Monetary Policy Analysis on the Dutch Economy

The macro-economic implications of monetary policy and macro prudential measures in the Dutch economy from a Keynesian and Classic perspective
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The macro-economic implications of monetary policy and macro prudential measures in the Dutch economy from a Keynesian and Classic perspective

By

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Executive Summary

The main focus of monetary policy is price stability, but steady growth and financial stability also depend on monetary policy. Adequate monetary policy is a crucial part of a well performing economy. Central banks are able to deploy multiple monetary policy measures.

Setting the rate on marginal lending facilities, on main refinance operations, and on deposit facilities, the rates that respectively determine the amount that the central bank charges banks that lend money overnight, the amount charged on loans from the central bank with a maturity up to a week, and the amount with which banks are remunerated when they store money overnight at the central banks, are powerful tools to influence the interest rates in the other parts of the economy and also impact factors such as economic activity and GDP development. Even though banks are able to lend from each other, it is unlikely that they will do this outside the boundaries of the interest corridor set by the central bank, as this is unfavourable for one of the banks involved.

Open market operations are a way for the central bank to control the amount of money in the economy directly. By buying or selling short term bonds the central bank can inject or retract money in and from the economy. When this does not have the desired effect, other parts of the yield curve and other segments of the economy can be targeted by buying and selling debt with longer maturities. This is called quantitative easing. However, in order for an asset purchase program to be successful, the money that is injected should start flowing through the economy, hence the central bank alone is not solely responsible for the success of monetary policy.

Macro prudential regulation is another monetary policy measure. Macro prudential measures are typically aimed at bolstering stability in the financial sector. Due to the fractional reserve banking system, banks can create credit and can directly exert influence on the money supply. Macro prudential regulation limits this ability and, besides stabilizing the financial sector, therefore also limits the money supply. Again, the central bank is dependent on the behaviour of other actors in its efforts to control the economy.

A profound understanding of the causal mechanism is a prerequisite for the implementation of monetary policy measures. Unprecedented situations ask for tailored solutions which is only possible when a policy maker is familiar with the dynamics in the system. A final challenge stems from the fact that most of these dynamics are disputed in economics, leaving room for more than one explanation for the same phenomenon. These challenges, identifying the causal mechanisms relevant to the success of monetary policy and discerning different views on these mechanisms, are addressed in this work.

This research, focussed at the Dutch economy, does not attempt to find the correct theory, yet embraces two theories as uncertainty to come with monetary policy recommendations. By exploring different theories and learning about their respective translations to models, in particular stock flow based models, this work is after an answer to the question:

“What is the impact of monetary policy and macro prudential regulation on the GDP development, price development, and employment in the Dutch economy?”

While monetary policy is focused at macro-economic performance indicators and macro prudential regulation is aimed at financial stability, macro prudential regulation also impacts macro-economic performance indicators. The purpose of this study is to examine how both monetary policy and macro
prudential regulation have their effect on key performance indicators in the Dutch economy, such as GDP, inflation and unemployment, while the stability of the financial sector lies outside the scope of this work.

A stock flow model with five actors will act as surrogate economy to run both Keynesian and classic simulations of the Dutch Economy. These five (groups of) actors are the consumers, the producers, the banks, the government and the central bank. By understanding what drives and constrains these actors, the interaction between those actors can be explained. From this interaction between these actors, that take place on the goods market, the financial market, and the labour market, follows the emergent behaviour that can be captured in three performance indicators: GDP development, price development and employment.

While the purpose of this work is to present a Keynesian and a classical model suitable for the analysis of the effects of monetary policy and macro prudential regulation, and explain the mechanism in these models, this works includes the simulation of a few scenarios of the model. From these simulations follows that when monetary policy is conducted, it is important to keep a healthy balance between setting interest rates and purchasing assets. An abundance of asset purchases causes an underperforming economy with a GDP far below the capacity of the Dutch economy and high unemployment in the Keynesian model structure. A monetary policy with too much weight on interest rate manipulation with respect to the asset purchase possibilities, causes a bubble in the classical model structure. This works recommends setting the deposit facility rate between -0.015 and 0.01, keep a corridor between the deposit facility rate and the marginal lending rate of 200 basis points and limit the size of asset purchase programs to a tenth of the gross domestic product.
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<tr>
<td>BCBS</td>
<td>Basel Committee on Banking Supervision</td>
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<td>BIS</td>
<td>Bank of International Settlements</td>
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<td>CES</td>
<td>Constant Elasticity of Substitution</td>
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<td>CRD IV</td>
<td>Capital Requirement Directive</td>
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<td>Capital Requirements Regulations</td>
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<td>EBA</td>
<td>European Banking Authority</td>
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<td>ECB</td>
<td>European Central Bank</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>IS</td>
<td>Investment and Savings</td>
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<td>LCR</td>
<td>Liquidity Coverage Ratio</td>
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<td>LM</td>
<td>Liquidity preference and Money supply</td>
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<td>NSFR</td>
<td>Net Stable Funding Ratio</td>
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<td>OMO</td>
<td>Open Market Operations</td>
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<td>QE</td>
<td>Quantitative Easing</td>
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<td>SEM</td>
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1. Introduction

Economics is the study of production, consumption and distribution of wealth. One might raise the question: “where does money fit in, let alone monetary policy”. Money allows economies to transcend from a barter economy, where one good or service has to be directly trade to another. Leaving the inconveniences of such a system to the reader’s imagination, the challenges that come with money in a system are very relevant to this work.

Money acts as the medium of exchange and measure of value (Hawtrey, 1919). Its value is derived from all the prices of goods and services it can be traded for. However, when the amount of goods and services traded increases, which can be caused by an expansion of demand, the discovery of new resources, or technological advancements, it is convenient to increase the amount of money in a system, which is a form of monetary policy. Expanding the money supply faster than the increase in goods and services, can result in inflation. Besides keeping the money supply up with the supply of goods and services, monetary policy also enable the central bank to stimulate a depressed economy or slow down an overheated economy. Even though the inclusion of money facilitates the economy, inadequate monetary policy erodes the success of the physical parts of the economy. Adequate monetary policy requires a deep understanding of the causal mechanism that connects the money supply to other parts of the economy.

The central bank is able to control the money supply by lending money to banks, by purchasing and selling government and corporate bonds, and by imposing requirements on banks. The latter also controls the money supply, as banks are also able to create money in a fractional reserve banking system and through these requirements, the amount of money created by banks can be limited or controlled. By controlling interest rates and the money supply, the central bank has a tremendous effect on the economy. The importance and magnitude of impact of central bank policy is especially apparent during financial crises.

Financial crises, crises that find their origins in the financial sector, also have impact on the physical part of the economy. Reinhart and Rogoff identified three characteristics of the aftermath of financial crises: a collapse of the asset market, profound declines in output and employment, and a great expansion of the real value of government debt (Reinhart & Rogoff, 2009). Especially the second characteristic exemplifies how other parts of the economy are affected by a financial crisis. Employment declines on average with 7% and total output declines with 9% the years after a crisis (Reinhart & Rogoff, 2009).

After the Financial crisis of 2007 to 2009, the ECB stimulated the economy with both conventional and unconventional policy measures. Conventional interference includes open market operation, where the central bank buys short term government bonds and unconventional measures refer to quantitative easing, which is the purchase of debt with a longer maturity by the central bank. This also includes the purchase of corporate bonds.

Besides stimulating the economy through asset purchase programs, the ECB also has a macro prudential function. Even though national authorities within the Euro-area maintain the right to discard the advice of the central bank, the ECB advices authorities on both technical and strategic levels regarding macro prudential measures. These measure are aimed to reduce and map system-wide financial risks (ECB, 2017).

High leverage ratios in combination with a large share of illiquid assets were identified as main causes of the financial crisis of 2007-2009 (King & Tarbert, 2011). A higher leverage ratio reduces the relative size of the buffer that is required to cope with adversities and illiquidity impairs a bank’s capacity to return
the money to depositors and other creditors. These risks are now further mitigated by liquidity requirements, minimum leverage ratios and limitations set by the Basel III framework. Although these measures are expected to mitigate the chance of another crisis, the liquidity and leverage ratios as well as the capital requirements come with higher cost of capital.

Two tasks of the central bank can be distinguished: monetary policy and macro prudential regulation. Monetary policy includes asset purchase programs and setting interest rates against which banks can lend or store money. Asset purchase programs include open market operations and, less conventional, quantitative easing. While open market operations mainly affect the left side of the yield curve, due to the short term of the debt that is traded by the central bank, quantitative easing can be employed directly affect long term interest rates. By setting rates against which banks can lend money (marginal lending rate) and the rate that banks pay for lending money from the central bank (deposit facility rate), the central bank can make an impact on the interest rate in the market, as banks issue loans with a rate that is, among other factors, based on the rate they pay to the central bank. The interest rate in the market determines the amount of projects that are profitable. A lower interest rate in the market renders more projects worthwhile and therefore stimulates economic activity.

Macro prudential regulations are meant to control the risk level of individual financial institutions, and therefore the risk in the financial sector as a whole. The fractional reserve banking system comes with the risk that banks do not own the money when it is reclaimed by its creditors. The reserve ratio, that prescribes the percentage outstanding debt that must be held (and therefore cannot be relend), is an example of a countermeasure that reduces this risk. A more sophisticated solution is the liquidity coverage ratio, which also prescribes an amount that must be held as reserves, but based on the expected outflows and inflows over a 30-day period. Macro prudential regulation targets individual banks but has also a macro-economic impact as the whole system strengthens. The more interconnected the system, the more this adagio proves to be true. Both the chance of an individual bank’s bankruptcy, as the extent of the impact for the financial system of one bank’s bankruptcy, decrease. The implementation of these measures and the consequential positive impact on the system come at a price. Micro level prudential measures impact our macro-economy, sometimes with undesirable consequences as well. Higher capital requirements and a reduction in maturity mismatch drive the funding cost for banks (Berben et al., 2010). Increased cost of capital slows investment and therefore the economy.

