analysis. The triangle can only shift out and inwards, but not change its shape as in the Austrian framework. The point here is to illustrate the differences between the Keynesian and Austrian school.

While the Austrians emphasise the process of moving along the PPF in the short-run, Keynesians approach this totally differently. The circular flow identity⁷¹ together with the simple consumption function imply that consumption exhibits a positive linear relationship with investment. Let us consider a closed private economy without government spending:

$$Y = C + I \tag{7}$$

The simple Keynesian consumption function is defined as:

$$C = \alpha + \beta Y \tag{8}$$

⁷⁰ These potential benefits of Keynesian policies are rarely mentioned by today’s Austrian economists. The emphasis on avoiding any government intervention in the face of crisis puts shadow on this opinion

⁷¹ Circular flow refers to a simple economic model which describes the circulation of income between households and firms (Mankiw 2007, p. 18)

C is total consumption, α is autonomous consumption ($\alpha > 0$), β is the marginal propensity to consume ($0 < \beta < 1$), and Y is disposable income after taxes and transfer payments. Combining the two equations gives us:⁷²

$$C = \frac{\alpha}{(1-\beta)} + \frac{\beta}{(1-\beta)} I \tag{9}$$

The Keynesian demand constraint is drawn in Figure 4.8, and we can see that the only place the constraint intersects with the frontier is where the economy is aligned with the natural rate of employment. Clearly, an increase in I will increase C with the multiplier $\frac{\beta}{(1-\beta)}$. However, the PPF plays a limited role. When the multiplier theory is put through its paces, the frontier serves only to mark the boundary between *real* changes in the spending magnitudes (*below* the frontier) and *nominal* changes in the spending magnitudes (*outside* the frontier). Significantly, the economy is precluded by the demand constraint from moving *along* the frontier.⁷³

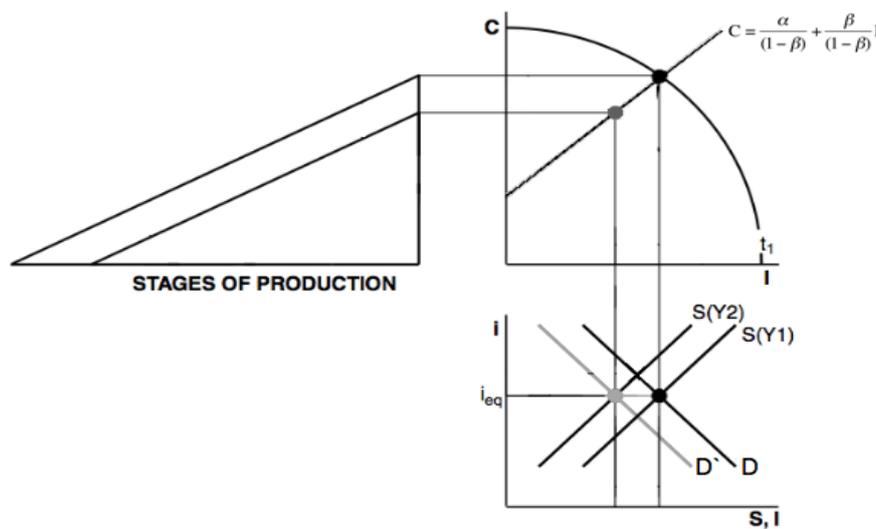


Figure 4.8 – Keynesian recession in Austrian framework. Source: Garrison 2001 and drawings by author.

An increase in savings would decrease the parameter α and shift the curve downwards. Austrians claim that Keynes was not concerned about the implications of increased savings since the parameter α was not subject to change.⁷⁴

Investments are based on future prospects and increased uncertainty reduces business confidence. Recessions are initiated by a collapse in investment demand from firms.⁷⁵ In Figure 4.8, firms demand less funds, making D shift to D'. Less

⁷² Proof: Combining eq. (7) and (8) gives: $C = \alpha + \beta(C + I) \rightarrow C - \beta C = \alpha + \beta I \rightarrow C = \frac{\alpha}{(1-\beta)} + \frac{\beta}{(1-\beta)} I$

⁷³ Snowdon & Vane 2005, p. 36

⁷⁴ Snowdon & Vane 2005, ch. 9

⁷⁵ Keynes 1936, p. 315

investment decreases income and thus consumption. The multiplier effect causes the economy to go inside the frontier, marked by the grey point. Less income means also less savings causing the supply curve to shift from $S(Y1)$ to $S(Y2)$. Here demand and supply of funds shift inwards by equal magnitudes only by assumption.

The main contrast between Keynesian and Austrian views is the departure from PPF. While Austrians claim that an increase in savings makes the economy move downwards *along* the frontier, Keynesians claim that the economy moves *inside* the frontier.

In the Austrian view, the supply curve shifts *outwards* as a result of increased savings, while in the Keynesian view, supply of funds shifts *inwards* through the income effect.

4.6 Austrian Economics in Perspective

ABCT is different from other schools of thought. Till now we have mostly highlighted the main differences between Austrians and Keynesians since Keynesian economics often seems to be the “winning” school of thought in academia and for use in government policies.⁷⁶ Mainstream macroeconomics pays little or no attention to the time dimension dealing with variations and employment, while this is a fundamental concern for the Austrians. As we will see, the Austrian school actually has several similarities with other schools of thought. Figure 4.9 summarises the differences among different schools in terms of consumption and investment.

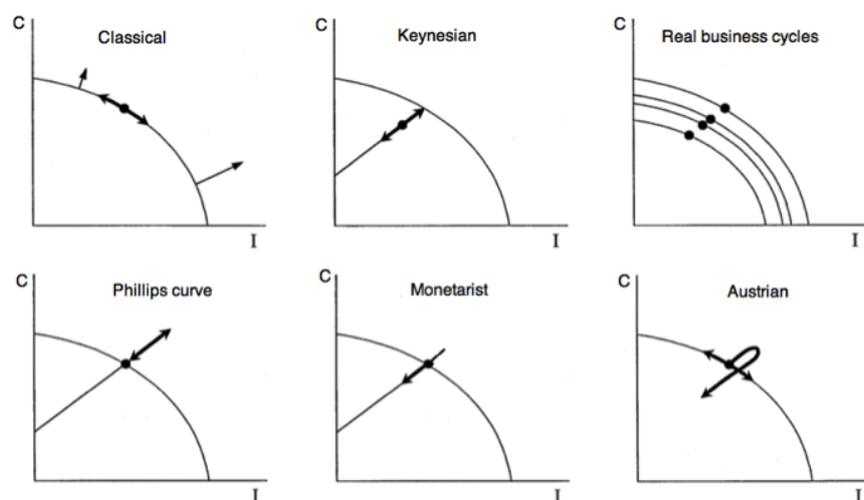


Figure 4.9 – Business cycles and different schools of thought. Source: Garrison 2001

⁷⁶ See Mankiw 2006 for his opinion about different schools of thought

In the classical view, with its long-term focus, the economy is at the PPF, and there is a trade-off between consumption and investment. These two variables move in opposite directions in the short-run and move the economy *along* the frontier. In the long-run, higher investment makes the economy grow faster, indicated by the long arrow in the figure. If the economy chooses more consumption, it will experience lower growth.

The Keynesian view is that the economy is generally not on the PPF. Lack of demand will cause the economy to be inside the frontier. Monetary and fiscal policies can increase demand making the economy move towards the PPF. Consumption and investment will have positive correlations.

Real business cycle theory sees the variations in the economy as real shocks. Markets are assumed to be in equilibrium, and there is no deviation from PPF. The PPF moves constantly and is caused mainly by productivity shocks.⁷⁷ These shocks are exogenous. This is in contradiction to Austrian economics which focuses on endogenous reasons for business cycles. Real business cycle theorists see money as irrelevant with regards to economic ups and downs.

The well-known Philips curve states that there is a trade-off between employment and inflation in the short-run. Expansionary policy can make the economy produce outside the PPF in the short-run. In the long-run, as prices adjust, the economy goes back to the frontier.

In Monetarists' vision, a decrease in money supply or increase in money demand will drive the economy into recession. "That is, except in the implausible case in which prices and wages adjust downward quickly and smoothly to adjust to the lower money supply, the economy will experience quantity adjustments. Output and employment will fall."⁷⁸

ABCT can be contradictory compared with other schools, but it also shares fundamental theories. It stresses the trade-off between consumption and investment as the classicists. ABCT also recognises the fact that the economy can operate outside the PPF as theories based on the Philips curve do. The most distinctive and characterising aspect in ABCT is the claim that the economy simply cannot return to the PPF after the "artificial" expansion, but rather ends up *inside* the PPF once the recession is a fact.

⁷⁷ See Kydland & Prescott 1982 for extensive explanation of the theory

⁷⁸ Garrison 2001, p. 250

Austrian business cycle theory is considered a theory which mainly focuses on supply side shocks on business cycles and can be summarised as follows:

- A monetary shock engineered by monetary authorities causes the market interest rate to be inconsistent with people's time-preference and initiates the business cycle. In fact, Austrians do not believe that business cycles exist in the absence of interference from government or central monetary authorities.
- As the market interest rate is lower than the natural interest rate determined by people's time-preferences, firms realise projects that would not have been started before the monetary shock. This is referred to as malinvestments.
- The malinvestments causes capital resources to be misallocated into sectors that would not attract these investments in the first place.
- As inflation and market interest rate get higher during the expansion period, the malinvestments become apparent and have to be liquidated.
- The liquidation process forces the economy into recession causing the economy to end up *inside* of the PPF. Markets clear and resources are allocated back to equilibrium level unless this process is interfered by governmental policies.

5 Hypotheses and Data

In chapter 5, we present our testable hypotheses and how we test them empirically. The hypotheses are based on the last part of our key question. We introduce the data that are used in the analysis and discuss briefly their origin and purpose.

5.1 Hypotheses

The hypotheses aim to test if ABCT can help understand Norwegian business cycles between 1979 and 2009. We divide our hypotheses into two main groups based on the separation of mechanisms (“trigger” and “propagation”) of the business cycle.⁷⁹ We test the two groups of hypotheses with two different testing methodologies. The first group of hypotheses represents the “trigger mechanism” of the business cycle:

- I Expansionary monetary policy makes the market interest rate go below the natural rate of interest.⁸⁰
- II-a A market interest rate below the natural interest rate makes investment expenditure increase more than consumption expenditure due to the investment bias in the beginning of the cycle.⁸¹
- II-b A market interest rate below the natural interest rate shifts resources away from middle-stage production to early and late-stage production, but relatively more to early-stage.⁸²
- II-c As the investment bias takes place, producer prices (PPI) increase and relatively to consumer prices (CPI).⁸³

To test these four hypotheses, we want to use correlation with lags to check for interrelation between the variables. We will use Granger causality testing to see if we can increase the strength of the hypothesised causal relationships.

The second group of hypotheses corresponds to the “propagation mechanism” which allows the business cycle to play itself out. We want to construct a simple multiple regression model to see if these variables can explain variations in GDP:

⁷⁹ See ch. 4.3 “Monetary Policy and Expansion”

⁸⁰ See Figure 4.6 – Monetary expansion

⁸¹ See Figure 4.6 – Monetary expansion

⁸² See Figure 4.6 – Monetary expansion

⁸³ See Table 3-1 – Effects of relative prices changes on economic profit

- III-a A change in the ratio of investment to consumption affects the business cycle. The ratio increases in the beginning of the cycle, but is expected to fall during the cycle.
- III-b A change in the ratio of late-stage to early-stage recourses affects the business cycle. The ratio increases in the beginning of the cycle, but is expected to fall during the cycle.
- III-c A change in the ratio of producer prices to consumer prices affects the business cycle. The ratio increases in the beginning of the cycle, but is expected to fall during the cycle.

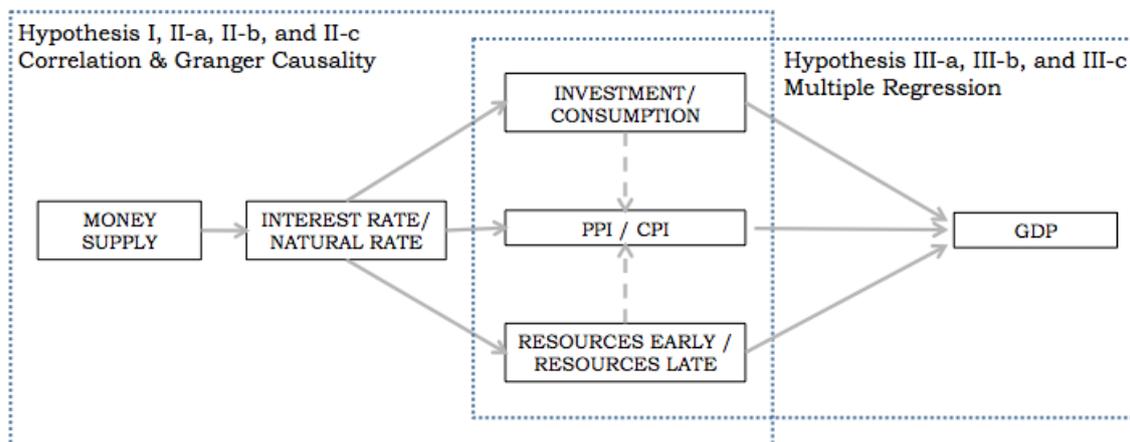


Figure 5.1 – Flow chart of hypothesis.

Figure 5.1 shows a flow chart for our empirical testing. The flow chart is based on the hypotheses which are related to the loanable funds market, the Hayekian triangle, and the production possibility frontier. The terms in the boxes will be defined in the following sub-chapter.

5.2 Data

Testing the hypotheses of group one, we need variables for aggregate output, money, short-term and natural interest rate, and a measure of late versus early-stage resource usage.

For the purpose of this paper, we choose to use quarterly data from 1978 to 2010. A few observations on each side were cut in order to reduce the issues of data revision and the issues regarding the ends of time series with the use of Hodrick-Prescott filter. This leaves us with 121 observations from 1979Q2 to 2009Q2 (30 years).

5.2.1 Aggregate Output

Mitchell and Burns defines business cycles as: “(...) expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions and revivals which merge into the expansion phase of the next cycle”.⁸⁴ Economic activities might be purposefully vague in that it accounts for an array of various data such as production, unemployment rate, and payroll employment. A recession is often defined as two consecutive quarters of negative GDP growth. Since the mentioned variables often coincide, GDP may in many cases suffice as a measure of business cycles. GDP measures a nation’s economic output in terms of market value of all products and services produced.

In Norway, there are two common GDP measures due to the big impact of the oil industry; GDP and GDP mainland (oil industry excluded). Figure 5.2 shows the difference between detrended GDP and GDP Mainland in constant prices. How we detrend GDP will be discussed in ch. 6.3.1 "HP-Filter". Even though the two measures have a high degree of interrelation, their difference is significant in their impact on other variables. GDP is a more volatile measure since it accounts for the oil industry which is very large compared to the overall economy. We use GDP Mainland which is less volatile and more influenced by local underlying factors, as our measure of business cycle.

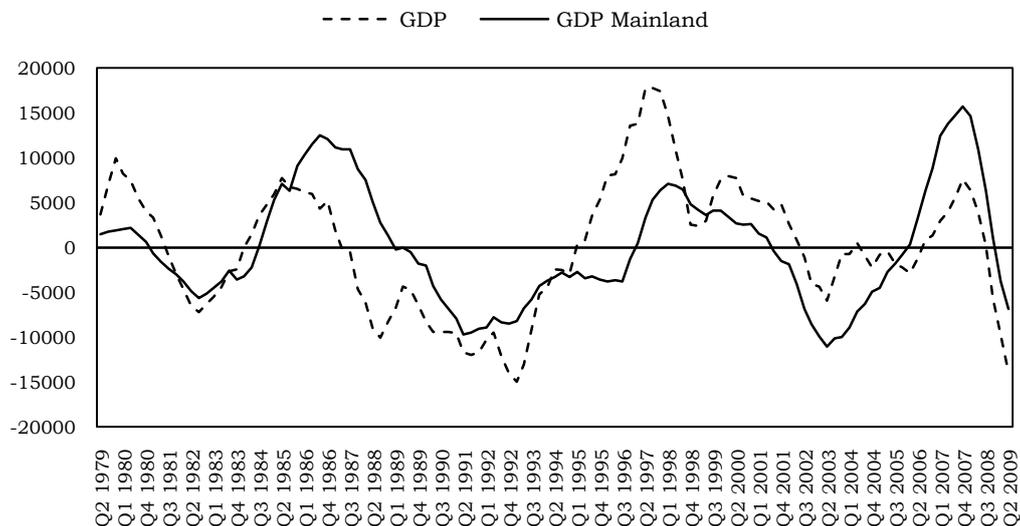


Figure 5.2 – Difference between GDP and GDP Mainland

We use seasonally adjusted numbers from Datastream which sources back to Statistics Norway (SSB). The GDP numbers can be revised two years after they are published before they are considered final. Since we have cut out some of the last

⁸⁴ Burns & Mitchell 1946, p. 21

observations in our time series, this problem is somewhat reduced. The variable will from now on be denoted as GDP.