While monetary policy is focused at macro-economic performance indicators and macro prudential regulation is aimed at financial stability, macro prudential regulation has also impact on macro-economic performance indicators. The purpose of this study is to examine how both monetary policy and macro prudential regulation have their effect on key performance indicators in the Dutch economy, such as GDP, inflation and unemployment. The stability of the financial sector lies outside the scope of this work. This work provides insight into these important policy options of the central bank, both monetary policy and macro prudential measures, by translating causal mechanisms identified by economists with different views on the economy to models that allow to simulate effects intervention by the central bank. Indeed, figuring out a proper monetary policy is not only a challenge of adjusting policy measures to a dynamic economy, the dynamics to which the policy must be adjusted are also disputed.

1.1. Monetary Policy Analysis from two opposing views
Contrary to other sciences, it is near impossible to create a real controllable environment in the economy to run tests and to replicate those tests. Hence, economists often study real life situations that are
currently occurring or have already occurred in the past. Multiple interpretations to the same situations are possible when the situation cannot be easily replicated while altering different parameters at a time to eliminate or verify hypotheses of causal frameworks. This allows for multiple economic views to co-exist and consensus in economics is therefore limited. Even the fact that there are multiple kinds of economics is disputed. Hayek asserts that deviations between theories originate from semantics, rather than fundamental different school of thought and mourns the redundant work resulting from findings in one “language” that were well-known principles in another “language” (Hayek & Kaldor, 1933). Consequently, Hayek only distinguishes “good economics” and “bad economics”. In this work, emergent behavior from the causal frameworks is inquired by using structural disparities that emanate from opposing views as starting assumptions in the model. The different assumptions from Keynesian economists and classical economists are ground for diverging opinions regarding the expected success of monetary policies in the same economic conditions. The most prominent reason for the construction of this model is to identify and explain relations relevant to the impact of monetary policy and macro prudential regulation on macroeconomic key performance indicators. These relations will differ in the Keynesian structure from the classical structure. Although insight in the differences between these views on the causal mechanism that connect different forms of monetary policy and macro prudential regulation to other parts of the economy is the main goal of this work, the model that is constructed from these insights will be used to simulate a few Keynesian and classic scenarios.

Even though monetary policy is carried out with the intention to control these parameters, while macro prudential measures are put in effect with the intention to stabilize the financial system, it is expected that both policy measures have their effect on the key performance indicators in the economy.

1.2. Methodology

In this work, the focus will be mapping and explaining the different channels through which various policy measures of the central bank have their impact on the economy, rather than predicting exactly what this impact will be. In order to properly identify these relations, first the behavior that (groups of) actors exhibit is studied by inquiring their goals and limitations. These actors are the consumers, the producers, the banks, the government and the central bank. The behavior that follows is the interaction between those actors on the goods market, the financial market and the labour market. The behavior on these markets feeds back signals, the price and a quantity of money, labour and goods, to which actors adjust their behavior.

The objective is to make an assessment of the impact of macro prudential regulations and monetary policy measures of changes in inflation levels, real GDP development and unemployment as a result of monetary policy and macro prudential regulation. For this research, a method is required that enables to capture the mechanisms that connects the limits within which a bank is able to operate to the economy.

As the macro economy consists of multiple related variables that change over time, the method must allow modelling with multiple equations. Multiple methods satisfy this requirement.

Given the fact that the macro-economy is a complex system, the presence of feedback loops, non-linear behaviour and interactions between endogenous variables, a static model cannot give an adequate reflection of its behaviour. In order to capture the full consequences of monetary policy on the economy, a more appropriate modelling technique must be used to simulate macro-economic behaviour. Furthermore is it hard to explore non-implemented policy options, simply because data of those options
in an economy are not available. For this research a system dynamics model is more suitable to capture interdependent relations and feedback loops present in the economy, while being able to explore new policy options.

System dynamics is a stock-flow based modelling approach able to capture circular causalities resulting in feedback loops and non-linear emergent behaviour of a dynamic system. The stock-flow approach is suitable to capture different financial statements in one picture. The balance sheet can be seen as a collection of stocks that change based on the income statement. The income statement can be modelled by the flows.

These flows are governed by preferences of the actors, regulation and macro-economic behaviour. The values of certain macro-economic variables are indirectly dependent on its past values due to the occurrence of feedback loops. An increase in labour force results in an increase in total wages earned, which impacts the increase in demand in labour force through increase in aggregated demand of goods and services. This is an example of a positive feedback loop, as the value of a variable has a positive effect on its future values. While one feedback loop can be comprehensible for the human mind, determining the dominant feedback loop and understanding the interaction between feedback-loops with the aim to understand what the available information means in terms of behaviour is inconceivable for the human mind (Forrester, 2009). The potential to structure these information flows is crucial when performing a policy analysis on a complex system, such as the macro economy, and a system dynamics model is able to provide insight in the behavior of such a perceived system over time (Forrester, 1992).

1.3. Robust policy analysis

This work embraces the uncertainty originating from diverging economic theories by acknowledging more than one causal framework. The Keynesian and the classical framework are taken into account. While the original goal was to map which monetary policy options and macro prudential regulations are suited to which situations, and to be able to make recommendations based on initial economic conditions, taking the complexities of a multi actor system into account, the overwhelming amount of relevant causal mechanisms in the economic system and the level of accuracy required in a model that could produce a robust policy analysis changed the goal into laying down the foundations for such a model. However, with the insights gained in this work, a model was build and some scenarios were simulated from both a Keynesian and classic perspective. The model that is developed is able to facilitate multiple causal structures and maps the result of five actors that are active on the goods market, the financial market and the labour market. The model respects accounting identities, enabling it to accurately track the money supply.

This work examines the effects of monetary policy and macro prudential regulations on GDP, price level development and unemployment. Especially the causal foundations that are laid out in this work should be taken into account by macro prudential advisors and aid them in their decision making. These metrics were not only chosen because they are measurable and relatively objective, but also because they reflect the more physical parts of the economy and are therefore useful for the assessment of the impact of monetary policy and macro prudential regulation on this part of the economy. Furthermore is the goal of the European Central bank price stability in the Eurozone, balanced economic growth and full employment.
GDP indicates the total economic performance of all producers in the economy and it is an often seen metric of economic performance (Stiglitz, Sen & Fitoussi, 2009). This total of all goods and services can be consumed or added to the capital stock and is the product of the physical part of the economy. Unemployment is not only a function of economic performance, but can quite directly impact the well-being of a population. Oswald mentioned that amongst the British population, people who were involuntarily unemployed, showed higher levels of mental distress than those who were employed (Oswald, 1994). A steady, low level of inflation is not only a sign that the central bank is successful in controlling the economy, but also avoids uncertainty and inconveniences for the society as a consequence of rising prices, such as frequent adjustment of prices or difficulties with strategic planning under uncertainty. The development of these key performance indicators, is not only a product of the causal mechanisms that connect monetary policy and macro prudential regulations to the physical part of the economy, but also of the initial value of model parameters, that were tailored to represent the Dutch economy.

The initial values of stock variables in the model, that represent the posts on the aggregated balance sheets of the five actors and macro-economic figures, such as total workforce and initial wage rate, are initially populated by data from OECD, Statista, Bank Scope and the SNL database. As import and export are excluded from the model, aggregated balance sheets are somewhat stylized, so that double entry booking is respected and all debts are someone else’s assets, as are all outstanding shares owned by another actor in the model.

Even though this model is adjusted to the Dutch economy, altering the initial parameters to the economic situations of other countries could also offer insight to the suitability of monetary policy abroad. In this process, the way is paved for other economic modelers, as the model choices are all documented and the translation of economic concepts of different economic schools into the stocks and flows that constitute the system dynamics model can be transposed to other models to enlighten similar complex economic challenges.

The macro-economic model itself is relevant for economists as it is able to discriminate expectations based on conflicting economic theories regarding the same macro-economic relations. In historical scenarios where we already know what the outcome of the model should be, this could offer deepened insight in the most suitable theory.

1.4. Research Questions
This research focusses on the impact of monetary and macro prudential policy analysis. While both the stability of the financial sector and the stable, sustainable growth of an economy are desired, these goals can conflict. However, achieving stable growth alone through monetary policy is a challenge alone, as the timing and the parameters related to the monetary policy must be adequate. This research addresses the following question:

“What is the impact of monetary policy and macro prudential regulation on the GDP development, price development and employment in the Dutch economy?”

The thesis will start with an inquiry into the views of other authors on the subject. This literature review will be covered in chapter 2.
1) **What have others written on the subject of monetary policy analysis from a macro-economic perspective?**

The nexus between monetary policy and the impact on macro-economic key performance indicators passes multiple groups of actors. The second step towards answering the main research question is to map and categorize relevant groups of actors.

2) **Which groups of actors populate the socio-economic background relevant to the nexus between monetary policy and its impact on the key performance indicators mentioned in the main research question?**

Once the relevant actors are mapped, it is important to understand their behavior, hence research question three covers:

3) **Which goals do the actors, identified in chapter 2, pursue and by which limitations are they bound?**

This is an important question as it identifies the structure of multiple subsystems that result in the behavior and interaction of the actors. This results in one, larger system: the economy. While it is already hard to properly identify desires and limitations of the various actors in the system, it is even harder to explain their behavior. Multiple theories prevail regarding the behavior of groups of actors. As economics is subject to different schools of thought, rather than one, it is important to explore differences between them.

4) **How do economists claim the causal mechanism work in the economy?**

Research question four answers, from multiple perspectives, how different actors behave and gives already a glimpse of the emergent behavior of the system as a whole. In order to complete the understanding of this socio-economical system research question five answers:

5) **What are the effects of the various kinds of behavior among the different groups of actors on the key performance indicators identified in the main research question?**

A model will then be created that can be used to determine the success of macro-economic policy in real systems.

6) **How do we translate the causal mechanisms, identified in the previous research questions to a macro-economic model, suitable to test the impact of macro-economic policy?**

The answer to research question six will be sought in the work of others, who also have created models to capture the causal mechanisms relevant to the main research question. The theory regarding economics and modelling must now be melted into a unified framework that can be used to asses macro-economic policy measures. What is left, is to implement data relevant to the scope of this work in the model and evaluate the results of them model.

Chapter two explores different views on monetary policy and macro prudential regulation in an attempt to answer the first research question. Chapter three presents an analysis of the socio-economic structure, in order to explain the behavior and predict the outcome in the Dutch economy. As it is outside the scope of this research to identify the correct view, multiple views are considered. Chapter four explores the work of other modelers and weighs pros and cons of different models. In order take lessons from these models, the models are translated to the same stock-flow environment in which the final model will be build.
Lessons learned from chapter three and four are applied in chapter five, where the technical details relevant to the model for the Dutch economy are identified and where theory is translated into a model. Chapter six discusses the results of both Keynesian and classic simulations, in which the central bank deploys different policies. While the main goal of this work is the identification of causal mechanisms that connect monetary policy and macro prudential regulation to the real part of the economy and the translation of these mechanisms into a model, chapter seven presents conclusions based on the simulations described in chapter six. Chapter eight reflects on the process and results of this work.
2. Views and facts on monetary policy and macro prudential regulations

This chapter maps views and opinions on monetary policy and its place in the economy. Throughout history proponents and opponents argued the justification of the intervention by a monetary authority. This chapter identifies advocates and their reasoning on both sides of the argument. The first part of the chapter takes these views into account that are concerned with asset purchase programs and interest rates, set by the central bank. The latter part of the chapter does the same for macro prudential regulation, measures by the central bank that impose limitations on the risk levels banks can assume.

2.1. Opponents and proponents for monetary policy

The central bank can employ multiple tools to stimulate or cool down the economy. It can focus on asset purchase programs, where it increase the amount of money in the economy by purchasing government or corporate bonds and it can influence bank lending behavior by setting interest rates. Financial intermediaries are typically funded with short-term debt and have outstanding loans with a long maturity as assets on their balance sheet. The spread for these institutions therefore depend on the yield curve. A steep yield curve causes a high spread for these institutions, inducing lending activity. Adrian, Estrella and Shin found that focusing on short term interest rate to steepen or flatten the yield curve, induces or halts economic growth (Adrian, Estrella & Shin, 2010).

Asset purchase programs are also meant to increase economic growth, yet many are dissatisfied with the alleged side-effects that come with influencing the money supply through monetary policy. Hawtrey advocates that monetary policy is the sole driver of the business cycle and that the physical part of the economy has little to do with ups and downs in the economy. He even argues that physical shocks, such as strikes, wars and disappointing harvests are not able to bring an economic system out of balance (Hawtrey, 1919). Milton and Schwartz assert that not only do appreciable changes in the rate of growth of money supply directly cause changes in gross income, but also that these changes in income are solely caused by changes in the rate of growth of money supply. This does not only apply to changes in money supply during business cycles, but also when the money supply is increased over a longer period of time. While they felt confident in these assertions, they admitted that the causal mechanisms that connect monetary policy to other sectors of the economy was still unclear (Friedman & Schwartz, 1987).

Hayek and Kaldor discarded any non-monetary trade cycle explanations due to a lack of connection between the economic events in the trade cycle and the fundamental theories that were used to explain these trade cycles. In an attempt to dispute these theories, they identified that excessive production of capital good, disproportional to consumption was the argument that could be found in all non-monetary explanations. Names as “industrial fluctuations” or “cyclical movements of industry” are misleading from the real problem at hand, because even though excessive production might follow from economic data, the excessive production is not the problem but rather a symptom resulting from a monetary problem (Hayek and Kaldor, 1933). They identify artificially low interest rates due to expansionary monetary policy as culprit of industrial fluctuations. Low rates result in entrepreneurs that pick up uncalled for projects that are no longer profitable once interest rates rise again. These distorted price signals are the real cause for business cycles (Kaldor, 1960). Currie agreed that business cycles had monetary roots and proposed that the credit creating power should be taken from banks by the introduction of a 100% reserve banking system (Currie, 1934). The proposal faced too many political obstacles to become reality, yet was inspiration for the “Banking Act” in the United States that gave control over the credit creating power of banks to the Central Bank (Sandilands, 2010).
When the central bank did intervene in the market, it was usually in the government bond market. However, since the financial crisis of 2007 to 2009, central banks also engaged in quantitative easing. Bernanke mentioned that quantitative easing works through two channels: the signaling channel and the portfolio balance channel. The signal the central bank emits with quantitative easing is best understood when this is in combination with a low interest rate policy. The portfolio balance channel is the effect the central bank has on asset prices and risks. By purchasing assets from the market, the private sector needs to rebalance their portfolios for the assets the central bank has acquired with similar risk attributes, this lowers cost and boosts aggregate demand. Quantitative easing, through whichever channel, has proved to be an effective tool. Although he admits that direct links to macroeconomic outcomes are not straightforward, experience from various countries implies that QE has beneficial effects on a recovering economy (Bernanke, 2017). However, opponents of quantitative easing do not doubt its effectiveness so much as they fear possible side effects. These side-effect include debasement of the national currency, incontrollable inflation and artificial asset bubbles. Such concerns were published in an open letter to the chairman of the Federal Reserve, Ben Bernanke, by republican members of congress and senators (McConnel et al., 2010).

2.2. Origination of and criticism on modern macro prudential policy measures

Rationalizations for modern macro prudential policy measures can easily be found when one considers where and more importantly, under which circumstances they originated. Regulations for banks are not imposed for the sole purpose of controlling the money supply, but also to aid the economy by providing stability. Indeed, the potential of the financial sector to both stimulate the economy and make it collapse is a justification for regulatory interference apart from controlling the money supply. Regulations are meant to reduce the chance of a financial crisis and to mitigate its impact when it does occur. A financial crisis is often the cradle of renewed regulations, as was also the case with the global financial crisis in 2007-2008 after which Basel III was introduced (Cassis, 2012). Basel III was, not unlike its predecessors, meant to further stabilize banks.

The last crisis revealed that the capital base was insufficient and less absorbing than expected. Liquidity risks were not incorporated and additional regulation was required to deal with the heavily interconnected and complex financial system (BCBS, 2009). With respect to its predecessors, Basel III offers an even more thorough set of requirements. Two unprecedented liquidity requirements were implemented to bolster a banks liquidity and the capital ratio, while present in Basel II, was enhanced in Basel III. Besides the capital ratios, the leverage ratio was added to disallow dangerous levels of debt with respect to their equity, yet unlike the capital ratio regardless of the risk weights of a bank’s assets.

Micro level prudential regulation targets individual banks but has also a macro-economic impact as the whole system strengthens. The more interconnected the system, the more this adagio proves to be true. Both the chance of an individual bank’s bankruptcy, as the extent of the impact for the financial system of one bank’s bankruptcy, decrease. The implementation of these measures and the consequential positive impact on the system, however, come at a price. Micro level prudential measures impact the macro-economic system, sometimes with undesirable consequences as well. Higher capital requirements and a reduction in maturity mismatch drive the funding cost for banks (Berben et al., 2010). Increased cost of capital slows investment and therefore the economy, which can contradict other monetary policy goals.
After the financial crisis of 2007-2009 banks had improved their common equity ratio with 1.3 percentage points and their tier 1 capital ratio by 1.5 percentage points relative to pre-crisis levels, mainly due to market pressure (INF, 2010). When all banks are required to increase their reserve ratio, the amount of money circulating in an economy reduces. In order to comply with increased reserve ratios, a bank can either shrink its lending or attempt to attract more equity. The latter is not always an option for banks and reducing the money supply suppresses economic growth. When banks face a severe draw on liquidity, a possible reaction is the sale of illiquid assets. When multiple banks face this problem, their aggregated supply of illiquid assets could depress market prices. This results in losses, not only for already troubled banks, but also for other institutions, which are now also limited in the amount of capital they can lend.

The trade-off between instability in a laissez-faire system and the costs that come with implementing regulation requires careful thought as not all effects can be assessed directly. A financial crisis has a substantial impact on the structural unemployment (Guichard & Rusticelli, 2010). According to signals stemming from inflation priced indices, inflation becomes more volatile during financial crises (Galati, Poelhekke & Zhou, 2009). Especially liquidity constrained firms increase their prices during a crisis (Gilchrist et al., 2016). It’s is not uncommon for a financial crisis to start with a bubble that bursts which causes a huge stagnation of growth. However, stagnation of growth is not only with respect to bubble levels, but national output even decreases below pre-bubble levels when a financial crisis occurs (Gros & Alcidi, 2010).

2.3 Conclusion
The impacts of monetary policy and macro prudential regulation for the financial sector are not always straightforward, but can be manifold and complex. This complicates the process for policy makers in their assessment of the impact on the banking sector and the economy. This thesis is meant to support that assessment with a system dynamics model, while respecting uncertainties and the lack of economic consensus. The following chapter presents an overview of the Dutch economy and includes different views that attempt to explain behavior of the various relevant actors.
3. Economic Theory
The relevant economic background will be studied by an analysis of the structure of the market, an analysis of the behavior on the market and an analysis of the outcome from the market. This structure-behavior-outcome analysis will be conducted from the perspective of five actors. The structure can be seen as a combination of the boundaries within which the actors have to take decisions, and their preferences or mandates, towards which they wish to move. Their actions are determined by their preferences and if regulation proves to be a limiting factor to that preference, an actor will position itself near the boundaries of the structure. Actors face trade-offs between preferences and interact with other actors. This result is a product of both the structure of the system and the behavior of the actors. It does not necessary follow logically from either the structure of the system or the behavior of the actors, but emerges from the system as it functions. The following section elaborates on the nature of the actors. This will be the foundation for the structure analysis, which is discussed in section 3.2. The behavior of the actors, driven by their desires and restricted by the structure, results in trade-offs and interactions that are analyzed in section 3.3. Section 3.4 presents the outcome of the structure and behavior for the actors on the market.