5.2.2 Money

For our money aggregate we are faced with three different published measures; M_0 , M_1 and M_2 . For our purpose we wanted to have a measure that is closely related to the actions of the central bank. M_0 is commonly referred to as monetary base or narrow money which is closely related to the monetary actions of the central bank. We use quarterly M_0 which is found using Datastream which sources back to Norges bank.⁸⁵ The variable will from now on be denoted as MONEY.

5.2.3 Interest Rates

A central concept of ABCT is that monetary policy affects interest rates and more specifically the short end of the term structure. The Austrians believe that interest rates are affected to a level which differs from the natural interest rate that would exist if the interest rate was set naturally in the market place. The concept of natural interest rate is a classical concept in economic literature, and the natural rate has been given definitions more than a century ago.⁸⁶ John C. Williams of the Federal Reserve Bank of San Francisco writes: "In the long-run, economists assume that nominal interest rates will tend toward some equilibrium, or "natural", real rate of interest plus an adjustment for expected long-run inflation."⁸⁷

The Austrian theory has a strong focus on the concept of the natural rate of interest. They believe that this rate would be reflected in the market rates, if there was no governmental interference or monetary adjustments made by the central bank. With monetary expansion the interest rates becomes lower than the time-preference expressed as the equilibrium in the loanable funds market.⁸⁸ In today's environment, the natural interest rate is not observable, so a proxy or estimation is needed. Let us look at some alternatives:

Growth rate of an economy: Many mainstream economists look at the growth rate of an economy to proxy the natural interest rate.⁸⁹ Austrian economics claims that this proxy is not the best one as the growth rate in the short-run can be affected by monetary policy and government spending.

⁸⁵ See also definition of monetary base in sub-chapter 4.3.1 Effects on Nominal Prices

⁸⁶ Knut Wicksell defines the natural interest rate as "a certain rate of interest on loans which is neutral in respect to commodity prices, and tends neither to raise nor to lower them" ([1898] 1936, p. 102)

⁸⁷ Williams 2003

⁸⁸ See Figure 4.6 – Monetary expansion. Source: Garrison 2001

⁸⁹ Carilli & Dempster 2008, p. 275, Laubach & Williams 2003

Savings-consumption ratio: Some authors, such as Rothbard, suggest that the savings-consumption ratio is the appropriate measure of the natural interest rate since this ratio reflects the time-preference of economic agents.⁹⁰

Long interest rate: Keeler uses the long interest rate as a proxy of the natural rate.⁹¹ He looks at the slope of the yield curve to measure the relationship between actual and natural rates. This term structure approach assumes that differences between current short- and long-term interest rate are driven by expectations. This is referred to as the “expectation theory” in literature within financial economics. The “expectation theory” states that the interest rate on a long-term bond will equal an average of the short-term interest rates that people expect to occur over the life of the long-term bond.⁹²

The causal relationship between money and interest is well established by scholars around the world. Theoretically, money injections can be separated into having two opposing effects on the term structure of interest.⁹³

1. *Liquidity effect*⁹⁴: This effect is related to the additional liquidity that is injected into the economy. The liquidity effect puts a downward pressure on short- and long-term interest rates.⁹⁵
2. *Fisher effect*: Money injections will increase people’s inflation expectations and raise future short rates, putting an upward pressure on the long-term interest rate.⁹⁶

Therefore, an expansionary monetary policy will lower short-term interest rates and make the yield curve steeper.⁹⁷ The effect on the long-term interest rate is neutralised (or uncertain) as the liquidity and Fischer effect pull in different directions. After increased money supply, the new yield curve is indicated by the dashed line in

Figure 5.3 Figure 5.3.

⁹⁰ Rothbard 1962

⁹¹ Keeler 2001

⁹² Formal definition: $i_{nt} = \frac{i_t + i_{t+1}^e + i_{t+2}^e + \dots + i_{t+(n-1)}^e}{n}$ where n is period and i is the interest rate, t is time, and e is the expected value

⁹³ Cwik 2005

⁹⁴ The term liquidity effect is also referred to as the “Wicksell effect” (Cwik 2005) and was introduced by Joan Robinson (1953, p. 95) during a debate in the theory of capital

⁹⁵ Cwik 2005, p. 8

⁹⁶ The Fisher effect is a proposition by Irving Fisher and states that the nominal interest rate is the sum of real interest rate and expected inflation. Equation: $i_n = i_r + \pi^e$ where: i_n is the natural rate, i_r is the real rate, and π^e is the expected inflation

⁹⁷ Keeler 2001

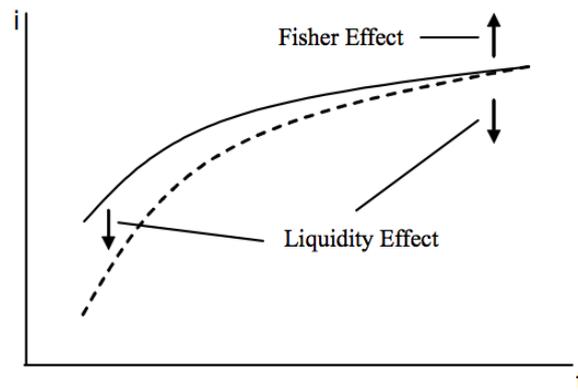


Figure 5.3 – The liquidity and Fisher effect on the term structure. Source: Cwik 2005

Most studies of the yield curve indicate that the interest rate also is driven by other factors (than expectations of future short-term rates) such as liquidity and risk premium.⁹⁸ This means that the long-term rate might not necessarily reflect the underlying time-preference.⁹⁹

The yield curve shows rate of returns on financial instruments and should in normal equilibrium have a positive slope since premiums increase with maturity. A monetary shock will have a liquidity effect that lowers short-term interest rate more than long-term interest rates.¹⁰⁰ Bernanke has reviewed several interest rates concepts and has shown that the short-term interest rate is more highly correlated with money supply growth than the long-term interest rate (0.29–0.33 compared to 0.06–0.20).¹⁰¹ He has also found that the slope of the yield curve shows highest correlation with money supply growth (0.55). The fact that long-term interest rate is less affected by monetary policy supports the notion that it might be a good representation for natural interest rate. Keeler shows that the slope shows more regularities than that of levels of interest rates during cycles. This analysis will use the long-term interest rates to represent the natural rate based on Bernanke’s findings and earlier empirical methods of Austrian authors.

For short-term interest rate we choose to look at the three month interbank interest rate (NIBOR3M) and 10 year government bond as the natural rate of interest. We will use the slope of the yield curve as our relationship between market rate and natural rate. The slope of the yield curve is calculated:

⁹⁸ The equation becomes very similar to expectations theory: $i_{nt} = \frac{i_t + i_{t+1}^e + i_{t+2}^e + \dots + i_{t+(n-1)}^e}{n} + l_{nt}$ where: l_{nt} is the liquidity premium for the n -bond at time t ($l_{nt} > 0$). See also Mishkin (2007) ch. 6 for different theories about the term structure

⁹⁹ Carilli & Dempster 2008, p. 274

¹⁰⁰ Romer 1996, 395-396

¹⁰¹ Bernanke 1990, 51-68

$$YIELD_t = \ln \left(\frac{1+10YRGOV_t}{1+NIBOR3M_t} \right) \quad (10)$$

The relationship will from now on be denoted as YIELD.

5.2.4 Resources

A fundamental part of the ABCT is that the term structure of interest affects where resources are demanded in the economy. As shown earlier, a low interest rate favours early stage relative to late stages of production. Resources can be measured in several ways. Examples or measures are capacity utilisation, sector specific investments, production capacity, and labour employment. We choose to look at labour for measuring resource movements. This is consistent with the Austrian empirical work of Mulligan.¹⁰² The labour ratio is created as an index by summing relevant early and late sectors and dividing them as shown in equation (11). In the early part we use construction, mining, and quarrying and for the late sector we use business service, post and tele communication, financial intermediation, hotels, and restaurants:

$$LABOUR_t = \frac{L_t^{Early}}{L_t^{Late}} \quad (11)$$

We use seasonally adjusted quarterly labour statistics collected from Datastream. The variable will from now on be denoted as LABOUR.

5.2.5 Investment and Consumption

To test hypothesis II-a and III-a, we need aggregates for investment and consumption. These variables are expenditure parts of aggregate demand and downloaded from Datastream. We want to see the evolution of these aggregates expressed as ratios. The ratio can be shown as follows:

$$I/C_t = \ln \left(\frac{Investment_t}{Private\ Consumption_t} \right) \quad (12)$$

The relationship will from now on be denoted as I/C.

5.2.6 Prices

¹⁰² Mulligan 2006

Based on the Hayekian triangle and the Austrians focus on relative prices, we have looked at two different prices: Producer price index (PPI) and consumption price index (CPI). Lack of available data for PPI made us construct an index based on a quarterly four quarter growth rate (%YOY). Same procedure is done with CPI. Correlation between constructed and official CPI measures 0.9998 which indicates a good procedure. The constructed and actual CPI are shown in Figure 5.4. 1979Q1 is set to an index value of 100 and presented in natural log form.

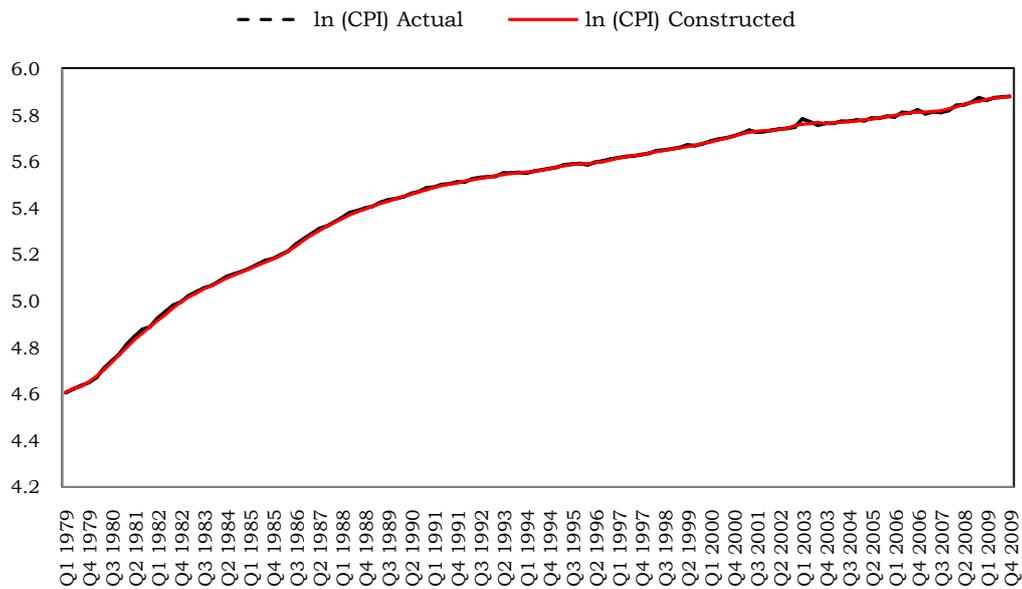


Figure 5.4 – Comparison between actual CPI and constructed CPI. 1979Q1 = ln (100)

This paper will focus on the ratio of these variables which can be shown as follows:

$$PRICES_t = \ln \left(\frac{PPI_t}{CPI_t} \right) \quad (13)$$

The relationship will from now on be denoted as PRICES.

6 Stationarity and Detrending

6.1 Stationarity

Before testing the hypotheses in accordance with Austrian business cycle theory on Norwegian business cycles, we have to take a closer look at the different variables and their properties. Computing correlations and regressions based on raw data can show significant relations, but can be highly misleading if the data are non-stationary. From a policy perspective, it is important to know if a time series is persistent or not. For example, if GDP is strongly dependent on GDP several periods ago, then a policy change that affects GDP can have long-lasting effects.¹⁰³

A time series is said to be stationary, if the mean, variance, and covariance are constant over time.¹⁰⁴ That is, the time series of one variable is stationary if:

$$E(y_t) = \mu \quad (\text{constant mean}) \quad (14)$$

$$\text{Var}(y_t) = \sigma^2 \quad (\text{constant variance}) \quad (15)$$

$$\text{Cov}(y_t - y_{t-s}) = \gamma_s \quad (\text{covariance depends on } s, \text{ not } t) \quad (16)$$

A time series that does not satisfy these conditions are often non-stationary. Non-stationary time series with non-constant means are often described as not having property of mean reversion. The condition of constant mean is the feature that receives most attention. As shown in Table 6-1, the sample means and variances for the two different periods show quite different values for GDP and M_0 , while INV/CON, E/L LABOUR, PPI/CPI, and YIELD seem to be quite similar for the different periods.

The sample mean is a simple and convenient indicator of the variable characteristics. However, a formal test of non-stationarity is needed. This can be tested by different unit root test such as: Kwiatkovsky–Phillips–Schmidt–Shin, Phillips–Perron, and augmented Dickey–Fuller tests. Before one or several of these tests are conducted, it is often helpful to conduct the first-order autoregressive model.

¹⁰³ Hill 2008, p. 328

¹⁰⁴ Hill 2008, p. 328

Table 6-1 – Descriptive variable statistics

	GDP	M ₀	INV/CON	E/L LABOUR	PPI/CPI	YIELD
Whole period						
Mean	307471	47975	0.4771	0.4552	0.8734	-0.0012
Stddev	62748	25579	0.0547	0.0993	0.1327	0.0134
1979Q2-1994Q1						
Mean	255281	28548	0.4871	0.5304	0.8900	-0.0077
Stddev	16498	6015	0.0600	0.0916	0.0973	0.0090
1994Q2-2009Q2						
Mean	358805	67085	0.4672	0.3812	0.8571	0.0053
Stddev	46946	22897	0.0473	0.0151	0.1593	0.0140

The first-order autoregressive model (AR(1)) is a univariate time series model explaining the difference between stationary and non-stationary series. The AR(1) can be shown as:¹⁰⁵

$$y_t = \rho y_{t-1} + \varepsilon_t \quad (17)$$

where the errors ε_t are independent, with zero mean and constant variance. In the context of time series models, the errors are referred to as shocks. The coefficient ρ measures dependency of the variable y_t on its own value in the previous period. If $|\rho| < 1$, then y_t is stationary and non-stationary if $\rho = 1$.

Consider the case of $\rho = 1$ in the previous equation:

$$y_t = y_{t-1} + \varepsilon_t \quad (18)$$

This non-stationary model is known as the random walk model without drift.¹⁰⁶ Equation (18) shows that each value of y_t contains the last period value of itself plus an error ε_t . The random walk has a mean equal to its initial value and a variance that increases over time. Even though the mean is constant, the increasing variance implies that the time series may not return to its mean.¹⁰⁷

¹⁰⁵ The AR(1) model is concerned with only one lag, and therefore called autoregressive model of order 1. The term "univariate time series" refers to a time series that consists of "single observations recorded sequentially over equal time increments" (NIST/SEMATECH e-Handbook of Statistical Methods 2003)

¹⁰⁶ These time series are called random walk because they appear to go slowly upward or downward with no real pattern (Hill 2008, p 331)

¹⁰⁷ Recognising that ε_t is independent, taking the expectation and the variance of y_t yields for a fixed value of y_0 : (1) $E(y_t) = y_0 + E(\varepsilon_1 + \varepsilon_2 + \dots + \varepsilon_t) = y_0$ (2) $Var(y_t) = var(\varepsilon_1 + \varepsilon_2 + \dots + \varepsilon_t) = t\sigma_\varepsilon^2$

It is important to not confuse trend and non-stationary behaviour.¹⁰⁸ Variables such as interest rate, inflation, and unemployment rates are thought to be persistent, but without an obvious upward or downward trend. However, variables are often persistent in addition to containing a trend component. Adding a constant into the equation can show another model:

$$y_t = \alpha + y_{t-1} + \varepsilon_t \quad (19)$$

This model is known as random walk with drift where α is the drift component. The equation shows that y_t is dependent on the intercept α , its previous value y_{t-1} , plus ε_t . As shown in the equation 18, the main difference between random walk with or without trend is the intercept α , where $\alpha \neq 0$.