3.1. Actors
In order to examine the effect of macro-economic monetary and prudential policies, this section starts with a brief overview of the different actors distinguished in the model and their relation to the policy instruments. These five groups of actors are consumers, producers, banks, the government and the central bank.

3.1.1. Consumers
The consumers play an important role in the economy because basically everything that is produced, is eventually produced for use or consumption by consumers. Adam Smith wrote already in 1776:

“The value of goods circulated between the different dealers never can exceed the value of those circulated between dealers and consumers; whatever is bought by the dealer being ultimately destined to be sold to the consumers.” – Adam Smith, 1776

The group of consumers is diffuse and the individuals have little impact on the economy alone. However, the behavior of the total group has tremendous influence on the economy. However, monetary policy and macro prudential regulations do not affect this group directly yet their impact is certainly felt through other actors.

3.1.2. Producers
Producers create goods and services with human labour and capital stock. Producers are able to create value, but often need funding to undertake their projects, which is used to pay for interest, wages and other factors of production. The three sources of funding for producers are debt financing, equity investments and retained earnings. Typically retained earnings make up for a limited part of the funding, making producers dependent on other actors that can fund them. Most monetary policy measures do not directly affect this group, yet in extreme conditions the central bank might directly buy corporate bonds, providing funds for the producers. This is called quantitative easing and is an unconventional policy measure. Macro prudential regulations for producers (e.g. IFRS 9) falls outside the scope of this research. A more conventional way of corporate funding is by banks.
3.1.3. Banks
For the purposes of this research, other financial institutions, such as pension funds or insurance companies, which perform to some level of abstraction similar tasks in an economy as banks, are lumped under the definition of banks.

In short, banks connect actors with a cash surplus, to those who are in need for cash. At first, it does so by taking deposits, which are then being redistributed to those in need for cash in the form of either bonds or equity. The difference between the rate a bank receives on its assets and the rate a bank pays on deposits is a revenue source for the bank. Retail banks are able to fund corporations by accepted deposits and investment banks raise funds for companies by underwriting loans or equity. Most banks aim to maximize their profit while maintaining acceptable risk levels. The trade-off between risk and returns requires attention for both aspects. Macro prudential regulations from the central bank require banks to limit their liquidity and solvability risks.

3.1.4. The Government
The government collects taxes and typically aims to carry out anti-cyclical movements within their budget deficit boundaries and debt rate limits. These limits are imposed by the European Union. Macro prudential regulation does not impact the government, yet the government plays a role in converting European directives to national regulation. Earnings from central banks are transferred via national central banks to governments.

3.1.5. The Central Bank
The main goal of the ECB is to maintain price stability in the Eurozone, as is prescribed by the Treaty on the Functioning of the European Union. The ECB also pursues full employment and balanced economic growth, when this does not conflict with maintaining price stability (ECB, 2018). Conventional methods of central banks to target inflation include the expansion of money supply, which is possible in case of a fiat currency such as the Euro. The process often referred to as “printing money”, is the issuance of a loan with money that did not exist until the loan was issued. The process does not cause inflation right away as the issuance of these loans does not cause prices to rise or wage claims to increase. In order to cause inflation, this money has to be spend. This makes central banks dependent on receivers of loans in their way to target inflation and is the reason why monetary expansion in a depressed economy might not yield the desired results.

Another tool for the central bank to target inflation is through interest rates setting. As interest rates are low, only a low return on equity is required to profit from lending which increases the demand for money. As less return is received when money is deposited, spending increases. Both mechanisms have a positive effect on the inflation. The main interest rates the central bank set are the discount rate, which is the rate charged to banks when they lend money from the central bank and the interest return on deposits by other banks. When the target interest rate required for a desired inflation is lies between the discount rate and the interest on reserves, we speak of a corridor system. When this interest rate is equal to the interest rates on reserves we speak of a floor system (Bernhardsen & Kloster, 2010). The central bank sets a discount rate for lending to banks and a rate that is returned to reserves stored at the central bank. The Taylor rule approximates how the central bank should set its interest to target a desired inflation rate using equation 3-1 (Taylor, 1993).
\[ i_t = \pi_t + r_t^* + \alpha_\pi (\pi_t - \pi_t^*) + \alpha_y (y_t + y_t^*) \]  

Where \((\pi_t - \pi_t^*)\) represents the difference between actual inflation and desired inflation, \((y_t + y_t^*)\) is the difference between the logarithm of real GDP and the logarithm of the potential output, \(\pi_t\) is the current inflation, \(r_t^*\) the assumed equilibrium real interest rate and \(\alpha_\pi\) and \(\alpha_y\) are both 0.5, but can assume other positive values.

3.2. Structure

This thesis considers preferences and limitations to be both a part of the structure and it is only in the outcome analysis, that the desires become once more relevant. This section describes the structure, constituting those limitations and desires.

The line between structure and behavior requires specification, as the structure of one player might be the behavior of another. In this section, the structure from the perspective of consumers, producers, banks, the government and the central bank is considered. Actors are typically bounded by physical limitations and laws prescribed by other actors. Besides these limitations, the structure analysis also constitutes the desire of the actors.

3.2.1. Consumption system

Maslow created a hierarchical structure of human needs. The pyramid shaped structure, with needs to survive at the bottom and the desire for self-development at the top is shown in figure 3-1. The reason for this classification and order was that Maslow argued that higher order needs were only addressed when lower order needs were satisfied (Maslow, 1943).

![Maslow's Pyramid of human needs](image)

While this theory was not empirically proven, it shows how limitations and desires can be treated as two opposite ends of the needs spectrum. Consumers are limited by their biology to provide a minimum amount of food and shelter. When these needs are satisfied, remaining funds and energy can be allocated to desirable needs such as social acceptance and education. However, enough should be reserved for the next time period, in which the consumer, again, need to fulfill the basic needs. Consumers in the Netherlands are free to trade with whomever they want, as long as the subject of the transaction is not illegal and there is a two party consent. Consumers, as end-users, are obliged to pay VAT on each transaction. This is typically included in the price and handled by the producer. Consumers can trade their time for money at the labor market or start their own business, in which case they are both treated as
consumer and producers in this work. The next section elaborates on the structure for consumers that engage in entrepreneurial activities.

3.2.2. Production system

The producers constitute the part of the economy that supply goods and services that are sold to consumers, other producers or the government, be it within the same country, or to another country in case of an open economy. Whether producers operate at the top of a supply chain, e.g. harvesting materials from mother earth or are active in the retail sector, at the bottom of the supply chain, producers typically derive their right to exist from the fact that they add value to the supply chain. This addition of value is a necessary requirement to the right to exist, rather than a sufficient requirement as the added value must also offset the cost of the factors of production employed to add this value. Besides adding value, a producer should also be concerned with competitive forces and its capital structure.

Porter identified five competitive forces that producers should incorporate in their competitive strategy. The forces are based on the producer’s place in a vertical supply chain and come from five different groups of actors (Porter, 1979). The forces are shown in figure 3-2. The added value reflects the difference in value between the goods supplied by the supplier and the goods sold to the customer.

![Figure 3-2: Competing forces for a producer](image)

A producers needs to negotiate with both its supplier and customer to convert this added value to a revenue. When a producer aims to increase revenue with respect to the intrinsic added value by lowering the price he is willing to pay for his input, while increasing the price for his own product, suppliers might opt to supply to another producer and consumers will look for other producers offering similar products or services. However, in the case that the offered volume of similar products is low, with respect to supplier and customers, a producer can be successful in increasing its revenue with respect to its added value. In this case it might be lucrative for new entrants to start a similar business and for customers to find substituting products or services, although this is not always possible.

Producers are typically required to cover at least a part the cost of production factors before revenue flows in. This cost can be funded by retaining earnings from previous projects, by emitting equity or by debt financing. Retaining earnings limits a producer in returning dividends to shareholders, emitting equity reduces the profit share for the producer and existing shareholders and debt financing comes with the obligation of repayment, even when the project turns out the be unsuccessful. The funding of a business is referred to as the capital structure.
Modigliani and Miller argued that the capital structure is irrelevant for the market value of the business, under the condition that there is an absence of dividend policy, taxes bankruptcy cost, information asymmetry and agency cost (Modigliani & Miller, 1958). The fact that these conditions are never met in real-life originated a debate on what would be the best capital structure under realistic conditions. The pecking-order theory and the trade-off theory prevailed (Graham & Leary, 2011).

The trade-off theory constitutes a cost-benefit analysis on raising debt as funding, taking amongst others the factors into account that were discarded by the Modigliani-Miller theory, while the pecking order theory assumes that the use of retained earnings is preferred, as there are no cost of debt or equity issuance and no need to release private information to third parties. This is followed by debt financing, as this is cheaper than equity financing. Consequently, retained earnings are used until they are exhausted, in which case debt is issued until the producer has reached its debt capacity. Only when there is need for additional funding while those sources are drained, producers should raise equity (Myers, 1984).

3.2.3. Banking system
The analysis of regulation in the banking system is important to this work as this concerns macro prudential regulations. It is in this section that the considered macro prudential regulation is addressed.

In a fractional reserve banking system banks, only a part (fraction) of the deposits is kept, while the majority is used to fund loans or investments. This is condoned by the assumption that not all money needs to be in the vault at all times as depositors keep the better part of their money at the bank and deposits cancel out withdrawals. The fractional banking system allows loans to be funded by both debt and equity, which means that the bank does not need to own everything they lend. This exposes the bank to certain risks, from which the potential adverse effects are also felt by other actors in the economy. This justifies regulatory interference, which comes in the form of macro prudential regulation. The Basel Committee on Banking Supervision (BCBS), a committee within the Bank of International Settlements (BIS), came with the Basel framework to mitigate these risks.