6.2 Statistical Properties

There are many ways to test for non-stationary. The most popular one is the Dickey-Fuller test which we will be using in this paper. This test is based on the AR(1) model and tests if the time series contains a unit root. Consider again the AR(1) model:

$$y_t = \rho y_{t-1} + \varepsilon_t \quad (20)$$

By subtracting y_{t-1} from both sides, we obtain:

$$y_t - y_{t-1} = (\rho - 1)y_{t-1} + \varepsilon_t \quad (21)$$

Simplifying the equation gives us three different Dickey-Fuller (DF) tests:

$$\text{DF1: } \Delta y_t = \gamma y_{t-1} + \varepsilon_t \quad (\text{without constant and without trend}) \quad (22)$$

$$\text{DF2: } \Delta y_t = \alpha + \gamma y_{t-1} + \varepsilon_t \quad (\text{with constant and without trend}) \quad (23)$$

$$\text{DF3: } \Delta y_t = \alpha + \theta t + \gamma y_{t-1} + \varepsilon_t \quad (\text{with constant and with trend}) \quad (24)$$

where $\gamma = (\rho - 1)$ and $\Delta y = y_t - y_{t-1}$. We can then test for non-stationarity by testing the null hypothesis that $\rho = 1$ against the alternative that $\rho < 1$. If $\rho = 1$, it indicates that the data are non-stationary. The hypothesis can then be written in terms of either ρ or γ as follows:

$$H_0: \rho = 1 \leftrightarrow H_0: \gamma = 0 \quad (25)$$

$$H_0: \rho < 1 \leftrightarrow H_0: \gamma < 0 \quad (26)$$

¹⁰⁸ Wooldridge 2009

To test the hypothesis in all the cases, we estimate the test equation by least squares and examine the t-statistics for the hypothesis where $\gamma = 0$. The problem is that this statistics no longer has the normal t-distribution. The reason for this is that if the null hypothesis is true, y_t is non-stationary and has a variance that increases as the sample size increases.¹⁰⁹ This increasing variance changes the distribution of the usual t-statistics when H_0 is true. Due to this problem, we have to compare the coefficient to “critical values”,¹¹⁰ often called τ -statistics. The critical values vary with the different DF-models and are higher than usual critical values. Notice that these critical values have higher negative values than standard critical values, which implies that the τ -statistics must take a larger absolute value than usual for the null hypothesis to be rejected. We reject the null hypothesis of non-stationarity if $\tau \leq \tau_c$.¹¹¹

There is no clear rule to which one of the Dickey-Fuller tests that is appropriate, so the method of use is dependent on the author. We will present the time series visually and then determine which method we will use on the different variables. Presenting the time series visually will help us to indicate trends and signs of non-stationarity. The equation chosen is based on these visual indicators:

- If the variable seems to fluctuate around average of zero, use DF1
- If the variable seems to fluctuate around average of nonzero, use DF2
- If the variable seems to fluctuate around a linear trend, use DF3

6.2.1 Augmented Dickey-Fuller Test (ADF test)

The augmented Dickey-Fuller test is an extension of the Dickey-Fuller test and allows for the possibility of the error term to be auto-correlated. The extended equation becomes:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{s=1}^m a_s \Delta y_{t-s} + \varepsilon_t \quad (27)$$

where $\Delta y_{t-1} = (y_{t-1} - y_{t-2})$, $\Delta y_{t-2} = (y_{t-2} - y_{t-3})$. The critical values in this test are the same as in the regular Dickey-Fuller test. We will in this paper focus on the augmented Dickey-Fuller test, since this is the most reliable test for a unit root and takes autocorrelation in the error term into account.

¹⁰⁹ Hill 2008, p 336

¹¹⁰ These critical values were tabulated by the statisticians David Dickey and Wayne Fuller

¹¹¹ Vice versa, we do not reject the null hypothesis that the time series are non-stationary if $\tau > \tau_c$

6.2.2 Order of Integration

To bring the analysis of stationarity one step further, we have to consider the concept of “order of integration”. If a variable follows a random walk, then $\rho = 1$ and the first difference becomes:

$$\Delta y_t = y_t - y_{t-1} = \varepsilon_t \quad (28)$$

By taking the first difference, we can make the time series stationary since ε_t , an independent $(0, \sigma_\varepsilon^2)$ random variable, is stationary. Series like this are said to be integrated of order 1 and denoted as $I(1)$.¹¹² Likewise, stationary series that are not differentiated are integrated of order zero, $I(0)$.

6.2.3 Cointegration

Cointegration is another economic property of time series. Non-stationary time series should not be used in a regression analysis as a general rule to avoid spurious regressions.¹¹³ However, there is an exception to this rule. Time series including unit roots can be regressed if they are cointegrated.

A method to test for cointegration of two variables is to see if the residuals are stationary. First step can be done by conduct a simple regression analysis:

$$y_t = \beta_0 + \beta_1 x_t \quad (29)$$

By subtracting the right hand side in the equation on both sides gives us:

$$e_t = y_t - \beta_0 - \beta_1 x_t \quad (30)$$

If y and x have unit roots, then usually e has a unit root. However, in some cases, unit roots in y and x cancel each other out and e does not have a unit root. The problem with spurious regression vanishes, and the time series are said to be cointegrated.¹¹⁴

A formal test of stationarity in the residuals could be based on (assuming no constant term):

$$\Delta \hat{e}_t = \gamma \hat{e}_{t-1} + v_t \quad (31)$$

Since we cannot observe it directly, it is possible to use a Dickey-Fuller test. The test is basically a test of the stationarity of the residuals. If the residuals are stationary, y

¹¹² Hill 2008, p. 338

¹¹³ Even if the true value of $\beta=0$, OLS can yield an estimate of $\beta \neq 0$. T-statistics and P-value may indicate that β is not zero. This would also yield a R^2 different from zero. A regression analysis based on time series including unit roots will therefore be highly misleading referred to the term “spurious regressions”

¹¹⁴ Note that if cointegration does not occur, then e will have a trend in it

and x are said to be cointegrated. However, in a multiple regression analysis we expect most of the variables to be non-stationary. Instead of conducting cointegration tests to see if we can use non-stationary data, we will only use stationary variables in the regression model.

6.2.4 Unit Root Results

We expect several of the variables to be non-stationary after having looked at different macroeconomic time series. If variables turn out to be non-stationary in the unit root test, we have to make them stationary. Before conducting tests for stationarity, it is often helpful to illustrate the variables visually to determine the time series properties. By doing this, we can get an impression of trend and non-stationarity. Below is an illustration of Norway's quarterly GDP from 1978 to 2009. The other variables are shown in the appendix.¹¹⁵ We also used a logarithmic scale of GDP because in that case the slope of a trend line represents the rate of growth.¹¹⁶

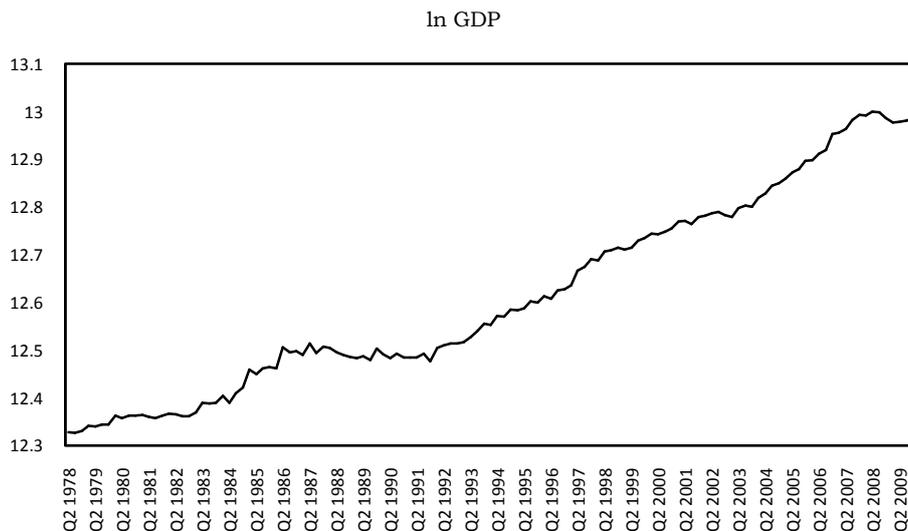


Figure 6.1 – GDP from 1978 to 2009. Converted to natural log form. Source: Datastream

¹¹⁵ See appendix section “Time Series Properties”

¹¹⁶ Krugman 2010

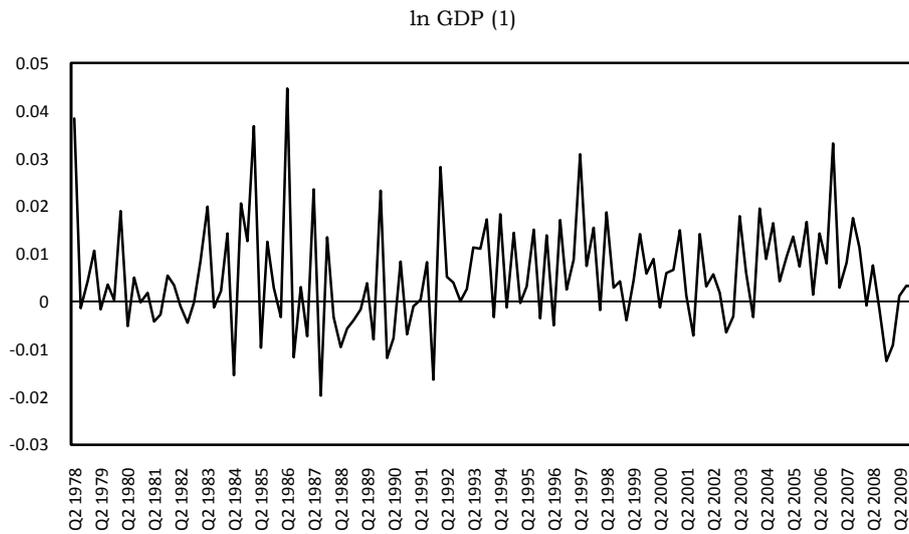


Figure 6.2 – Ln (GDP) first differentiated.

As we can see from Figure 6.1, the GDP level follows a clear positive trend which implies different means in the different time periods. Therefore, it does not satisfy the condition of stationarity. First difference 1(0) shows that GDP is fluctuating above zero. An augmented Dickey-Fuller test will confirm these properties.

Table 6-2 shows the results of the unit root test. The column “Lags” in the table shows the highest significant lags within the range of twelve lags based on the formula of Schwert.¹¹⁷

Table 6-2 – Unit root t-test table

30 year quarterly sample: 1979 Q2 - 2009 Q2 (121 observations)

Null hypothesis	Lags	ADF C	Lags	ADF C&T	Lags	ADF 1.diff.
GDP has a unit root	0	1.8352	0	-1.1724	3	-2.3667**
M ₀ has a unit root	1	1.1340	2	-2.4521	0	-17.8809***
YIELD has a unit root	1	-3.6381***	1	-3.9013**	0	-9.7948***
LABOUR has a unit root	5	-2.9328**	5	-2.0938	4	-2.6050***
I/C has a unit root	1	-2.2511	1	-2.0588	0	-16.5730***
PRICES has a unit root	0	-0.1825	0	0.0076	0	-9.4522***

*, **, and *** denote statistical significance at 10%, 5%, and 1% levels. C = constant, T = trend.

The statistical properties show that GDP, M₀, I/C, PRICES are non-stationary in levels regardless of inclusion of a constant or a constant and a trend component. YIELD is stationary both with constant and with constant and trend at respectively one percent and five percent significance levels. LABOUR is stationary with constant at a five

¹¹⁷ Ng & Perron 1995: $p_{max} = 12 \times (\frac{T}{100})^{1/4}$, where p_{max} is max number of lags, and T is the number of observations

percent significance level, but not stationary with constant and trend. All variables are stationary in first difference $I(0)$ at one percent significance level except GDP at a five percent level. We will make the non-stationary variables stationary with a Hodrick-Prescott filter except for YIELD since it is stationary at level form. The Hodrick-Prescott filter will be discussed in the following chapter.

6.3 Decomposition of Trend and Cycle

There are several ways of isolating the trend component of a macroeconomic time series. The methods can be categorised into roughly two main categories: Univariate and multivariate methodologies. The univariate types make only use of information from the time series itself whereas the multivariate methods utilize several time series or variables.

We tackle the issue of non-stationarity by using the HP-filter as our detrending methodology. It is a widely used method and has an intuitive understanding. According to Schlicht, the HP-filter is preferable to one-sided filters like the Kalman filter because a two-sided filter uses all information available in the time series itself.

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When it comes to GDP data, the HP-filter is the most used method today on Norwegian GDP data.¹¹⁹ It is applied by Norges Bank (the central bank of Norway) and the Norwegian Ministry of Finance. Even though the HP-filter is a univariate method, Bjørnland finds that the HP-filter estimates trend and cycle values for Norwegian GDP data to approximately same levels as more complicated methods.¹²⁰

6.3.1 HP-Filter

The HP-filter is a technical method which estimates the trend in time series and the deviation from trend. It is based on an algorithm which aims to separate the trend component, which can be defined as smoothed values of the time series, from the other components in the time series. The HP-filter allows the trend to fluctuate over time and minimises these variations at the same time as it minimises the deviations between trend and observed value. This can be shown by the following expression:

$$\min \sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t \tau_{t-1})]^2 \quad (32)$$

¹¹⁸ Schlicht 2004

¹¹⁹ Bjørnland 2004

¹²⁰ Bjørnland 2004

The first term of the expression is the difference between the actual (y_t) and trend value (τ_t). It is squared to ensure equal weighting of negative and positive deviations. In terms of the GDP time series, this term can be defined as the production gap. Production gap can be defined as the difference between actual and potential (trend) production. The production gap says something about how much pressure there is on the economy. The second term is the square of trend growth. It is weighted by λ which determines to which extent variations in the trend growth should be allowed. In other words, λ decides how smooth the trend will be, and is therefore often called the smoothing parameter.

If λ is chosen to zero, the second term is gone and only the difference between actual and trend value is minimised. The actual and the trend value then become identical which implies that the trend captures itself all fluctuations in the time series. This is called a stochastic trend.¹²¹ Though, implying e.g. that business cycles are non-existing is rather unrealistic.

If λ goes towards infinity, the first term of the expression will be negligible and only the second term is minimised. This is a deterministic trend which allows no variation in trend.¹²² This means that the cyclical component includes all of the volatility of the time series.¹²³ Therefore, a higher λ puts more emphasis on the temporary shocks to the fluctuations of the time series. This implies that the trend growth is linear¹²⁴. However, for instance looking at GDP data, it seems unlikely that the GDP trend grows by the same factor every time period.

Choice of Lambda

We choose to use an HP-filter with λ of 40,000 for all the variables that are detrended in our paper. The choice of value to put in for λ is determining the result of the analysis. However, there is no established truth on which value to use. The final choice can only be based on best practice and a subjective analysis.

Hodrick and Prescott suggest 1600 as the most accurate λ for quarterly-based time series and according to Frøyland and Nymoen this seems to have become the international standard.¹²⁵ However, according to Johansen and Eika, it is necessary to use a λ at 40,000 on Norwegian quarterly GDP data over the period 1979-99.¹²⁶ They

¹²¹ Balke 1991

¹²² Balke 1991

¹²³ Mathematically the trend will capture a value moving towards all trend

¹²⁴ Linear, or constant, growth in trend is shown by the second term equalling zero and then follows: $(\tau_t + 1 - \tau_t) = (\tau_t - \tau_{t-1})$

¹²⁵ Hodrick & Prescott 1981, Frøyland & Nymoen 2000

¹²⁶ Johansen & Eika 2000

claim that the deep and long-lasting recession in the Norwegian economy at the end of the 1980's would otherwise distort the trend from being coherent with the fundamental development of the real capital and the population base. Another reason for using a high λ on Norwegian GDP data is that Norway is dominated by the petroleum sector which can result in bigger cyclical movements. Finally, a λ of 40 000 is also commonly used by Statistics Norway and Norges Bank. We use the same level of λ for the other variables to show consistency in length of cycles. This also adds simplicity to the methodology.

Weaknesses of the HP-filter

The HP-filter is a two-sided filter which is shown when estimating trend growth by using data from time t_{-1} , t , and t_{+1} . This leads to a problem, since there are missing observations at the beginning t_{-1} and at the end t_{+1} of a time series. In that case, the HP-filter would act like a one-sided filter making the size of the difference between actual and trend value more influenced by the actual value at these points than in the rest of the series. Concerning the most recent end of a time series, the problem is amplified by the fact that current data often are revised.¹²⁷ A high λ will also intensify the trouble, as the λ is part of the second term of the expression where there is use of the two-sided filter. This would make the trend estimate lose even more validity.¹²⁸

The assessment problem can be avoided to a certain extent by using estimates for future or past values. However, estimates are uncertain and may not add value. Another possibility is to make the time series shorter, but that might not be in accordance with the scope or goal of the assignment.