The BIS is an organization which serves central banks in their pursuit of both monetary and financial stability and aims to foster international cooperation. Even though the BCBS does not possess any formal supranational authority and its decisions do not have legal force, the BCBS relies on its members' commitments to achieve its mandate. The international character of this advisory body levels the playing field for international banks.
The third Basel accord was revised and transformed into Capital Requirements Regulation (CRR) and Capital Requirements Directive IV (CRD IV) by the European Banking Authority (EBA) in response to a request by the European Commission. While there is a number of options and discretions to implement the CRD, the CRR is directly applicable in member states and ensures equal application of Basel III in Europe. The Dutch banking sectors must also comply with these regulations. An overview from guideline to law is presented in figure 3-3.

Basel III comprises -not unlike Basel II- three pillars and is built on its predecessors. The capital definitions, capital requirements and liquidity ratios are a part of the first pillar. The second pillar demands adequate risk management and supervision and the third pillar urges banks to disclose details of the components of regulatory capital and their reconciliation to the reported accounts. Explanations of calculations should also be publicized by the banks. The term "banks" is a collective for all deposit-taking credit institutions and investment firms.

The capital requirement determines the amount of capital a bank must have, based on the amount and risk of the loans a bank has on its balance sheet. Total required capital depends on the total risk-weighted assets. The total risk-weighted assets is the sum of the amount of assets per asset class multiplied by their respective risk weights. Risk weights are determined based on the risk associated with the asset. A fraction of this total amount of risk weights must be held in capital.

Three subsets of capital are to be distinguished to determine compliance with the capital ratios. Tier 1 capital includes both share capital and retained earnings, this narrow definition is called “common equity tier 1 capital”. Non-cumulative preferred stock are labelled as “additional tier 1 capital” and form together with core tier 1 capital the total tier 1 capital. Tier 2 capital comprises subordinate debt to depositors with an original maturity of five years.
The amount of tier 1 capital can never be lower than 4.5% of the risk-weighted assets. Assets for a bank include loans to counterparties and the risk weights assigned to these assets depend on market risk, credit risk and operational risk. Total amount of tier 1 capital, i.e. core tier 1 capital with additional tier 1 capital included, can never be lower than 6% of the risk-weighted assets. Total capital, i.e. the total amount of tier 1 capital plus the total amount of tier 2 capital can never be lower than 8% of the risk-weighted assets (Hull et al., 2003). An example of the calculation of the capital requirements can be found in figure 3-4.

**Figure 3-4) Calculations of the capital requirements**

Besides the capital requirements that must be met at all times, as described above, an additional buffer of 2.5% core tier 1 capital must be conserved during normal times. This buffer can be used during periods of stressed market conditions. Basel III does not come with a definition of “stressed market conditions” but limits bank in their discretion to pay dividends to shareholders when this buffer is not met. The gradual development of the implementation of all risk-based capital requirements is depicted in figure 3-5.

**Figure 3-5) Implementation Basel III Requirements**

The leverage ratio also requires banks to hold capital. The leverage ratio is not based on the risk of the assets and requires a bank to hold 3% of 100% of its total assets in capital in tier 1 equity. This can be seen as a backstop for banks that hold assets with relatively low risks.
A new aspect of Basel III, relative to its predecessors, is an imposed reduction of liquidity risk. Banks tend to finance long-term assets with short-term liabilities. In this practice, it is important that borrowed funds are rolled-over until assets are paid back to the bank. Failure to do so results in liquidity problems and as liquidity risk are believed to be one of the culprits of the financial crisis in 2007, countermeasures were incorporated in Basel III.

The Liquidity Coverage Ratio (LCR) is used to limit liquidity risks. The LCR is the ratio of high-quality liquid assets in times of stress over the net cash outflows in 30 days. The 30-day period in this formula is a scenario where the bank’s debt is downgraded, while a partial loss of deposits and a compete loss of wholesale funding takes place. In addition to those encumbered conditions, increased haircuts on secured funding and draw downs on lines of credit are simulated. The net cash outflows under stress equals the stressed cash outflows minus the stressed cash inflows. The outflows represent the total outstanding debt multiplied by the expected rate by which this is expected to run off. Both numbers are assumed to represent their respective amounts under stressed conditions and the fact that this ratio needs to be above one requires banks to hold more high-quality liquid assets than the possible amount of total net cash outflows under stress in 30 days. This is summarized in equation 3-2.

\[
\frac{\text{High quality liquid assets}}{\text{Required amount of stable funding}} = \frac{\text{High quality liquid assets}}{\text{Expected outflows} - \text{expected inflows}} \geq 100%
\]  

3-2

High quality liquid assets come in two levels, level 1 and level 2. A further separation is made between level 2a and level 2b assets. The classifications represent different levels in quality. The total amount of level 2 assets can comprise a maximum of 40% level 2B assets and the total amount high quality liquid assets can comprise of a maximum of 15% level 2 assets. An abundancy of inferior assets above these thresholds does not contribute to the total amount of high quality liquid assets. This is summarized in equations 3-3 and 3-4.

\[
\text{Total HQLA} = \text{Min (Level 1 Assets + Level 2 assets, } \frac{\text{Level 1 Assets}}{1 - 0.15})
\]  

3-3

\[
\text{Total Level 1} = \text{Min (Level 2a Assets + Level 2B assets, } \frac{\text{Level 2a Assets}}{1 - 0.4})
\]  

3-4

3.2.4. Government system

The policy goals of the Dutch government should ideally reflect the needs of the Dutch citizens as revealed through the democratic parliamentary process. The government is limited by imposed EU-law and the Dutch constitution. The stability and growth pact, which was agreed upon by the Netherlands and 27 other member states by the European Union, states that the fiscal policy of member states should aim to limit the budget deficit to 3% and the debt rate to 60% of the GDP. This statement seems a directive, rather than a law as it includes back-up plans in case the conditions are not met. In case the debt rate exceeds the prescribed threshold, considerable efforts should be made to reduce the debt rate with a satisfactory pace and temporarily excesses of the budget deficits should be close to the prescribed 3% of the GDP. However, when member states fail to comply with these terms, a non-interest-bearing deposit is required, that can be turned into a fine when the violating situation prolongs (Kesner-Škreb, 2008).
The Netherlands has a progressive wage tax rate scheme that manifests in a tax rate that increase with the wage rate for individuals. The tax rates are denoted in table 3-1.

<table>
<thead>
<tr>
<th>Tax Bracket</th>
<th>Annual Wage</th>
<th>Tax Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>€0 – €20.142</td>
<td>36.55%</td>
</tr>
<tr>
<td>2</td>
<td>€20.142 – €33.994</td>
<td>40.85%</td>
</tr>
<tr>
<td>3</td>
<td>€33.994 – €68.507</td>
<td>40.85%</td>
</tr>
<tr>
<td>4</td>
<td>&gt;€65.507</td>
<td>51.95%</td>
</tr>
</tbody>
</table>

*Table 3-1 Wage Tax Rates in The Netherlands*

Besides wage tax, consumers also pay value added tax on the products they consume and services they use. Producers are exempted from this tax when they do not consume their purchases as the value added tax is only paid by the final consumer. Business to business sales are not taxed. Currently, in 2018, a common value added tax of 21% applies, while for some goods and services a lower rate of 6% applies, as this concerns goods and services beneficial to or necessary for the society, such as food, barber services and transportation. For goods that are deemed harmful to society, such as cigarettes and liquor an excise duty applies.

### 3.2.5. Monetary Policy system

The central bank has three important policy options to implement monetary policy. First, the central bank can set the interest rates charged by the central bank when money is lent to other banks and set the interest rate that is rewarded by storing money at the central bank overnight. Secondly, the central bank is able to purchase and sell government bonds with money that did not exist in the economy. Through these open market operations, the central bank is able to increase the amount of money in an economy. A less conventional way to increase the amount of money in an economy is to directly buy bonds from companies. (I.E. Quantitative Easing.) The third way for the central bank to control the money supply, is to impose requirements for other banks. An example is the money multiplier, as explained in the section above. However, not all central banks chose to impose reserve ratios and other requirements might be applicable as well.

**Open market operations**

Money created when bonds are purchased by central bank either ends up in money circulation or reserves, depending on whether the bonds were sold by person and money is held as cash, or bond was sold by a bank. Either way, the amount of high powered money increases with the value of the original purchase, as the amount of high powered money equals reserves + money in circulation. Open market operations might change either reserves or currency in circulation, but always changes the monetary base.

This is not unlike discount loans, although open market operations are aimed at the long term, while discount loans are usually paid back a day later, only increasing the monetary base temporarily.

**Interest rate corridor**

An interest rate corridor consist of an interest rate charge to banks when they lend money from the central bank and an interest rate that is remunerated by banks when they store money at the central bank. It is up to the banks whether they use the central bank, either to store or to lend money, or use other banks. However, it would be illogical for a shareholder conscious bank to store money at a bank that offers a lower rate than the central bank, or lend money from a bank that charges a higher rate than the central bank. A direct consequence is that it also becomes counter intuitive to charge or remunerate higher or
lower rates. This mechanism provides the central bank with a tool to set a floor and a ceiling to interbank offered rates. Typically, a narrow symmetric spread around the target rate is set up the central bank (Whitesell, 2006).

Reserve Requirements
Some central banks opt to set reserve requirements for banks. This ratio limits the amount of deposits that can be used to originate new loans, directly limiting the money supply and increasing the stability of the financial sector.