We choose to analyse our time series from quarter two (Q2) of 1979 to quarter two of 2009. This gives us time series of 30 years, and we have data from Q1 of 1978 and Q4 of 2009 to avoid the problem of assessing the ends of a series.

The HP-filter assumes that positive and negative deviations from trend values are equally weighted as shown by the first term of the HP equation being squared. This implies that periods of positive and negative deviation are of same length on average. However, for instance, Romer has shown that this is not always true for GDP series.¹²⁹

If the time series includes a long-lasting period of difference between actual and trend value, the HP-filter using too low values for λ will analyse this as a change in trend. The opposite, using a too high value for λ , will not capture structural changes in terms

¹²⁷ See also ch. 5.2.1 "Aggregate Output"

¹²⁸ Bernhardsen et al. 2004

¹²⁹ Romer 1999

of the trend value, even though that might be more aligned with reality. This is basically the debate of deterministic versus stochastic trend which is closely linked to the level of λ .

For use on GDP data, the HP-filter is criticised for lack of theoretical definition of potential production (trend value). It finds the trend level as a statistical natural production of the economy. This is only a mechanical way of finding trend production and not based on established economic theory.

6.4 Transforming Variables

Figure 6.3 shows the seasonally adjusted real GDP with a Hodrick-Prescott trend from 1978Q1 to 2009Q4 with λ value of 40,000. The variable is then transformed to natural logarithm. The other variables are showed in appendix.¹³⁰

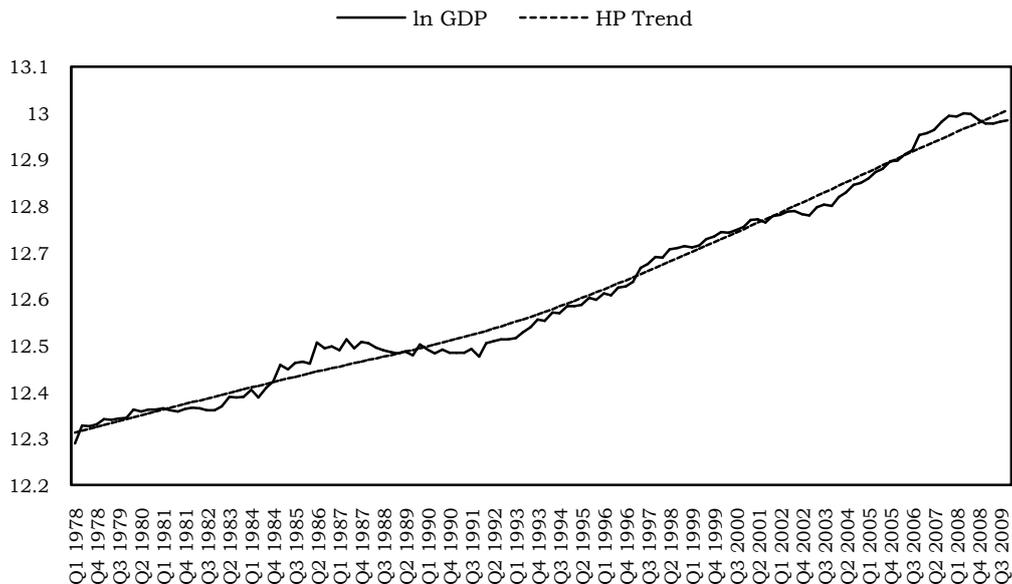


Figure 6.3 – Real GDP time series with a HP-filter 1978Q1-2009Q4. Source: Datastream

¹³⁰ See Appendix, HP-filter

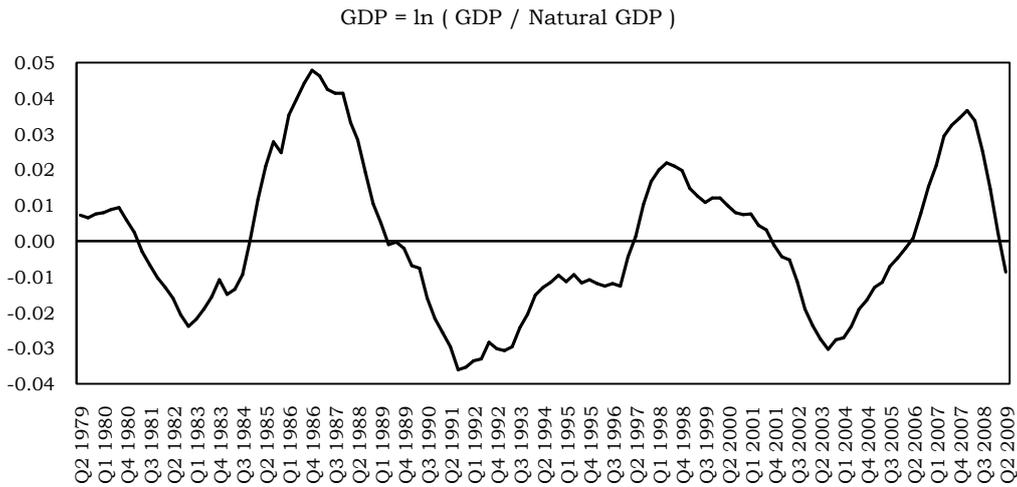


Figure 6.4 – GDP variable. Source: Datastream

In order to make the variables stationary, we choose to look at deviation from trend by dividing GDP by natural GDP (HP-trend). The final GDP variable can be seen in Figure 6.4.

6.4.1 Smoothing

All variables used are smoothed in order to find the underlying cycle variations and eliminate noise. A common method is using moving average. For time series a recommended method is using one quarter backwards and two forward. However, this method relies more on expectations and being forward-looking than a pure historical analysis. One can see an example of the transformation in Figure 6.5. We choose to use a noise reduction method with four-quarter moving average with two quarters back, one current, and one forward:

$$\bar{Q}_t = \frac{Q_{t-2} + Q_{t-1} + Q_t + Q_{t+1}}{4} \tag{33}$$

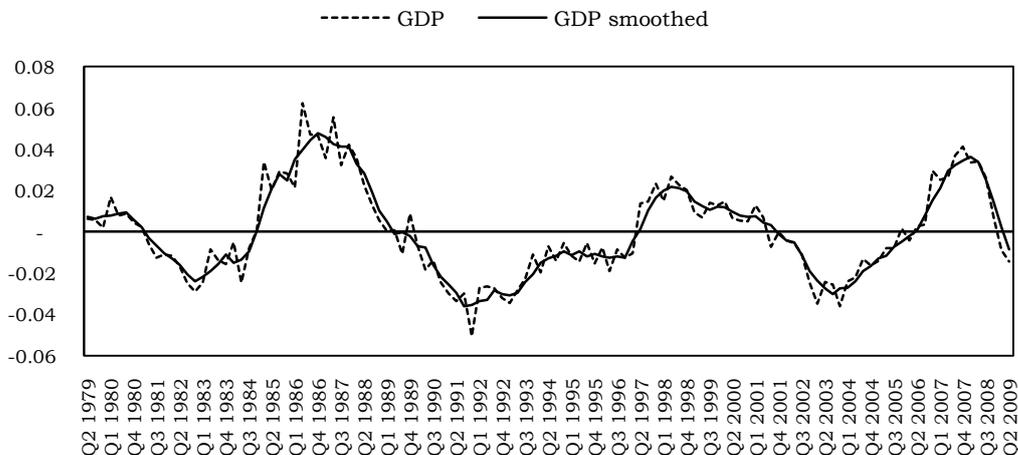


Figure 6.5 – GDP and 4-period moving average

7 Empirical Analysis

Few empirical analyses have been done on Austrian theory partly due to lack of clearly defined operational concepts and philosophical opposition to empirical testing of hypotheses. Mises claimed that “the impracticality of measurement is not due to the lack of technical methods for the establishment of measure. It is due to the absence of constant relations”.¹³¹ The Austrian focus on the microeconomic structure of production is especially susceptible to problems regarding too much aggregation.¹³² This implicates that less aggregated data should be considered and explored from an Austrian perspective. Even though, during the last decades, several scholars have conducted empirical tests of Austrian business cycles.

One of the first and most significant econometrical tests on Austrian theory is done by Wainhouse in 1984.¹³³ He sets forth nine testable hypotheses in conjunction with ABCT. He uses Granger causality to identify a sequence of events beginning with a monetary shock which affects interest rates which in return affects output. Hughes and Cwik apply ABCT to the first Gulf War recession.¹³⁴ Garrison provides convincing accounts of both the Great Depression and the stagflation of the 1970s using the Austrian model.¹³⁵ Carilli and Dempster argue that ABCT focuses on economic agents misperceiving credit expansion as real loanable funds.¹³⁶ They claim that even though people anticipate future inflation due to credit expansion, they will still under profit maximising assumptions try to take advantage of a market interest rate below the real time-preference rate. Keeler finds that monetary shocks cause nominal interest rates to change and affect aggregate production through the mechanism of change in the structure of production.¹³⁷ Mulligan finds that nominal interest rates reallocate resources among early, middle, and late stages of production as predicted by ABCT.¹³⁸

7.1 Trigger Mechanism of the Business Cycle

Correlation is a statistical measure of how two variables move in relation to each other. The level of correlation explains the degree of linearity between the variables which means to which extent they move together. The coefficient ρ ranges between 1

¹³¹ Keeler 2001, Mises 1966, p. 56, see also ch. 2.4 “Controversies” for more on Austrian methodology

¹³² See ch. 2.3 “Austrian Economists: Third Generation” for more on problems with aggregation

¹³³ Wainhouse 1984

¹³⁴ Hughes 1997, Cwik 1998

¹³⁵ Garrison 2001

¹³⁶ Carilli & Dempster 2001

¹³⁷ Keeler 2001

¹³⁸ Mulligan 2002

and -1. If $\rho=1$, there is perfect correlation which means that x has a perfect positive relationship with y . This means that x and y move lockstep in the same direction. Oppositely, if $\rho=-1$, then x is perfectly negative correlated with y which signifies that they move in lockstep in opposite directions. If there is no linear relationship between the variables, $\rho=0$.

To test hypothesis I, and II-a, II-b, and II-c, we look at the correlation between the relevant variables with different lag lengths. Since there are no official dates for Norwegian business cycles, there is no easy way of testing similarities between defined standardized cycles. Neither do we attempt to define lengths of business cycles ourselves as this exceeds the scope and purpose of this paper. We choose to look at a time period of six years which we find appropriate for our analysis (in addition to) allowing us to look for the possibility of a reversal of variables during a cycle. A length of six years is between the cycle lengths described by Kitchin and Juglar; two pioneers in the field of cycles.¹³⁹

Patterns of interrelation which reflect cyclical behaviour are examined with cross-correlations, as presented in Table 7-2. Variables used are defined in Table 7-1.

Table 7-1 – Variable definitions

MONEY	= $\ln (M_0/M_0 \text{ trend})$	
	M_0	M_0 definition of monetary base. Source: Norges Bank
YIELD	= $\ln [(1+10YRGOV) / (1+NIBOR3M)]$	
	10YRGOV	10 year government bond. Interpolated by Norges Bank with different maturities. Source: Norges Bank
	NIBOR3M	3 month interbank interest rate. Source: Datastream
GDP	= $\ln (GDP/GDP \text{ trend})$	
	GDP	Quarterly, seasonally adjusted real GDP. Source: Statistics Norway
	GDP Trend	Hodrick-Prescott filter trend derived from GDP with λ of 40.000
LABOUR	= $\ln [((CONSTRUCT + MINING) / (POSTTELE + BUSINESS + FINANCE + HOTELREST)) / \text{Trend}]$	
		Quarterly four-period moving average - index of early stage relative to late stage labour. Detrended with HP filter. Various labour statistics equals number of persons employs in sector, Source: Datastream
PRICES	= $\ln (PPI/CPI)$	
	PPI	Producer Price Index. YoY% figures converted to an index. 1979=100. Source: Datastream
	CPI	Consumer Price Index. 1979=100. Source
I/C	= $\ln (INV/CON)$	
	INV	Investment expenditure. Source: Datastream
	CON	Private consumption expenditure. Source: Datastream

From Table 7-2 we see that money supply levels above trend are positively correlated

¹³⁹ Grytten & Hunnes 2009, Kitchin 1923, Juglar 1916

with higher growth rate in the slope of the yield curve for the coinciding period and the two next periods with respectively 0.3023, 0.2669, and 0.2138 at a significance level of one and five percent. The positive correlation indicates an immediate and strong liquidity effect.

We see that the other correlation coefficients of YIELD to LABOUR, YIELD to I/C, and YIELD to PRICES are negative and not significant with no time lags. The negative sign of the correlation coefficient could be that changes in YIELD requires some time before it correlates positively with the respective variables.

Table 7-2 – Correlation matrix

30 year quarterly sample: 1979Q2 2009Q2 (121 observations)

Quarterly lag ¹⁴⁰	MONEY and Δ YIELD	YIELD and LABOUR	YIELD and I/C	YIELD and PRICES
0	0.3023 ***	-0.0241	-0.1252	-0.1193
1	0.2669 ***	0.0650	-0.0253	-0.0776
2	0.2138 **	0.1531 *	0.0783	-0.0233
3	0.1506	0.2326 **	0.1688 *	0.0338
4	0.1001	0.2988 ***	0.2442 ***	0.0839
5	0.0681	0.3440 ***	0.3075 ***	0.1224
6	0.0218	0.3684 ***	0.3554 ***	0.1493
7	-0.0240	0.3763 ***	0.4050 ***	0.1692 *
8	-0.0747	0.3766 ***	0.4534 ***	0.1859 **
9	-0.1108	0.3738 ***	0.5007 ***	0.2000 **
10	-0.1337	0.3674 ***	0.5431 ***	0.2117 **
11	-0.1474	0.3559 ***	0.5698 ***	0.2181 **
12	-0.1677 *	0.3311 ***	0.5743 ***	0.2168 **
13	-0.1857 *	0.2936 ***	0.5522 ***	0.2090 **
14	-0.2237 **	0.2398 **	0.5108 ***	0.1961 **
15	-0.2471 **	0.1732 *	0.4495 ***	0.1759 *
16	-0.2573 ***	0.1008	0.3773 ***	0.1456
17	-0.2520 **	0.0269	0.2954 ***	0.1003
18	-0.2068 **	-0.0384	0.2072 **	0.0339
19	-0.1451	-0.0897	0.1077	-0.0506
20	-0.0449	-0.1226	0.0038	-0.1446
21	0.0883	-0.1381	-0.1081	-0.2381 **
22	0.2248 **	-0.1404	-0.2200 **	-0.3188 ***
23	0.3699 ***	-0.1364	-0.3145 ***	-0.3796 ***
24	0.4687 ***	-0.1249	-0.3929 ***	-0.4289 ***

*, **, and *** denote statistical significance levels at respectively 10%, 5%, and 1%. Lags in fat writing represent the highest initial correlation with the maximum of 15 lags.

A higher yield slope level is positively and significantly correlated with LABOUR from period three through period 14 at five and one percent significance levels. Max correlation is 0.3766 at eight lags. This indicates that an increase in the slope of the yield curve correlates with the relative labour employment. Labour is moved from

¹⁴⁰ The first variable leads the second variable with the assumption of a casual relationship. For instance in the second column: Money leads Δ YIELD with a certain number of quarterly lags, and money is assumed to cause Δ YIELD.

middle to early and late stages of production, but more so in the early stage. The influence of YIELD to LABOUR requires several periods to maximise. This is expected since much of the labour in Norway is bound/protected by contracts in addition to laws and regulations slowing the restructuring/downscaling of labour. Moreover, one expects a reversal at the end of a cycle, when resources are constrained and moved back to equilibrium levels. The negative correlation at the end of the cycle is weak and not statistically significant within the 24-period sample.

The slope of the yield curve has a similar pattern of correlation with I/C; the relative relationship between investments and consumption. The correlation becomes positive and statistically significant at a one percent level after four lags lasting until period 17, and significant at a five percent level in period 18. This indicates that a low short-term rate relative to the natural rate increases investment relative to consumption expenditures, though they might both increase in the short-term. Looking back at Figure 4.6 at the PPF graph, this correlation is consistent with the investment bias in the beginning of a cycle. The results show a negative and statistical significant reversal at the end of the 24-period sample. This indicates that a low interest rate first increases investments relative to consumption, but as the “malinvestment” becomes apparent due to a mismatch between consumption goods demanded and consumption goods supplied (people’s time-preferences), the correlation becomes negative at the end of the cycle.

YIELD to PRICES are correlated from eight to 14 lags with a significance level of five percent. YIELD is believed to affect relative prices through the mechanism of changing relative profit rates with sticky consumer prices.¹⁴¹ We see a strong reversal at the end of the cycle which reflects that consumer prices rise relative to producer prices towards the end of the cycle.

7.2 Sub-Periods

Additionally, we investigate the correlations by checking for time-specific differences between sub-periods. Table 7-3 presents three sub-periods of equal length and the whole period. Though each sub-period only contains 40 quarterly observations and might overestimate the strength of real correlation, it may indicate specific sub-period differences.

¹⁴¹ See Table 3-1 – Effects of relative price changes on economic profit

Table 7-3 – Max correlation for three sub-periods

		1979Q2-1989Q1	1989Q2-1999Q1	1999Q2-2009Q2	Whole period
I	MONEY and Δ YIELD	0.7468 (11) ***	-0.5494 (4) ***	0.6657 (3) ***	0.3023 (0) ***
II-a	YIELD and LABOUR	0.6243 (8) ***	0.8319 (8) ***	0.7443 (4) ***	0.3766 (8) ***
II-b	YIELD and I/C	-0.4469 (7) ***	0.8584 (12) ***	0.8953 (11) ***	0.5743 (12) ***
II-c	YIELD and PRICES	0.5188 (0) ***	0.3455 (0) ***	0.7598 (9) ***	0.2181 (11) ***

*, **, and *** denote statistical significance levels at respectively 10%, 5%, and 1%. Numbers of lags are shown in parenthesis. Max correlation is chosen with maximum of 15 lags.

From MONEY to Δ YIELD, we can see a positive correlation in sub-period one and with values respectively of 0.7468 and 0.6657 as expected. Also, as we can see from the max correlation of 0.3023 for the whole period, the max correlation at zero lags is consistent with what we expected. However, this seems to be an unreasonably long lag length in the first sub-period with a lag length of eleven quarters. We find negative correlation with a value of -0.5494 in the second sub-period, significant at a one percent level. This is inconsistent with the pattern for the whole period.

We see that the correlation of YIELD to LABOUR shows a positive correlation with varying degree in all of the three sub-periods with a significance level at one percent. Lag lengths are found to be eight in first and second sub-period, and four in the last sub-period. The sign of the coefficient is as expected, and the lag length is reasonable considering the time dimension in moving labour as previously discussed.

Correlation of YIELD to PRICES shows a similar pattern as YIELD to LABOUR. It is significant at one percent level in all the sub-periods with no lags in sub-period one and two, but nine lags in sub-period three. For sub-period one, the max correlation of YIELD to I/C is -0.4469 with seven time lags at a one percent significance level. The negative sign is not consistent with the overall period. In sub-periods two and three, the coefficients are 0.8584 and 0.8953 at a one percent significance level with twelve and eleven lags respectively. The negative coefficient in the first sub-period reduces the validity of the positive significant correlation for the whole period.

The first sub-period shows an atypical yield slope when comparing the development of YIELD to LABOUR, and I/C. Figure 7.1 and Figure 7.2 show an example of the yield slope with a rapid decline before the decline in LABOUR in the last two out of three large cycles, but have a more unclear relationship in the first sub-period. This might be due to the high interest level of this time period which affects and flattens the slope of the yield curve. When the collective level of long-term and short-term interest rate

fall lockstep, they do not significantly change the slope as it does for the last two cycles.

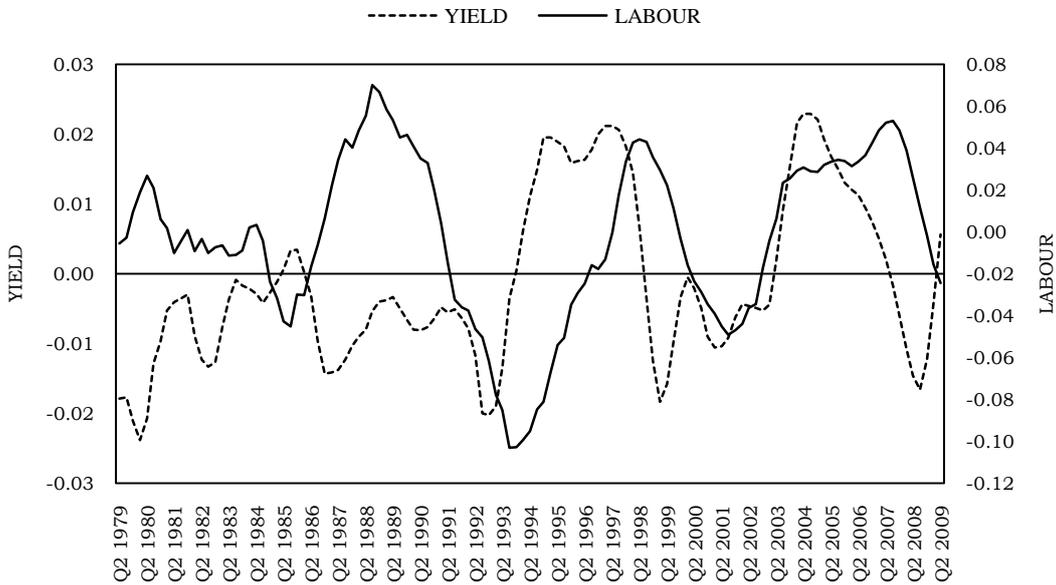


Figure 7.1 – YIELD and LABOUR cycles

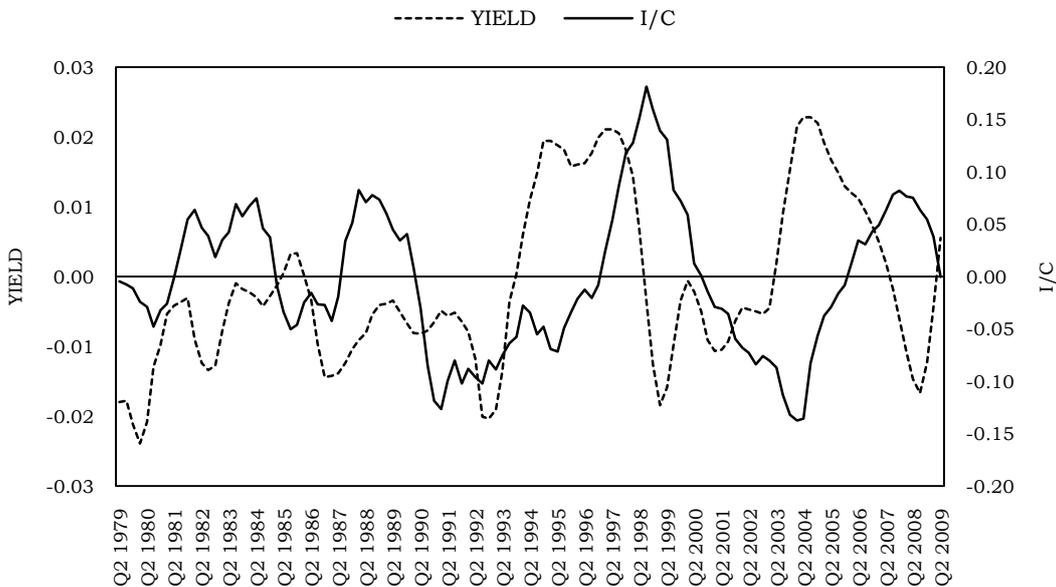


Figure 7.2 – YIELD and I/C cycles

To sum up, the tests show ambiguous results for correlation of MONEY to Δ YIELD when we look at the different sub-periods, but significant and positive results for the whole period. The level of YIELD correlates with LABOUR, I/C, and PRICES at different lag lengths for the whole period and the sub-periods. Graphical inspection shows that the slope of the yield curve might not be a good indicator for the cycle in the first sub-period of I/C to LABOUR.

7.3 Investigation of Causal Relationships

We would like to know whether a specific time series seems to cause another. In other words, we want to investigate the possibility of causality between one variable and another. Galileo Galilei and David Hume connected causality to the terms cause and effect. One could say that a variable x is causal to a variable y if x can be understood as the cause of y and/or y as the effect of x . One way to look into this is the Granger test developed by Clive W. J. Granger. His statistical approach is commonly used on causality tests in time series.¹⁴²

It is not given that the information needed for testing a causal relationship is available. However, this is assumed by traditional econometrics.¹⁴³ Granger causality requires covariance stationary time series which is already done based on the ADF test in ch. 6.2.4. Our test is simple (or bivariate) which means that only data in the two time series themselves are used in the test.

“Granger causality is a circumstance where one time series variable constantly and predictably changes before another variable does”.¹⁴⁴ As we will see in the algebraic explanations below, a variable x Granger-causes y , if y can be better predicted using the histories of both x and y than it can using the history of y alone. The presented test procedure only takes into account the past and present values of x and y as the relevant information set.

Granger’s definition of causality has been criticised for reducing causality to incremental predictability. Causality implies predictability, but predictability does generally not imply causality. If Granger causality holds, it does not conclude that x causes y , but it suggests that x might be causing y .¹⁴⁵

One cannot take for granted that there are no other variables affecting the relation between the two variables under consideration. “In time series analysis, this concept of causality is nevertheless widely accepted today”.¹⁴⁶ The above definition of Granger causality does not imply such a limitation despite the fact that we use a simple (or bivariate) model. However, to distinguish between (real) causal and spurious relations, it is crucial to enlarge the relevant information set.

¹⁴² Kirchgässner & Wolters 2007

¹⁴³ Kirchgässner & Wolters 2007

¹⁴⁴ Granger 1969

¹⁴⁵ Studenmund & Cassidy 1992

¹⁴⁶ Kirchgässner & Wolters 2007

There are various tests for Granger causality, and they all involve distributed lag models in one way or another.¹⁴⁷ We can assess Granger causality in a fairly direct way by putting our variables into the following equation and regress on values with lag for both itself and the other variable:

$$Y_t = \alpha + \sum_{i=1}^m \beta_i Y_{t-i} + \sum_{j=1}^n \tau_j X_{t-j} + \mu_t \quad (34)$$

We use an F-test to test the following null hypothesis of joint coefficients:

$$H_0: \tau_1 = \tau_2 = \dots = \tau_j = 0 \quad (35)$$

This requires us to consider equation (34) as an unrestricted equation while we need results from the restricted equation to perform the F-test:

$$Y_t = \alpha + \sum_{i=1}^m \beta_i Y_{t-i} \quad (36)$$

The “reverse” equation allows for determination of the direction of the causality:

$$X_t = \theta + \sum_{i=1}^p \varphi_i X_{t-i} + \sum_{j=1}^q \omega_j Y_{t-j} + \delta_t \quad (37)$$

Based on the estimated OLS coefficients for equations 34 and 37, four different hypotheses about the relationship between x and y can be formulated:

1. *Unidirectional Granger causality* from x to y : x increases the prediction of y , but not vice versa: $\sum_{j=1}^n \tau_j \neq 0$ and $\sum_{j=1}^q \omega_j = 0$
2. *Unidirectional Granger causality* from y to x : y increases the prediction of x , but not vice versa: $\sum_{j=1}^n \tau_j = 0$ and $\sum_{j=1}^q \omega_j \neq 0$
3. *Bidirectional (or feedback) causality* between x and y : x increases the prediction of y and vice versa: $\sum_{j=1}^n \tau_j \neq 0$ and $\sum_{j=1}^q \omega_j \neq 0$
4. *No Granger-causality* in any direction. There is independence between x and y : $\sum_{j=1}^n \tau_j = 0$ and $\sum_{j=1}^q \omega_j = 0$

The choice of lags, i and j , is critical: Too few lags lead to auto-correlated errors while too many lags may decrease the validity of the test. Various approaches exist and are used in empirical analysis, such as Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quinn Information Criterion (HQIC). Instead of using one particular lag length, we choose a max lag length of ten for the unrestricted variables and test for all lags in between. For the restricted variable we choose a lag length of two periods which gives all restricted regressions an explanatory

¹⁴⁷ Studenmund & Cassidy 1992

power above 90%. This indicates that the variables are highly auto-correlated and that adding more variables would only distort the results.

Having chosen lag lengths, we perform an F-test which tests if the coefficients added to the unrestricted model are jointly different from zero by comparing the two regression results:

$$F = \frac{(SSR_R - SSR_U)/n}{SSR_U/(T - (m + n + 1))} \quad (38)$$

where SSR_R is the residual variation of the restricted regression and SSR_U is the residual variance of the unrestricted regression, T equals number observations, and m and n are the lags for the Y and X variable.

Granger Causality Results

The Granger causality results for MONEY and Δ YIELD in Table 7-4 show no consistent causal relationship as hypothesized. The F-values accepts the null hypothesis of joint coefficient values equalling zero. These results cannot establish any Granger causality between the variables MONEY and Δ YIELD.

Table 7-4 – Granger results for MONEY and Δ YIELD

MONEY Granger-causes Δ YIELD				Δ YIELD Granger-causes MONEY			
m	n	Obs.	F-stat.	p	q	Obs.	F-stat.
2	1	119	0.7642	2	1	119	3.9719 **
2	2	119	1.7395	2	2	119	2.0523
2	3	118	1.1217	2	3	118	1.8643
2	4	117	1.5817	2	4	117	1.4445
2	5	116	1.3296	2	5	116	1.2375
2	6	115	1.2955	2	6	115	1.3811
2	7	114	1.1984	2	7	114	1.2138
2	8	113	1.0443	2	8	113	1.0945
2	9	112	1.0546	2	9	112	1.1869
2	10	111	0.9318	2	10	111	1.0685

*, **, and *** denote statistical significance levels at respectively 10%, 5%, and 1%. m and q = lags of MONEY, n and p = lags of YIELD,

Table 7-5 shows consistent results in the causal relationship between YIELD and LABOUR where six out of ten lag lengths show a significant F-value on a one percent level. This confirms that the null hypothesis of investigating whether the added unrestricted coefficients jointly equalling zero is rejected. This means that the slope of the yield curve does Granger-cause the relative resources measured through labour statistics. Weak F-statistics of the reversed relationship indicate this to be

unidirectional Granger causality from YIELD to LABOUR without any bi-causal relationship or feedback.

Table 7-5 – Granger results for YIELD and LABOUR

YIELD Granger-causes LABOUR				LABOUR Granger-causes YIELD			
m	n	Obs.	F-stat.	p	q	Obs.	F-stat.
2	1	119	5.1936 **	2	1	119	0.7579
2	2	119	2.7410 *	2	2	119	0.6826
2	3	118	3.2295 **	2	3	118	0.5995
2	4	117	2.5714 **	2	4	117	0.9886
2	5	116	3.3653 ***	2	5	116	1.0749
2	6	115	4.2219 ***	2	6	115	2.0297 *
2	7	114	3.3255 ***	2	7	114	1.8617 *
2	8	113	2.9558 ***	2	8	113	1.6858
2	9	112	2.5941 ***	2	9	112	1.7445 *
2	10	111	2.5116 ***	2	10	111	1.6526

*, **, and *** denote statistical significance levels at respectively 10%, 5%, and 1%. m and q = lags of YIELD, n and p = lags of LABOUR

Table 7-6 shows consistent granger results where the null hypothesis where no causal relationship is rejected at all lags at a five percent level of significance (except at lag length 2). This confirms that the relative interest rate relationship Granger-cause the relative relationship between investment and consumption suggested by ABCT. We see that the reversed causal relationship is accepted when including seven to ten lags into the model. This might be explained as a logical feedback loop where an “artificial” set interest rate affects agents to change their behaviour which in turn affect the same market interest rates. We consider these results to accept that there exists a bidirectional Granger causal relationship between YIELD and I/C.

Table 7-6 – Granger results for YIELD and I/C

YIELD Granger-causes I/C				I/C Granger-causes YIELD			
m	n	Obs.	F-stat.	p	q	Obs.	F-stat.
2	1	119	4.4467 **	2	1	119	1.1658
2	2	119	2.9145 *	2	2	119	1.7706
2	3	118	3.0576 **	2	3	118	1.1817
2	4	117	3.7670 ***	2	4	117	2.4337 *
2	5	116	3.2698 ***	2	5	116	1.8714
2	6	115	2.4889 **	2	6	115	2.1193 *
2	7	114	3.0614 ***	2	7	114	2.5471 **
2	8	113	2.6417 **	2	8	113	2.7219 ***
2	9	112	2.7632 ***	2	9	112	2.8702 ***
2	10	111	2.5819 ***	2	10	111	2.6438 ***

*, **, and *** denote statistical significance levels at respectively 10%, 5%, and 1%. m and q = lags of YIELD, n and p = lags of I/C

Table 7-7 shows no Granger-causal relationship from YIELD to PRICES. The F-test of statistical significance is rejected when all lag lengths are considered. We see from the reversed relationship that PRICES do Granger-cause YIELD at four out of ten lag lengths. The scattered granger-causes along lag lengths show how Granger test can be very sensitive to the choice of lag. Choosing six or ten lags would accept the hypothesis while seven, eight and nine lags would reject it. The causal relationship from PRICES to YIELD could indicate a feedback loop from the price information in the market back to demand-led changes in interest rates. Such feedback loops are not uncommon considering events as overreactions or changing perceptions and expectations due to changes in price levels.