3.2.6. Conclusion
Consumers are interested in meeting their preferences. Consumers face the choice to self-provide these needs or exchange their time for those goods, using money as medium of exchange on the goods market. Consumers can either be employed or produce goods themselves, possibly with the use of labour and capital. The supply and demand for labour meet in the labour market. Producers require capital to initiate projects while consumers typically have an excess of money. However, consumers feel comfortable having direct access to at least a portion of this money, even though they do not always invoke possibility. The financial sector acts as an intermediary between actors with excess capital and those with a cash deficit. This all takes place on the financial market, a combination of the short term money market and the longer term capital market. The interacting behavior of the five actors can be summarized in three markets. The next section elucidates the behavior of the five actors in the goods market, the labour market and the financial market.

3.3. Behavior
Actors interact on the goods market, the financial market and the labour market with one another, based on their desired demand or supply on that market. The demand and supply of each actor is a product of trade-offs originating from desires and limitations as described in the previous sections. The quantity of demanded and supplied units, can be adjust by altering the price. The price paid in the financial market is return in the form of interest or dividend and the price in the labour market is typically a wage, although in the Netherlands almost any form of compensation is allowed. The trade-offs for actors, based on their limitations and desires often include the price of the product in the concerning market.

Other characteristics of the products in these market cause short term frictions. A non-exhaustive list of these characteristics includes the type of products that are sold, the type of education or training a job-seeker possesses or risk profile associated with a loan. The following section focuses the trade-offs actors and how this impacts the goods market, the financial market and the labour market. The behavior of great masses of people is aggregated, which comes with certain assumptions. Multiple views on aggregating behavior are presented in this section.

3.3.1. Goods market
The aggregate demand in a country is the sum of consumer consumption, capital investment and government expenditure and export minus import. As this work focusses on a closed economy, import and export are left out of the scope and will not be considered in this section. This section will first examine the total demand as function of consumption, investment and expenditure which will be followed by a section on total supply.
Consumption
Consumer consumption is a vital part of most economic theories, yet are often a cog in a larger proposed mechanism. Attempts to isolate consumer consumption from these theories yield somewhat confusing images which is why they’re presented within their context. This context often involves the income function.

Keynesian Consumer Consumption
Keynes thought of production as a function of disposable income. Households would, regardless of their income consume a minimum amount and, besides that, a marginal amount based on their disposable income. This marginal propensity would decrease with income, creating a diminishing increase of consumption with income. Keynes goes even as far as saying that it’s human nature to increase their consumption with their income, but not as much as their income has increase.

However, this is the case for a single household. Keynesian economists estimate that the consumption of the aggregate group of households is linearly increasing with income.

$$C = a + bY$$  \hspace{1cm} 3-5

Blinder asserts that the relation between consumer spending and income is one of the oldest in statistical regularities of macroeconomics (Blinder et. al., 1985). In the simplest Keynesian models, a closed economy with only firms and households, total national income is a function of consumption and investment.

$$Y = C + I$$  \hspace{1cm} 3-6

In order to get to an equilibrium, investment must equal savings and aggregate supply must equal aggregate demand.

$$AS = AD$$  \hspace{1cm} 3-7

$$C + S = C + I$$  \hspace{1cm} 3-8

Resulting in

$$Y = \frac{1}{1 - b}(a + I)$$  \hspace{1cm} 3-9

However Keynes calls the coincidence that the amount saved equals the amount demanded for investment unlikely.

Permanent Income Hypothesis
Friedman starts his theory with the assumption that consumers are aware of the prices, the interest rate and its income not only of this period, but also of all period to come. Expected future cash flows must be discounted to their current value and the amount consumed in one time period yield diminishing
increasing utility. In this case, it would be rational to consume the amount required to flatten the income of various periods and adjust their lending or borrowing to the current interest rate. By adding (and discounting), all future flows of income, Friedman states that consumption is not a function of current income, but a function of total income of all years to come. When income is unexpected high or low, it cannot be expected that consumption is immediately adjusted to this outlier. Annual income consists of a permanent component and of a transitionary component. The transitionary component are all unforeseen cost and revenues, while the permanent income component entails the expected, more stable income. When aggregating income, the transitionary components of individual actors do not cancel each other out, as large groups may be subject to the same unforeseen shifts in income.

\[ Y = Y_p + Y_T \]  \hspace{1cm} \text{3-10}

The same is true for consumption. Consumption among households, even when aggregated, consists of a permanent and a trajectory component.

\[ C = C_p + C_T \]  \hspace{1cm} \text{3-11}

Friedman does not specify the differences between transitionary and permanent consumption in further detail, as it is his believe this is a task left for statisticians. However, he mentions that the permanent component of consumption is a function of the interest rate against which a consumer can borrow or lend \((i)\), the ratio of current assets to future income and the personal preferences of the consumer \((w)\) and any other variable which may affect the utility attached to the services of money \((u)\) (Dwividi, 2005).

\[ C_p = k(i, w, u)Y_p \]  \hspace{1cm} \text{3-12}

A specification to this theory is that the correlation between transitionary and permanent components is zero, as is the correlation between the two transitionary components. The latter specification, that transitionary consumption is not correlated to the transitionary income, is the first point so far that makes this theory testable, as disparities between theory and reality could be nullified by shifting data between transitionary and permanent components due to lack of Friedman’s specification regarding these components (Modigliani, 1944).

The spending pattern as predicted by Keynes fits into the set of limitations and desires described earlier. Consumers have to spend a certain amount to fulfill their physiological needs and pursue higher order desires based on the amount of money that is left, although Keynes’ motives for spending included enjoyment, short sightedness, generosity, miscalculation, ostentation and extravagance, rather than fulfilling physiological needs (Keynes, 1937). The permanent income hypothesis also mentions utility, rather than needs when it comes to consumption but does acknowledge that the utility of the marginal amount decreases. The fact that the utility per spending decreases with the total amount spend, suggests that the most crucial needs are taken care of first.
**Investment**

In most macro-economic theories, goods are treated as homogenous units that can both be used for production and consumption. This can be somewhat justified by the level of aggregation of the work, but even surpassing the notion that goods destined for various actors cannot be akin, goods produced to add to the capital stock are not necessarily homogenous either. Garrison, professor of economics at Auburn University, mentions that goods produced to complement the capital stock (i.e. capital), are even more heterogeneous than other factors of production as labor or land (Garrison, 2017). He calls capital radically heterogeneous due to the absence of a proper unit or dimension that can be attached to this magnitude. Multiple voices arise on how to deal with this radical heterogeneity of capital.

Knight abstains from the idea that either the production time or characteristics other than size of the production system need to be taken into account. Production time is an irrelevant detail when it comes to aggregate production. Imagine the production of trees from land. One tree takes fifty years to produce, yet the constant output of timber, forever, negates the waiting time. Production and consumption can be seen as concomitant. He does however acknowledge that a temporary production time might be relevant when the system is expanding (Knight, 1935).

Following Knight, the capital stock of an economy stock could be modelled as a black box with its size as only characteristic. This size can be increased when the increase in capital stock is greater than its depreciation. The concomitant notion of production and consumption was discarded by Hayek as wordplay. Hayek stresses that capital is heterogeneous and multi-specific and that production time is actually a key variable here. The value of higher order goods is derived from the anticipated value of respective lower order goods and finally consumer goods. This is known as “Manger’s law”. Besides the size of the capital stock, Hayek, argues that the respective sizes of the different orders of good production should also be taken into account (Hayek, 1936).

Increased investment does not only affect the size of the production apparatus, but a decrease in interest rates, caused by increased investment, especially enables the first stages of production to grow. These first stages are typically research and development projects. Those stages are typically unattractive with high interest rates. Increased savings thus reallocates resources to the early stages of production and not just increase the size of the production apparatus as a whole.

**Government Expenditure**

The Dutch government, regardless of the governing parties, typically carries out a trend-based fiscal policy. The underlying principle of the trend-based fiscal policy is the separation of government revenue and government expenditure.

The independence between government revenue and government expenditure results in the fact that windfall revenues flows cannot be used to increase expenditure as is it not required to compensate revenue setbacks by austere measure. However, this works both ways, as budget excesses should be compensated by a reduction in expenditure, rather than a tax increase. The inclusion of this principle has prevented pro-cyclical tendency to increase expenditure with revenue, as increasing government revenue is typically a sign of a booming economy.

However, the above mentioned principle does not prescribe the height of the total expenditure and revenues, but rather how to treat them once they are established. It was customary in the Netherlands to base the state budget on a precautionary growth scenario. This precautionary growth scenario assumed
a lower growth than is actually expected. After the elections of 2006, the House of Representatives choose to abolish this principle and base the state budget on realistic growth scenario.

**Total Supply**

In order to inquire the total supply and therefore make an analysis of the behavior on the supply side of the goods market, the outcome of the behavior of many have to be considered. The total amount of goods supplied in an economy is not a coordinated, but rather a product from a myriad of producers, pursuing their own strategy which is partly based on the consequences of the strategy of other producers. As mentioned before, most producers are subject to the five competing forces as described in 3.2.2.

Porter recognized that producers can cope with the competitive forces by means of a clear vision. Producers must take a clear position on the ends of two axis. The first decisions concerns whether a producers focusses on low cost or distinguish itself with a unique product or service. The second axis pertains to the choice between seizing a large size of the market or to specialize in a niche. Failure to make a clear choice make decreases chances for producers to cope with the five forces (Porter, 1979). For individual producers, failure to cope with the competing forces or any other reason to end in bankruptcy, is often considered a worst-case scenario.

From an industry-wide perspective, it is part of an evolutionary process. Producers that fail to add enough value, not only with respect to their production cost, but also to with respect to competing producers are removed from the market, leaving only the most productive, innovative and adaptive producers. (Schumpeter, 1942).

The task of adding enough value does not only depend on competition, but also on demand. When demand is low, competition is fiercer than when demand is low, even with the same producers as competition. This means that the demand plays an important role in the amount of producers and the total volume produced. When the demand increases, there is more room for producers resulting in an increase in supply and vice versa. Every producer has to make an analysis tailored on his production plan to estimate whether or not there is enough room in the market for him and whether he can add enough value to overcome not only production cost, but also current incumbents of the market.