Table 7-7 – Granger results for YIELD and PRICES

YIELD Granger-causes PRICES				PRICES Granger-causes YIELD			
m	n	Obs.	F-stat.	p	q	Obs.	F-stat.
2	1	119	0.1333	2	1	119	0.1880
2	2	119	0.5099	2	2	119	0.1419
2	3	118	1.0601	2	3	118	2.6572 *
2	4	117	0.8145	2	4	117	3.5846 ***
2	5	116	1.0709	2	5	116	2.7654 **
2	6	115	0.9638	2	6	115	2.1277*
2	7	114	0.8172	2	7	114	2.3508 **
2	8	113	0.7236	2	8	113	2.3304 **
2	9	112	0.6323	2	9	112	2.0687 **
2	10	111	0.5997	2	10	111	1.8560 *

*, **, and *** denote statistical significance levels at respectively 10%, 5%, and 1%. m and q = lags of YIELD, n and p = lags of PRICES

Hypothesis I with unidirectional Granger-causality from MONEY to Δ YIELD does not gain support by the performed Granger causality test. The test does not establish any causal relationship either way. Hypothesis group II is supported by Granger causal relationship where YIELD affects both LABOUR and I/C. The F-test shows significant values across the chosen lag lengths. Granger causality where YIELD affects PRICES is not supported by F-statistics, but reversed Granger-causality is established with certain lag lengths.

7.4 Propagation Mechanism of the Business Cycle

While correlation measures the linear relationship between two variables, a multiple regression analysis aims to explain variance of a dependent variable with several independent variables. Regression is the most common tool used in finance.¹⁴⁸ Besides measuring correlations and Granger causality, we develop a simple multiple regression model that fits into ABCT which aims to test hypothesis group III. In a general multiple regression model, a dependent variable y is a function of several independent variables through a linear equation and can be shown as follows:¹⁴⁹

$$y_t = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_K x_{iK} + e_i \quad (39)$$

The coefficients $\beta_0, \beta_1, \beta_2, \beta_K$ are the marginal effects on variable y , given a change in x_i , ceteris paribus, and e_i is the residual. The betas are simply partial derivatives:

$$\beta = \frac{\delta y}{\delta x} \quad (40)$$

The OLS (ordinary least squares) estimates are found by choosing the values of $\beta_0, \beta_1, \beta_2, \beta_K$ that minimise the sum of the squared residuals (SSR):

$$\sum_{i=1}^N (Y_i - \hat{Y}_i)^2. \quad (41)$$

For the model to be reliable, some assumptions of the regression model have to be satisfied. It is important to address the reliability of the data that set the fundamentals in the regression. This is important for any empirical work to have value.¹⁵⁰

The choice of GDP measure (y_t) has been a subject of debate in the Austrian empirical articles. Common to several of the latest papers is that GDP is measured in relation to natural GDP. The latter is a measure of equilibrium production and can be defined as potential production. Since this value is not observable, it has to be estimated. Earlier

¹⁴⁸ Koop 2006

¹⁴⁹ Hill 2008, p.109

¹⁵⁰ See appendix: Assumptions

testing of ABCT seems to approach this differently where other trend estimation methods are used.¹⁵¹

Low interest rates give people incentives to spend and invest more; i.e. both I and C increase pulling the economy outside the PPF constraint.¹⁵² Given the Austrian school's emphasis on how GDP is aggregated, we want to see the relative evolution of investment and consumption expenditure as an indicator of the production structure. According to the Austrian school, investment should increase (decrease) more than consumption in the beginning of an expansion (recession). In other words, if consumption rises rapidly relative to investment, it will have negative effects on GDP.

Figure 7.3 illustrates the detrended ratio of investment over consumption. Comparing this graph with GDP, the pattern seems to be quite consistent with ABCT. We can see an atypical relationship from 1978 to 1990 where I/C fall *after* GDP starts to decline. During the last two cycles, I/C seems move with GDP but in bigger magnitudes. These last cycles support the notion that resources are moved from early stage (investment) towards late stage (consumption goods) at the end of the cycle, and vice versa in the initial phases.

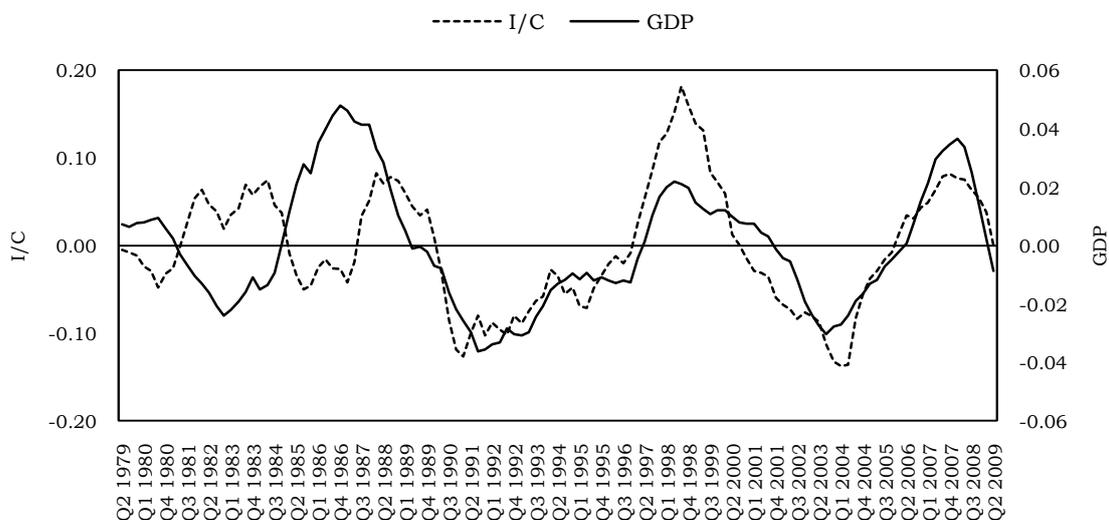


Figure 7.3 – Ratio of investment over consumption expenditure and GDP. Source: Datastream

The investment bias in the beginning of an expansion should increase demand of labour in early stages of production.¹⁵³ Figure 7.4 shows the detrended ratio of aggregated employment in early over late stages of production. We can see that LABOUR follows a cyclical pattern where it increases in the beginning of a cycle and

¹⁵¹ See ch. 6, “Decomposition of Trend and Cycle”, see also Keeler 2001, and Bismans & Mougeot 2009

¹⁵² See Figure 4.9

¹⁵³ See Figure 4.4

decreases towards the end. However, LABOUR seems to rise/fall *after* GDP starts to increase/decline from 1979 to 1993, move along with GDP from 1993 to 2001, and rise/fall *before* GDP from 2001 till today. The multiple regression will confirm its properties.

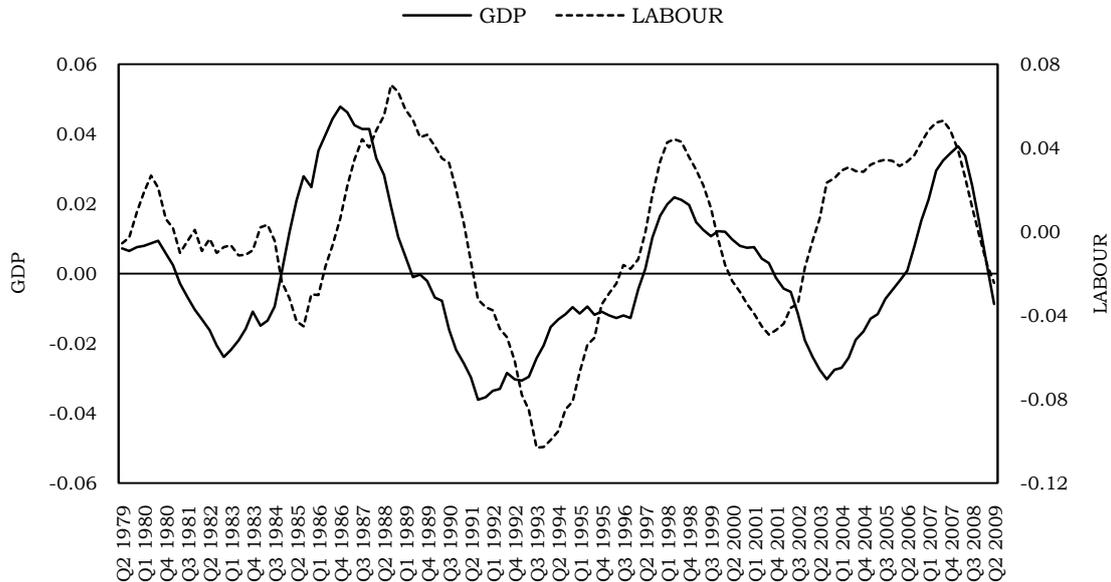


Figure 7.4 – Ratio of aggregated employment in early over late stages of production. Source: Datastream

ABCT claims that the policy-induced interest rate causes the business cycle since the actual rate becomes lower than the natural interest. It is not the change in yield slope that causes the business cycle, but rather the change in other variables as a result of change in the yield slope. Cycles are influenced by relative price disturbances created by monetary shocks. One effect which might be viewed as an instigator of business cycles is the relative relationship between producer prices relative to consumer goods prices.¹⁵⁴

Figure 7.5 shows the evolution of the ratio of producer price index over consumption price index (denoted PRICES) and GDP. If resources shift from middle to late and early stages of production due to a decreasing market interest rate, PRICES should increase at the beginning of an expansion. At the end of an expansion, it will decrease as consumer prices rise relative to producer prices.

¹⁵⁴ See also Mises who explicitly expressed this idea in [1912] 1953, p. 263: “The increased productivity that sets in when banks start the policy of granting loans at less than the natural rate of interest at first causes the prices of production goods to rise while the prices of consumption goods, although they rise also, do so only in a moderate degree”.

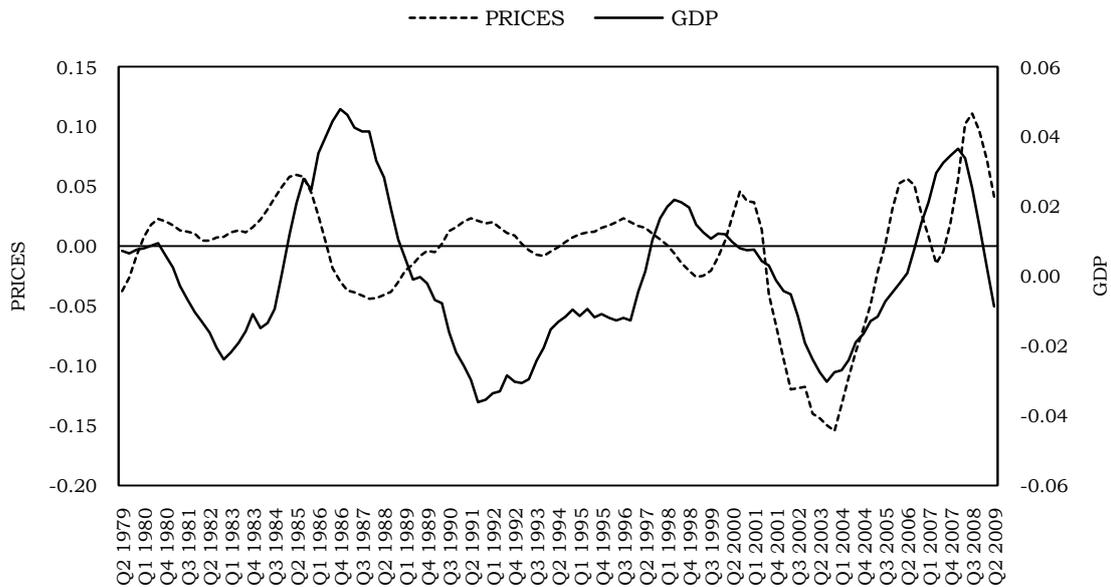


Figure 7.5 – Producer price index over consumption price index. Source: Datastream

The issue of co-movements of prices with Norwegian business cycles has been tested by several scholars. At best, they find ambiguous results. Falling prices with falling output has for a long time been the definition of a depression. However, history has shown that we can have both long periods of deflation with high growth and inflation with negative output growth.¹⁵⁵ PPI is also heavily influenced by the fact that Norway is an open raw material economy. This makes Norway sensitive to international disturbances. In Figure 7.5 we can see that PRICES moves in smaller magnitudes than GDP from 1978 to 2000, but it has far higher volatility from 2000 until 2009. PRICES seem not to follow a clear pattern with GDP levels and become difficult to analyse graphically.

After visualising the variables, the broad question of the regression analysis is if any change in variables related to the Hayekian triangle causes any change in GDP as a result of monetary policy. The multiple regression model can be illustrated as follows:

$$\ln GDP_t = \beta_0 + \beta_1 \ln PRICES_t + \beta_2 \ln LABOUR_t + \beta_3 \ln I/C_t + e_i \quad (42)$$

where GDP_t is percentage deviation in aggregate production from trend, $YIELD_t$ is slope of the yield curve, $PRICES_t$ is the the ratio of the PPI relative to CPI, $LABOUR$ is the ratio between labour employed in early and late stages of production/services, and I/C_t is the ratio between expenditure in investment over private consumption. Since all nominators in the ratios are related to early stages of production and all denominator variables are related to late stage of production, we expect all the beta coefficients to

¹⁵⁵ Grytten & Hunnes 2009, 3-4, Husebø & Wilhelmssen 2005, 1-23

be positive in accordance with the hypothesis to match the Austrian theoretical framework. Note also that the variables can be separated and expressed differently than ratios. In that case, we would also expect the beta coefficients to be positive but it would conceal the mechanism of change from between areas of the Hayekian triangle. For example, an expansionary monetary policy is expected to affect investment and consumption in positive magnitudes, pulling the economy outside the PPF. The Austrians emphasise the relative increase in investments over consumption after a monetary shock. By using ratios, we can interpret the coefficients more easily since ABCT predicts that investments will increase more than consumption after a monetary shock.

Preparing the Model

Multicollinearity can be defined as “high (but not perfect) correlation between two or more independent variables”.¹⁵⁶ This is a common problem with empirical work. If the explanatory variables are highly correlated, the OLS-estimator has trouble estimating the marginal effects from the different variables. If some independent variables are perfect correlated, then OLS-estimates cannot be calculated.¹⁵⁷ We can say that two variables are perfect correlated if they have a perfect linear relationship, for example in the form: $X_2 = 4X_3$. The coefficients in the regression model measure the marginal effect from a change in one variable, holding all the other variables constant. In this case, if X_2 changes, X_3 will change with four times, and there is no way of holding all the other variables constant.

One way to investigate correlation between the explanatory variables is to present a correlation matrix of the variables to see if correlations of independent variables are very high. Below is a correlation matrix of the explanatory variables:

Table 7-8 – Inter-correlation matrix for independent variables

	PRICES _t	I/C _t
I/C _t	0.3232	
LABOUR _t	-0.1400	0.4804

The correlations are based on all the final stationary variables. As we can see from the table, I/C and LABOUR have a high positive correlation with a value of 0.4804. This value is high but considered acceptable.

¹⁵⁶ Wooldridge 2009, p. 96

¹⁵⁷ Koop 2006

In Table 7-9, correlations with lag between PRICES and GDP, I/C and GDP, LABOUR and GDP are presented. Correlation between PRICES and GDP are positive and significant at one and five percent levels at zero to ten lags. Max correlation is found with six lags with a value of 0.3521. The positive value of the coefficient is as expected. Note also that the correlation steadily increases from zero to six quarters. This could imply that PRICES does not have an immediate effect on GDP.

Table 7-9 – Correlation matrix for dependent variables with GDP¹⁵⁸

30 Year quarterly sample: 1979Q2 2009Q2 (121 observations)

Quarterly lag	PRICES and GDP	I/C and GDP	LABOUR and GDP
0	0.2002 **	0.5467 ***	0.4191 ***
1	0.2245 **	0.5328 ***	0.3824 ***
2	0.2498 ***	0.5088 ***	0.3369 ***
3	0.2774 ***	0.4773 ***	0.2867 ***
4	0.3103 ***	0.4410 ***	0.2343 **
5	0.3406 ***	0.4032 ***	0.1823 *
6	0.3521 ***	0.3625 ***	0.1338
7	0.3423 ***	0.3193 ***	0.0877
8	0.3113 ***	0.2702 ***	0.0456
9	0.2599 ***	0.2138 **	0.0018
10	0.1977 **	0.1505	-0.0401
11	0.1322	0.0857	-0.0813
12	0.0699	0.0237	-0.1234
13	0.0143	-0.0341	-0.1647 *
14	-0.0335	-0.0873	-0.2117 **
15	-0.0725	-0.1402	-0.2592 ***
16	-0.1023	-0.1908 **	-0.3086 ***
17	-0.1216	-0.2345 **	-0.3510 ***
18	-0.1310	-0.2686 ***	-0.3810 ***
19	-0.1324	-0.2939 ***	-0.4017 ***
20	-0.1310	-0.3114 ***	-0.4097 ***
21	-0.1276	-0.3286 ***	-0.4083 ***
22	-0.1247	-0.3401 ***	-0.3959 ***
23	-0.1222	-0.3453 ***	-0.3722 ***
24	-0.1119	-0.3441 ***	-0.3356 ***

*, **, and *** denote statistical significance levels at respectively 10%, 5%, and 1%. Max correlations are marked with fat writing.

According to the Austrian theory, the beginning of an expansion should be characterised by a relative increase in prices of capital goods production, while rise in consumer products should increase later.

¹⁵⁸ First variable leads the second variable with the assumption of a casual relationship.

I/C and GDP exhibit a positive correlation from zero to nine quarters at one and five percent significance levels. Max correlation is found at zero lags with a value of 0.5467. The positive sign is logical since an increase in I/C ratio is expected to have a positive effect on GDP in the beginning of the cycle, and is expected to fall during the cycle.

Labour demanded is expected to increase in an expansion. A higher ratio of labour employed in early to late stages of production is expected to manifest in the beginning of an expansion, and fall during the cycle due to the investment bias in the beginning of the cycle. Correlation between LABOUR and GDP is positive and significant at one and five percent level between zero and four lags. Max correlation is found at zero lags with a value of 0.4191.

Regression Results

We present a multiple regression shown in Table 7-10 where causal relationships are assumed to be instant (no time lags). We get a significant F-test of the model with explanatory power (R^2) at 0.3227. PRICES has a p-value of 0.2110 which exceeds acceptable levels of significance. All variables show a positive coefficient which indicates that an increase in GDP can be explained by higher levels of investment relative to consumption, increased labour in early stage production relative to late stage labour, and higher producer prices relative to consumer prices.

Table 7-10 – Regression results with no lag

<i>30 year quarterly sample: 1979Q2-2009Q2 (121 observations)</i>				
Variable	Coefficients	Standard Error	T Statistics	p-value
Constant	0.0007	0.0016	0.4312	0.6671
I/C_t	0.1194	0.0290	4.1166	0.0001
$LABOUR_t$	0.1278	0.0479	2.6667	0.0087
$PRICES_t$	0.0451	0.0359	1.2578	0.2110
<i>Model statistics</i>	F value: 20.0610, p-value: 0.0000, Pearson R: 0.5828, Adjusted R ² : 0.3227			

This model confirms that I/C and LABOUR are statistically significant in explaining aggregate economic activity measured as GDP percentage deviation from trend. As PRICES is not significant within an acceptable level of confidence, it may not be a good explanatory variable for Norwegian business cycles in relation with I/C and LABOUR when no lags are considered. This contributes to justify Mises' abandonment from the focus where pro-cyclical price movements account for the cycle. Keeler also considers that "there may be no general hypothesis that can be stated about these relative prices

during the phases of the cycle".¹⁵⁹ However, current prices and expectations about future prices act as important market information which affects behaviour during the cycle.

Due to the difference between sub-periods, we construct a new regression model for the last two sub-periods in order to account for significant period specific variations. Results are given in Table 7-11. We see that adjusted R^2 increases from 0.3227 to 0.7469. All variables contain positive coefficients which confirm the statements suggested in our hypothesis. PRICES are still not a significant variable for explaining variations in GDP. T-statistics for LABOUR now accept the null hypothesis of a coefficient equal to zero. This might be explained with the very high correlation of I/C with GDP at 0.8654 at zero lag, which in turn accounts for most of the variations of GDP in this model.

Table 7-11 – Regression for last two sub-periods

<i>20 year quarterly sample: 1989Q2-2009Q2 (81 observations)</i>				
Variable	Coefficients	Standard Error	T Statistics	p-value
Constant	-0.0022	0.0011	-2.0251	0.0463
I/C _t	0.1911	0.0176	10.8462	0.0000
LABOUR _t	0.0425	0.0284	1.4971	0.1384
PRICES _t	0.0228	0.0213	1.0712	0.2874
<i>Model statistics</i>	F value: 80.1044, p-value: 0.0000, Pearson R: 0.8703 , Adjusted R ² : 0.7479			

Performed regressions show that the relative relationships of I/C and LABOUR offer explanatory power as a propagation mechanism for the business cycle. Their power is substantially increased when looking at the last 20 years and excluding the first sub-period.

¹⁵⁹ Keeler 2001, p. 334

8 Conclusions

Austrian macroeconomics and Austrian business cycle theory are prime advocates of a libertarian state with laissez-faire economic policy and blame monetary policy for the existence of business cycles. Monetary interventions disturb the term structure of interest rates. Thus, capital structure tends to change, which accounts for fluctuations of the business cycle. Credit-induced expansions with unchanged time-preferences create unsustainable growth which inevitably turns into recessions.

The Austrian business cycle theory helps explain reasons to Norwegian business cycles between 1979 and 2009. Empirical results show that expansionary monetary policy has a significant and positive correlation with changes in interest rates. However, there are inconsistencies when looking at sub-periods. No Granger-causal relationships are found between money supply and changes in interest rates.

Relative interest rates show a positive and significant correlation with the ratio of investment over private consumption and the ratio of labour employed in early to late stages of production. Granger-causal relationships further strengthens that changes in the interest rates help explain fluctuations in the investment-consumption ratio and the ratio of labour employed in early relative to late stages of production. This relationship regarding changes in the structure of capital is paramount to the Austrian business cycle theory. We find less consistent patterns in the relationship between interest rates and relative prices.

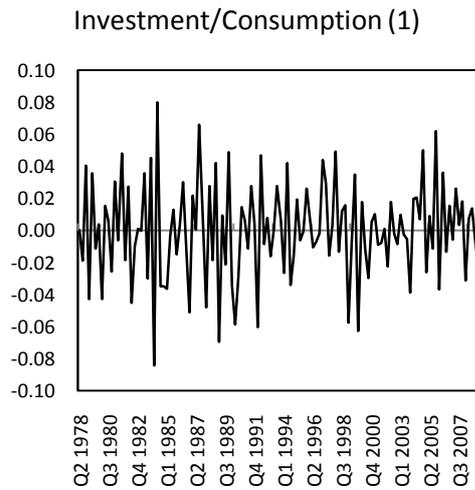
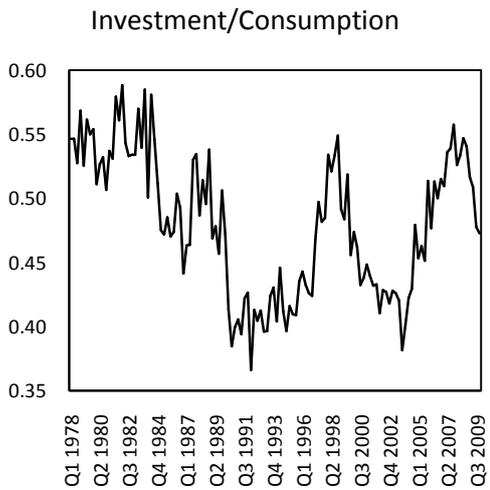
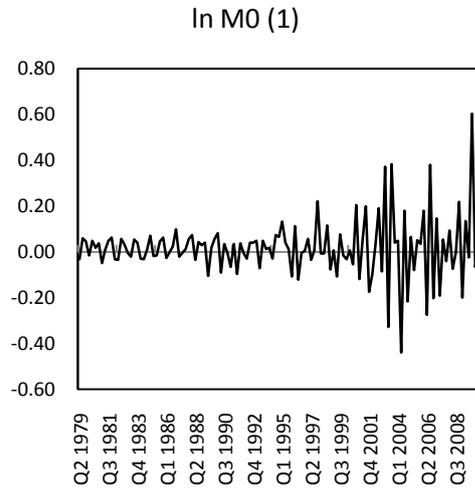
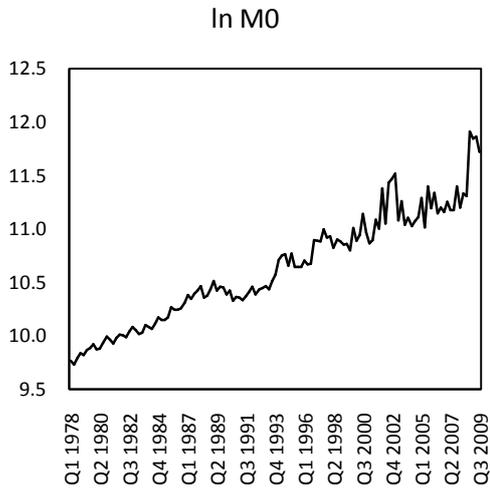
By using a linear multiple regression method, we find indications that the relative relationships predicted by Austrian business cycle theory help explain variations in aggregate output. The degree of explanation turns out to be much higher when we look at the last 20 years (1989-2009) compared to the overall time period (1979-2009). The signs on all the coefficients are in accordance with our hypotheses.

The Austrian school is a controversial school of thought. One critique is the inevitability of recessions due to malinvestments. Why *must* credit-induced expansions end up with recessions? Liquidation of malinvestments might be a too simple explanation as the sole cause of recession. The laissez-faire approach during recessions implicates that governments should let markets correct themselves. This view is highly controversial and probably politically implausible in today's economic environment. However, the Austrian school recognizes the potential benefits of Keynesian policies to avoid the situation called "secondary deflation".

Mainstream rejection of Austrian economics seems to be too harsh. The Austrian business cycle theory offers various aspects of logical reasoning and gives appealing analysis of business cycles. We believe it should receive more attention and deserves to be taken more seriously both in academia and political discussions.

Appendix

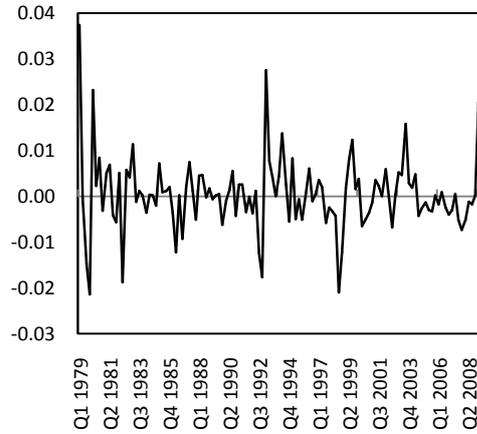
Time Series Properties



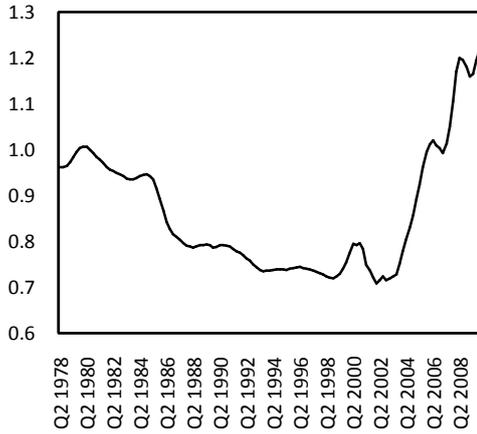
YIELD



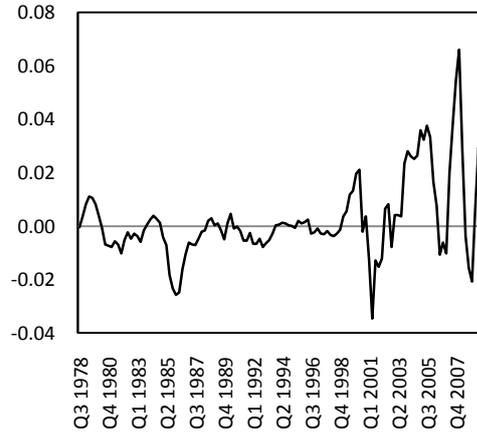
YIELD (1)



PPI/CPI



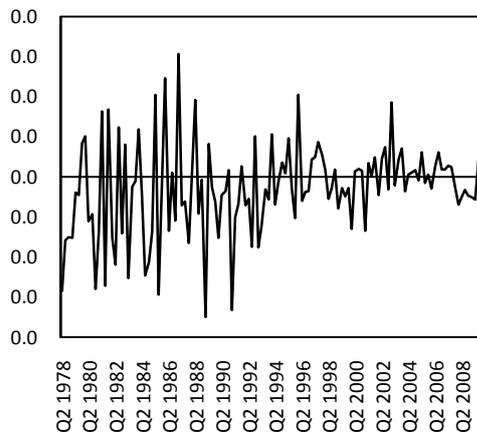
PPI/CPI (1)



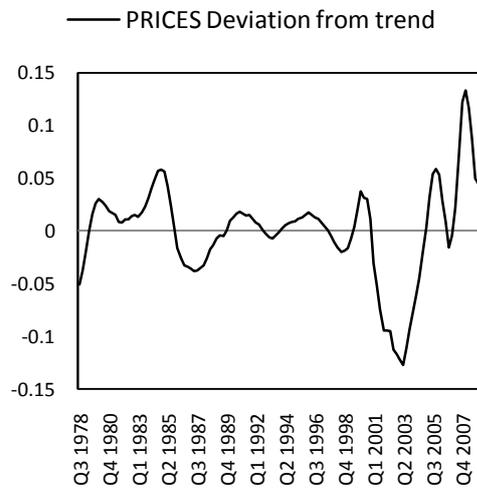
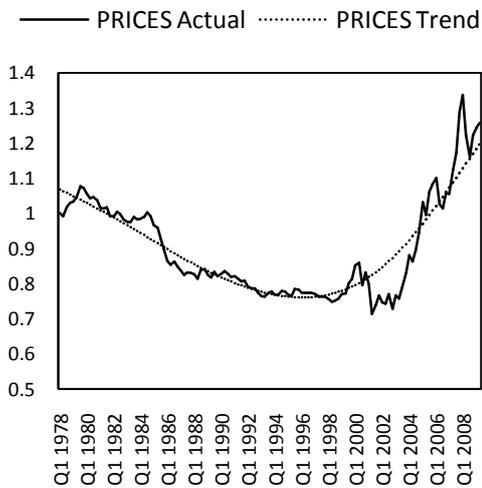
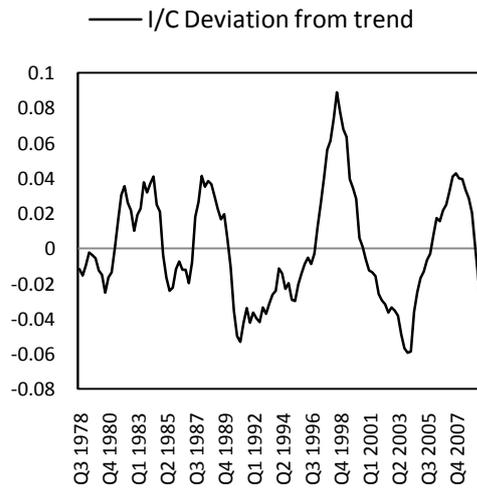
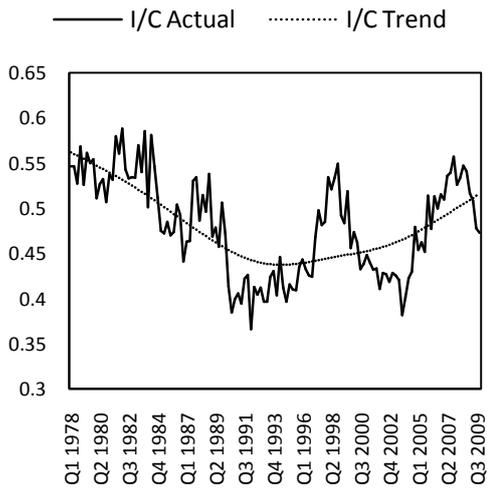
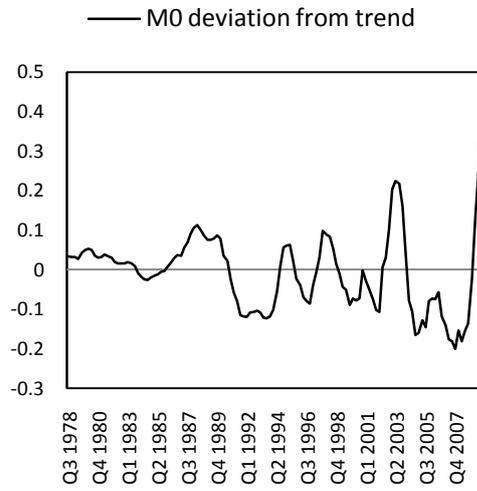
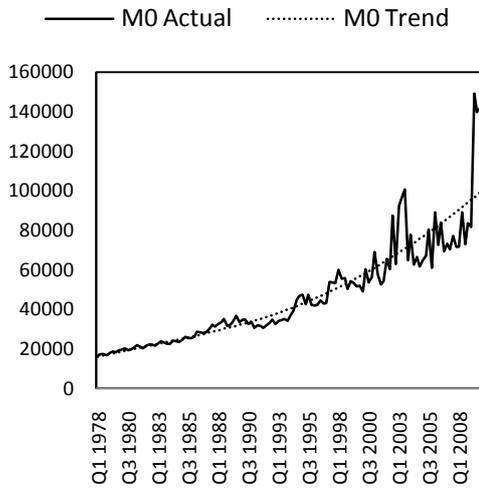
LABOUR EARLY/LATE