Adam Smith argued that producers, in pursuit of individualist goals, are led by an invisible hand that makes them achieve goals for society as a whole, that would not have been reached when these goals where the producers actual intention. Not only does balance demand and supply, but also is this achieved in a cost-effective manner. However, this is under perfect competition, as opposed to a monopoly where the market is constantly understocked hence the supply of good would be considerable less than under perfect competition (Smith, 1776). Schumpeter discards total competition as most favorable to maximum production and identifies a monopoly as the one more capable of innovation and therefore progress towards increased production. He points to the larger companies that booked the most progress as demonstration of his idea. Schumpeter recognizes that the economy never was and never will be stable but argues that this is not mainly because the economy is a social and natural complex system; rather does he point to new goods, new methods of production or any other innovations from producers as main driver (Schumpeter, 1942).

The total supply of goods depends on the demand, the market structure and the cost of capital. Producers are guided by an invisible hand to match demand, however, when there is a monopoly or an oligopoly, demand might exceed supply, driving up the price. Because producers must offset the cost of production
factors with their goods, the demand is also depends on the cost of capital. Even when producer are able to fund their operations with retained earnings, it does not make economic sense to start an operation when the cost of capital is higher than your expected return. Just as the price is a product of competing forces in the goods market, the cost of capital is determined in the financial market.

3.3.2. Financial Market
The financial market is the combination of the money market and the capital market, which can be distinguished by the maturity of loans. The money market typically pertains to loans with a maturity less than a year, while the capital market pertains to long term debt and equity. The money market is mainly used to cover liquidity issues and involves lower risk and therefore return than the capital market, which is used to fund long term projects. The money market only covers debt, while the capital market sees trades in debt and equity.

Irrespective of funding, operations are only worthwhile when they yield a return higher than the cost of capital. Even when a producers invests his own savings in a project that yields less than the cost of capital in the market, he would be better off lending it to somebody else. The amount of operations that are profitable, does not solely depend on the amount of good ideas, but also on the current cost of capital. The meaning of profitable, cannot be used in the same way for all actors and the fact that the motives of these actors differ, as seen in the previous sections, results in distinct behavior for each actor. In this section, the different roles of the five actors in the financial market are considered.

The role of the consumer in the financial market
For consumers, not all purchases yield a monetary return. Consumers still expect returns higher than the cost of capital, whether that return can be expressed in currency or in utility. However, the latter pertains consumption and require consumers to convert the cost of capital to the value of postponing this consumption. If a consumers takes a loan for consumption with the intention to pay the loan with interest at a later time, he might as well postpone this consumption to the point where he would be able to pay the loan back, unless he values the fact that he is able consume at an earlier point in time more than the amount of interest he must pay for it. This value is called the time value of money and has the same dimension as interest, yet the value is more a feeling than an exact number.

Consumers can also supply capital to the financial market, if their current cash position exceeds their money demand. Contrary to common misconception, consumer money demand has little to do with the amount of loans that the aggregated pool of consumers wants to attract but indicates the portion of wealth the average consumer wants to hold in cash, as opposed to other stores of values such as bonds and shares, which typically yields higher returns or other products that yield benefits other than liquidity. Indeed, an important reason to hold cash rather than other assets that yield economic or functional return, is liquidity.

However, there are multiple prevailing theories which differ fundamentally due to different views on money. This results in different motives for consumers to hold money which root divergent predictions regarding level and change of money demand. In the following sections, the behavior of a large group, the customers, regarding the demand for money, is considered from various perspectives.

Money demand according to the Baumol-Tobin transaction motive
The Baumol-Tobin model for money demand originates from the trade-off between foregone interest due to cash holdings and the number of trips one has to make to the bank in order to convert other assets to
liquid cash. Nowadays wealth owners do not have to make a trip to the bank, but the idea is still valid as there are still cost involved when converting assets to cash, e.g. a brokerage fee. These cost shall hereafter be referred to as “cost of a trip to the bank”. The foregone interest is now the difference between higher interest earning assets and the interest rate consumers receive for holding money in their bank account. This difference will hereafter be referred to as “foregone interest”. Given an income of \( Y \) per period, \( N \) “trips to the bank” or money to earning assets conversions, equally spread over this period, the average amount of earning assets that is owned during this period is given by equation 3-13. For example, when halfway the period the income is converted to earning assets. The amount of money held during the second half of the period equals 0, while this amount equals \( Y \) during the first half of the period. So for \( N = 1 \), the average amount of money held equals \( \frac{Y}{2} \). This amount decreases with the amount of money to asset conversions.

\[
M = \frac{Y}{2N} \tag{3-13}
\]

It is important to note that the foregone interest is lost over the amount of money that is held, rather than the earning assets. The foregone interest, decreases with \( N \), while the total cost of trips to the bank increases with \( N \). The total Cost, \( C \), is the amount of money that is held, multiplied by the foregone interest plus the amount of money to earning asset conversions times the cost involved in such a conversion.

\[
C = \frac{Y * i}{2N} + FN \tag{3-14}
\]

Where \( i \) is the interest rate that could have been realize had the money not been converted from interest yielding assets and \( F \), cost of a trip to the bank, times \( N \), amount of trips to the bank, equals the total cost of trips to the bank. This convex cost function can be minimized by

\[
\frac{dC}{dN} = \frac{Y * i}{N^2} - F = 0 \tag{3-15}
\]

Solving this for the number of trips to the bank tells us the optimal number of trips to the bank. And the ideal amount of money \( M^* \) as function of the foregone interest, trip cost and consumer wealth becomes

\[
M^*_{F,i,Y} = \sqrt{\frac{Y * F}{2 * i}} \tag{3-16}
\]

Money Market according to Keynesian economics

Keynes identified three reasons to hold money and thus drivers for money demand. The threefold classification constitute the transaction motive, the precautionary motive and the speculative motive (Whalen, 1966).

The transaction motive contributes to the demand for money as cash is required to make transaction of all kinds. The precautionary motive states that beyond keeping money for everyday transactions, money is held for unforeseen –sudden required- expenses.

As mentioned before, the money demand, often referred to as liquidity preference by Keynes, tells us something about the amount of assets that are desired to be held in form of money with respect to the total assets. When income increases, money demand also increases. Higher prices make that more money
is required to maintain the same level of liquidity, which renders price level also as driver for money demand beside interest rate and total assets. Money demand due to the transaction motive and the precautionary motive depend mainly on income and prices and is not very sensitive to changes in the interest rate.

The speculative motive hinges on the idea that a surplus of money, taken the other motives into account, is held because the rate of interest, otherwise received on bonds, is uncertain. This is an important distinction with other theories, as money is here also acknowledged as asset.

The amount of money in circulation is not subject to the same driving forces as the amount of goods in circulation. When the demand for goods increases, it becomes lucrative for producers to increase the amount of goods. While central banks can opt to increase the amount of money, their motives will differ from producers trying to earn money on increased demand. So while the amount of money is not fixed, increased money demand will not cause a greater supply. However, the return offered by bonds helps balance this market. Keynes imagines two groups of wealth owners. Wealth owners are either bulls or bears regarding to bonds. Bulls expect bonds to pay-off more than holding cash, while bears prefer to hold cash rather than bonds due to anticipated lower returns on bonds. While it is expected that consumers either hold only cash (for speculative reasons) or only bonds, the aggregate amount of money demand due to speculative reasons is a function of the amount of bears and bulls.

When the money supply is expanded, the bulls will increase the total demand for bonds, lowering the return on bonds and this lower return on bonds will shift the ratio of bulls-to-bears downward as some bulls will become bears due to the lower return, which will create a new equilibrium.

When money demand due to the speculative motive is low (i.e. everybody is bullish on the bond market), and the money supply would be increased, the interest rate should drop immediately to raise employment and wages because the money held for transaction and precautionary purposes must increase, which mainly increases with income (wages and employment). The other extreme is a situation where, due to a low interest rate, all wealth owners are bears. When more money enters the economy, it will eventually be trapped in the portfolios of consumers and interest rates will not move further down (Keynes, 1937).

Although it would be an oversimplification to say that the total money demand is the sum of the money held for each motive, as money held for one motive also serves other motives, key takeaway from this analysis is the fact that the money demand decreases with interest and increases with income.

\[ M^d = L_{p, y, r} \]

Money demand depends on liquidity preference which is a function of income and interest rates.

**Money demand according to the restated quantity theory**

The money demand according to monetarism is articulated in the reformulated quantity theory of money by Milton Friedman, where money is treated as an asset, more specifically, as a commodity. Contrary to the original theory of money, this is a theory of demand for money, not one of output, money income or price level.
Not unlike other economists, Friedman aims to estimate the portion of wealth that is held in the form of cash to predict money demand. However, Friedman does not only take non-human wealth into consideration as do other economists, but adds to this, what he calls, human wealth. Human wealth constitutes all future income from labour. The fact that this income is not yet earned (because the labour is not yet executed), is handled by discounting from the future point when the labour and thus the income is anticipated. However, when it comes to money demand, the ratio of human wealth (future income) and total wealth (future income and current assets), is crucial in money demand, as only current income can be used to increase non-human wealth and the amount of non-human wealth that can be converted to human wealth (education and training) is restricted. An important difference with other theories is that money demand depends on total future income, rather than current income.