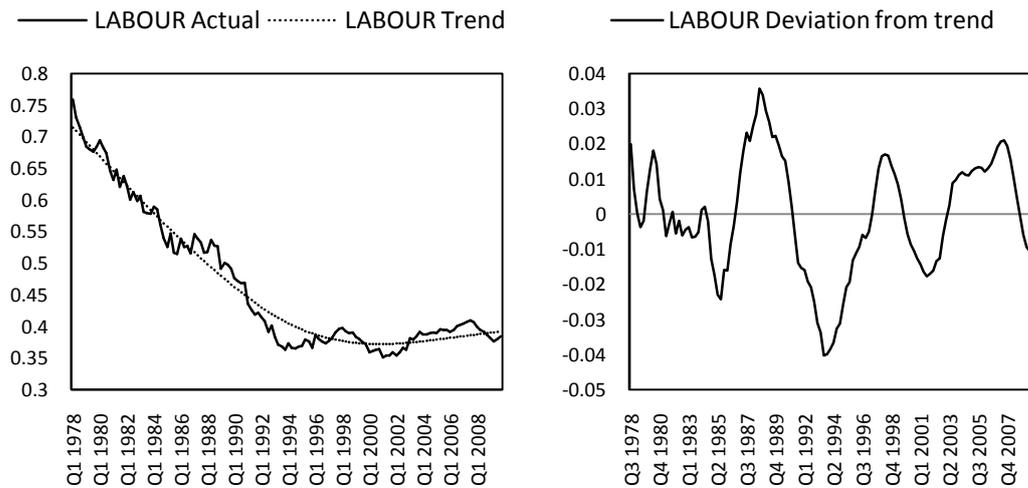


LABOUR EARLY/LATE (1)



HP-Filter





Regression Assumptions

1. $E(e_i) = 0$. Each random error has a probability distribution with zero mean. Some errors will be positive, some errors will be negative. Over time, this should be zero in average. By including a constant term in the regression model, the assumption will be valid.
2. $Var(e_i) = \sigma^2$. Each random error has a probability distribution with variance σ^2 . The variance is an unknown parameter and it measures the uncertainty in the model. The variance in the error terms should be constant across observations. Deviations from this assumption are called homoskedastic.
3. $Cov(e_i, e_j) = 0$. The covariance between two random errors is zero. The size of an error for one observation has no bearing on the size of an error for another observation. Thus, any prior errors are uncorrelated.
4. $Cov(e_t, X_{it}) = 0$. The independent variables and the errors terms are uncorrelated. If some of the independent variables should be correlated with the residual, it would be hard to interpret the impact on the dependent variable.
5. $e_i \sim N(0, \sigma^2)$ I.e. The random errors are normally distributed.

References

Books and Articles

- Anderson, W.L. (2009): "Say's Law and the Austrian Theory of the Business Cycle", *The Quarterly Journal of Austrian Economics*, 12, no. 2, 47–59, <mises.org/journals/qjae/pdf/qjae12_2_4.pdf> (12.03.10).
- Balke, N.S. (1991): "Modelling Trends in Macroeconomic Time Series", *Federal Reserve Bank of Dallas Economic Review*, May 1991.
- Bernanke, B. S. (1990): "On the Predictive Power of Interest Rates and Interest Rate Spreads", *New England Economic Review*, 51-68.
- Bernhardsen, T., Ø. Eitrheim, A.S. Jore, & Ø. Røisland (2004): "Real-time Data for Norway: Challenges for Monetary Policy", *Discussion Paper*, 26/2004, Deutsche Bundesbank, <www.bundesbank.de/download/volkswirtschaft/dkp/2004/200426dkp.pdf> (15.04.10).
- Bismans, F. & C. Mougeot (2009): "Austrian business cycle theory: Empirical evidence", *The Review of Austrian Economics*, vol. 22, no. 3 / September, 2009.
- Bjørnland, H.C. (2004): "Produksjonsgapet i Norge – en sammenligning av beregningsmetoder", *Penger og Kreditt*, 4/04.
- Burns, A. F. & W.C. Mitchell (1946): *Measuring Business Cycles*, New York: National Bureau of Economic Research.
- Carilli, A.M & G.M. Dempster (2008): "Is the Austrian business cycle theory still relevant?", *The Review of Austrian Economics*, 21.
- Cwik, P. (1998): "The recession of 1990: A comment", *The Quarterly Journal of Austrian Economics*, 1(n°2), 85–88.
- Cwik, P.F. (2005): "The Inverted Yield Curve and the Economic Downturn", *New Perspectives on Political Economy*, vol. 1, no. 1, 2005.
- Friedman, M. (1964): "The Monetary Studies of the National Bureau", 44th Annual Report, *National Bureau of Economic Research*, reprinted in *The Optimal Quantity of Money and Other Essays* (Chicago: Aldine, 1969).
- Frisch, R. (1933): "Propagation Problems and Impulse Problems in Dynamic Economics", *Economic Essays in Honour of Gustav Cassel*, London: Allen and Unwin, 171–205.
- Frøyland, E. & R. Nymoene (2000): "Produksjonsgapet i norsk økonomi – ulike metoder, samme svar?", *Penger og Kreditt*, 1/00.

- Garrison, R.W. (2001): *Time and Money: The macroeconomics of capital structure*, Routledge: London and New York.
- Granger, C.W.J. (1969): "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", *Econometrica*, Econometric Society, vol. 37(3), 424-38, July.
- Grytten, O. & A. Hunnes (2009): "The historical connection between short-term output and prices in a small open economy", Norges Bank's bicentenary project, *working paper*, 2009/21.
- Hayek, F. von (1931): "Reflections on the Pure Theory of Money of Mr J. M. Keynes", *Economica*, 11(31), 270-95.
- Hayek, F. von ([1935] 1967): *Prices and Production*, 2nd ed., New York: Augustus M. Kelley.
- Hayek, F. von (1994): *Hayek on Hayek, an Autobiographical Dialogue*, edited by Stephen Kresge and Leif Wenar, Chicago: University of Chicago Press, and London: Routledge.
- Hill, R.C, W.E. Griffiths, & G.C. Lim (2008): *Principles of Econometrics*, 3rd ed., Hoboken, N.J.: John Wiley.
- Hodrick, R. & E.C. Prescott (1981): "Post-war U.S. Business Cycles: An Empirical Investigation" *Working Paper*, Carnegie-Mellon University. Reprinted in *Journal of Money, Credit and Banking*, vol. 29 no. 1, Feb. 1997.
- Howitz, S. (1996): "Capital Theory, Inflation and Deflation: the Austrians and Monetary Disequilibrium Theory Compared", *Journal of the History of Economic Thought*, 18, fall 1996.
- Hugues, A. (1997): "The Recession of 1990: An Austrian explanation", *The Review of Austrian Economics*, 10, no. 1, 107-123.
- Husebø, T.A. & B.-R. Wilhelmsen (2005): "Norwegian Business Cycles 1982-2003", *Staff Memo*, 2/2005, Economics Department, Norges Bank.
- Johansen, P.R. & T. Eika (2000): "Drivkrefter bak konjunkturforløpet på 1990-tallet", *Økonomiske analyser*, 6/2000.
- Juglar, C. (1916): *A Brief History of Panics and Their Periodical Occurrence in the United States*, 3rd ed., Gutenberg project.
- Keeler, J.P. (2001): "Empirical Evidence on the Austrian Business Cycle Theory", *The Review of Austrian Economics*, 14:4, 331-351.
- Keynes, J.M. (1937): *The General Theory of Employment, Interest, and Money*, New York: Harcourt, Brace, and Company.

- Kirchgässner, G. & J. Wolters (2007): *Introduction to Modern Time Series Analysis*, Springer.
- Kitchin, J. (1923): "Cycles and trends in economic factors", *Review of Economics and Statistics*, 5.
- Koop G. (2006): *Analysis of Financial Data*, John Wiley & Sons.
- Krugman, P. (1998): "The Hangover Theory: Are recessions the inevitable payback for good times?", *Slate Magazine*, 04.12.98, <www.slate.com/id/9593> (13.03.10).
- Krugman, P (2010): "The Bestest Generation", *New York Times*, 23.05.10, <krugman.blogs.nytimes.com/2010/05/23/the-bestest-generation> (01.06.10).
- Kydland, F.E. & E.C. Prescott (1982): "Time to Build and Aggregate Fluctuations", *Econometrica*, vol. 50, no. 6, Nov. 1982.
- Laubach, T. & J.C. Williams (2003): "Measuring the Natural Rate of Interest", *The Review of Economics and Statistics*, 85(4) (November).
- Mankiw, N.G. (2006): "The Macroeconomist as Scientist and Engineer", *The Journal of Economic Perspectives*, fall 2006, <www.economics.harvard.edu/files/faculty/40_Macroeconomist_as_Scientist.pdf> (17.05.10).
- Mankiw, N.G. (2007): *Macroeconomics*, 6th ed., Worth Publishers.
- Menger, C. ([1871] 1976): *Principles of Economics*, translated from German by J. Dingwall and B.F. Hoselitz, New York University Press.
- Mises, L. von ([1912] 1953): *The Theory of Money and Credit*, translated from German by H. E. Batson, New Haven: Yale University Press.
- Mises, L. von ([1949] 1966): *Human Action: A Treatise on Economics*, 3rd rev. ed., Chicago: Henry Regnery.
- Mishkin, F.S. (2007): *The Economics of Money, Banking, and Financial Markets*, 8th ed., Pearson Education.
- Mulligan, R. (2002): "A Hayekian Analysis of the Term Structure of Production", *The Quarterly Journal of Austrian Economics*, vol. 5, no. 2, 17–33.
- Mulligan, R.F. (2006): An Empirical Examination of Austrian Business Cycle Theory, *The Quarterly Journal of Austrian Economics*, vol. 9, no. 2 (summer 2006): 69–93.
- Ng, S. & P. Perron (1995): "Unit Root Tests in ARMA Models with Data-Dependent Methods for the Selection of the Truncation Lag", *Journal of the American Statistical Association*, vol. 90, 268-281.

- Oppers, S.E. (2002): "The Austrian Theory of Business Cycles: Old Lessons for Modern Economic Policy?" *IMF Working Paper*, no. 02/2.
- Robinson, J.V. (1953): "The Production Function and the Theory of Capital", *Review of Economic Studies*, 21: 81-106.
- Romer, C.D. (1996): *Advanced Macroeconomics*, New York: McGraw-Hill.
- Romer, C.D. (1999): "Changes in Business Cycles: Evidence and Explanations," *NBER Working Paper*, 6948, National Bureau of Economic Research.
- Rothbard, M.N. (1962): *Man, Economy and State*, William Volker Fund and D. van Nostrand.
- Sachs, J.D. (2006): "The Social Welfare State, beyond Ideology", *Scientific American Magazine*, November 2006, <www.scientificamerican.com/article.cfm?id=the-social-welfare-state> (14.03.10).
- Salerno, J.T. (2001): "Does the Concept of Secular Growth Have a Place in Capital-Based Macroeconomics?", *Quarterly Journal of Austrian Economics*, 4 (3): 43-61.
- Schlicht, E. (2004): "Estimating the Smoothing Parameter in the So-Called Hodrick-Prescott Filter" *Munich Discussion Paper*, 2004-2, Volkswirtschaftliche Fakultät, Ludwig-Maximilians-Universität, München.
- Simpson, D. (2002): "Book review: Time and Money: The macroeconomics of capital structure", *Economic Affairs*, vol. 22, 58-63, 2002.
- Singh, M. (2010): "The Austrian School of Economics", *Investopedia*, <www.investopedia.com/articles/economics/09/austrian-school-of-economics.asp?partner=aol-d> (11.06.10).
- Sjølie, Ø. (2009): "Spådde boligkrakket først: Peter Schiff stiller til Senatet", *E24 Nyheter*, <e24.no/utenriks/article3279663.ece> (21.09.09).
- Snowdon, B. & H.R. Vane (2005): *Modern Macroeconomics: Its Origins, Development and Current State*, Edward Elgar Publishing.
- Studenmund, A.H. & H.J. Cassidy (1992): *Using Econometrics, a Practical Guide*, 2nd ed., Harper Collins Publishers.
- Trautwein, H.-M. (1996): "Money, Equilibrium, and the Business Cycle: Hayek's Wicksellian Dichotomy", *History of Political Economy*, 28 (1): 27-55.
- Wainhouse, C. (1984): "Empirical Evidence for Hayek's Theory of Economic Fluctuations", in B. Siegel (ed.), *Money in Crisis*, 37-71, San Francisco: Pacific Institute for Public Policy Research.
- Wicksell, K. ([1898] 1936): *Interest and Prices*, translation from 1898, edition by R.F. Kahn, London: Macmillan.

Williams, J.C. (2003): "The Natural Rate of Interest", *FRBSF Economic Letter*, 2003-32; October 31, 2003, Federal Reserve Bank of San Francisco, <www.frbsf.org/publications/economics/letter/2003/el2003-32.html> (08.03.10).

Wooldridge, J.M. (2009): *Introductory Econometrics: A Modern Approach*, 4th ed., South-Western Cengage Learning.

Young, A.T. (2007): "A Capital-Based Theory of Secular Growth", *The Quarterly Journal of Austrian Economics*, vol. 12, no. 1 (2009): 36–51, <mises.org/journals/scholar/young.pdf> (20.03.10).

Zarnowitz, V. (1999): "Theory and History behind Business Cycles: Are the 1990s the Onset of the Golden Age?" *Journal of Economic Perspectives*, 13(2): 69–90.

Other

Investopedia (2010): "Income Effect", <www.investopedia.com/terms/i/incomeeffect.asp> (10.02.10).

Ludwig von Mises Institute (2010a): "What is Austrian Economics?", <mises.org/about/3223> (11.03.10).

NIST/SEMATECH e-Handbook of Statistical Methods (2003), "Univariate Time Series Models", U.S. Commerce Department, updated 16.02.10, <www.itl.nist.gov/div898/handbook> (15.04.10).

Nobel Prize Committee (1974): "The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1974", <nobelprize.org/nobel_prizes/economics/laureates/1974/press.html>, (11.05.10).

The American Heritage Dictionary of Business Terms (2010): "Say's Law", Houghton Mifflin Harcourt Publishing Company, <www.yourdictionary.com/business/say-s-law> (14.04.10).

Thesaurus (2010a): "Heterodox", based on WordNet 3.0, Farlex clipart collection, 2003-2008, Princeton University, Farlex Inc., <www.thefreedictionary.com/heterodox>, (11.06.10).

Thesaurus (2010b): "Scholasticism", based on WordNet 3.0, Farlex clipart collection, 2003-2008, Princeton University, Farlex Inc., <www.thefreedictionary.com/scholasticism> (11.06.10).

Thesaurus (2010c): "Praxeology", American Heritage Dictionary of the English Language, 4th ed., 2000, Houghton Mifflin Company, updated in 2009, <www.thefreedictionary.com/praxeology> (11.06.10).

Time Magazine (1965): "The Economy: We Are All Keynesians Now", 31.12.65, <www.time.com/time/magazine/article/0,9171,842353-1,00.html> (11.05.10).