Friedman also acknowledges that opportunity cost (foregone interest) must be weighed against convenience of money (liquidity). Besides this familiar trade-off, the stability of the economy also factors in the demand for money according to this analysis; uncertain times call for certain measures c.q. money.

\[
\frac{M}{P} = f(y, w, r_m, r_b, r_e, \Delta P, u)
\]

Where \( M \) is the demand for nominal money and \( M/P \) the demand for real money, which is a function of real income, fraction of human-wealth to total wealth, expected rate of return on bonds, equities and money, the expected rate of change of prices and any other variable that attaches value to money. The latter may seem trivial, but is often seen in formula's expressing Friedman’s idea of money demand, stressing that he sees and treats money as any other good. The \( P \) on the right hand side of the equation can be seen as a conversion factor to other goods. Note that Friedman considers than one alternative investment opportunity, while Keynes only mentions the return on bonds. Demand functions for producers are similar, except that they only consider their own rate of return rather than market returns on equities and bonds. Furthermore is a distinction between non-human and human wealth not applicable as a producer has the ability to convert current assets to human wealth and vice versa.

Regardless of monetary policy, money demand will stay stable as GDP moves with money supply. An increase in money supply by the central bank, causes people who sell securities to have more money relative to their total human wealth. Excesses will be spend both on assets and goods which, in turn, increases GDP. A contractionary monetary policy will do the opposite. Money relative to human wealth decreases, assets are sold and consumption is limited, suppressing GDP.

While Keynes states that monetary policy only affects the economy through interest rates, Friedman excludes this step, claiming that all monetary policy causes changes in prices, leaving money demand unaltered as consumers spend excesses with respect to their total human wealth. The amount of money consumers own minus the amount consumers would like to own based on their money demand, is the amount available to the money market.

Money demand by producers is fairly similar to money demand by consumers. Because not unlike consumers, firms also have a pattern of receiving and spending cash, while also suffer from the opportunity cost if they hold money rather than other assets. However, payments by producers are typically more irregular and less predictable with respect to consumer expenditure patterns. Spending patterns for producers typically involve the funding of factors of production.
However, contrary to consumers, these other assets are typically capital that can be employed to produce output rather than other financial products such as government bonds. This does not mean producers will not hold these assets, as certain financial products allow them to hedge their exposure to risks outside the scope of their core competences. However, when it comes to earning assets, it makes more sense for a producer to invest in its own production than in the financial market.

**The role of the bank in the financial market**

Deposit taking institutions use deposits to fund long term investments such as mortgages and business loans. When deposits can be withdrawn at all times, which is the case in most current accounts, they resemble overnight loans which are renewed when clients forgo to withdraw their funds. Even though the bulk of deposits are not withdrawn on daily basis, it still boils down to the fact that long term investments are funded with short term liabilities. This results in a maturity mismatch which is not a problem as long as debts can be renewed. However, if for some reason, such as a change in sentiment, a large share of the depositors withdraw their money, a bank faces liquidity constraints. Funding of mortgages with overnight deposits is not the only example of a maturity mismatch within a bank. All long term funding with short term liabilities results in maturity mismatches. Only a fraction of the amount of cash received from consumers is held while the remaining amount is re-allocated. This is called fractional reserve banking and causes maturity mismatches on a grand scale. Depositors do not withdraw their total deposits on a regular basis, which allows a bank to grant loans several times the worth of the original deposit. This has two important consequences. The money supply in the economy increases and the stability of the bank decreases (Ulrich, 2011). The money multiplier effect of a fractional reserve banking system can be isolated from an economy by means of a model such as depicted in figure 3-6. This model simulates a fractional reserve banking system with two banks and a one-time money injection of 1000 units at the start of the simulation. The banks are represented by their balance sheets with their assets on the left, and their debts on the right. Both banks are subject to the same regulations that prescribe that 20% of all deposits must be present and both banks opt to not hold any additional reserves. Assuming sufficient demand for money, the remaining 80% of all deposits are re-lent, consumed and deposited in the other bank every day.

![Figure 3-6) Money Multiplier in a cashless economy](Image)
While the money injection was a singular event, deposits keep flowing in for an extended period of time and the total cash in the economy grows to $\frac{\text{Initial injection}}{\text{Reserve Ratio}}$. This behavior would not occur in a full-reserve banking system, where all deposit taking institutions pledged to keep 100% of the deposits in their vaults.

![Figure 3-7) Development of Total deposits, Total Cash in the Economy and the Money Multiplier in a Cashless Economy](image)

Besides the reserve ratios kept by banks (be it by regulations or own policy), the amount of cash that circulates in an economy is also a factor that determines the money multiplier. Banks pay interests to customers, which acts as incentive to store money at the bank. When interest is high, an increased amount of money is deposited.

Again, this can be demonstrated with a model that isolates this mechanism from the broader picture. A bank balance is simulated, as depicted in figure 3-8, where the bank keeps a reserve of 20% of all deposits, the remaining deposits are re-lend to consumers, who share an aggregated balance sheet. For every ten units the consumers have on the bank, they hold one unit in cash. A single money injection of 1000 units at the start of the simulation and new loans from the bank are the two sources of new cash for consumers. In order for consumers to hold a fixed percentage of their assets in cash, the amount consumers deposit equals $\frac{\text{Cash} + (\text{Current Account} \times \text{Currency Ratio})}{1 + \text{Currency Ratio}}$. The currency ratio is 10%. 


The money supply in an economy is the sum of all currency and all deposits.

\[
\text{Money Supply (} M^s \text{)} = \text{Currency (} C \text{)} + \text{Deposits (} D \text{)}
\]  

3-19

In this economy, the total amount of money circulating increases even after the initial (and only) money injection of 1000 units.

The monetary base is the sum of all currency and all reserves.

\[
\text{Monetary Base (} M^b \text{)} = \text{Currency (} C \text{)} + \text{Reserves (} R \text{)}
\]  

3-20

The money multiplier is the money supply is divided by the money monetary base.
While it takes some time to stabilize, figure 3-9 shows that the amount of money circulating in an economy is based on the amount of cash consumers hold with respect to the amount of money they hold in the bank and on the amount of reserves banks keep on these deposits.

The ratio of currency over deposits is defined as

$$\text{Currency Ratio (C_r)} = \frac{C}{D}$$  \hspace{1cm} 3-22

The reserve ratio \((R_r)\) is a combination of discretionary choices of the bank and obligatory regulatory requirements.

$$\text{Reserve ratio (R_r)} = \text{Required Ratio} + \text{Excess reserves}$$  \hspace{1cm} 3-23

And as only a fraction of the deposits is actually in the bank, the reserve ratio is defined as the currency ratio

$$\text{Reserve Ratio (R_r)} = \frac{R}{D}$$  \hspace{1cm} 3-24

Combining equations 3-21 to 3-24, it can be found that the money multiplier equals

$$m = \frac{C_r + 1}{C_r + R_r}$$  \hspace{1cm} 3-25

Given that the reserve ratio equals 0.2 and the currency ratio is 0.1, the expected money multiplier is \(\frac{3}{3}\). This is equal to observed money multiplier once the system stabilizes.

![MoneyMultiplier](image)

*Figure 3-10) Observed money multiplier in a cash economy*

This is assuming that banks only keep the required reserve ratio and that there is enough demand for money to re-lend the amount that is not required to be reserved. In an economy where confidence is low, this assumption may not always be valid and other factors might also have their impact on the amount of money that banks can create. In this case the legal minimum reserved fraction in the formula must be
replaced by the actual fraction that banks keep due to a lack of demand of money. This work shows that an expansion of the money supply is possible due to the fractional reserve banking system.

The government in the financial market
The government supplies debt in the financial market to fund government deficits. Governments are on average less likely to default than corporations. The Dutch Government has always had a solid credit rating, which makes that they can borrow money for a lower price. However, the government also invests in companies. Total public investments were 3.3% of the total Dutch GDP in 2014 (OECD, 2017), this number remained stable, between 3% and 4%, until 2017 (Statista, 2018). Public investments include, but are not limited to companies where it is deemed essential that the public voice is incorporated in the decision making process. The government typically has a permanent majority stake in these companies. An exception are the financial institutions that require governmental support. In this case, an investment is made because the default of a large financial institution is deemed undesirable for the society. The government stake is held until market conditions return to normal and the bank is healthy once again.

Central bank in the financial market
The amount of money in circulation is not subject to the same driving forces as the amount of goods in circulation. When the demand for goods increases, it becomes lucrative for producers to increase the amount of goods. While central banks can opt to increase the amount of money through open market operations or quantitative easing, their motives will differ from producers that capitalize on increased demand. So while the amount of money is not fixed, increased money demand will not necessarily cause a greater supply.

3.3.3. Labour Market
Consumers have to balance between consumptions, leisure and income. While these choices can occur concomitant, one choice has a limiting effect on the others, which typically results in the same behavior for the larger part of the population. Hours worked per workers through history are typically a bit short of 1500 per year, which is relative low of industrialized nations. This can be explained by the relative high number of mothers that continue to work after their first child, yet choose for a part-time hours (OECD, 2018).

3.4. Outcome
Inflation, real GDP and employment rates are the performance indicators used to measure the impact of the different economic policies on the economy. This chapter starts with an elaboration on these indicators which are expected to be impacted indirectly by macro prudential regulation and monetary policy. As the regulation does not impact the performance indicators directly, a better understanding of the position of these indicators in the economy is required. In economics, multiple theories regarding relations between economic variables co-exist. This signals that there exists some uncertainty in the relation between economic policy and these macro-economic indicators. It is not the goal of this work to identify the right economic theory.

3.4.1. GDP development
Consumers offer their labour to producers who employ them, in combination with their capital, to produce output. The total output, in turn is consumed by consumers for consumption, by producers for investment and by the government in the shape of government spending. Contrary to consumption and investment, government spending is a political decision and is meant to stimulate the economy.
The total production of a country, corrected for inflation, is referred to as real gross domestic product (real GDP). The GDP is a product of the use of capital and the employment of active labour force in a country. In order to estimate the total aggregate production, a function based on the total labour and capital is often employed. The use of this function is disputed, especially by Austrian economists, mainly with the argument that not all capital and labour can be aggregated. However, as the exact production structure is hard to determine, a production function can give an indication of the level of GDP that can be produced by a country. The constant elasticity of substitution production can be used to give such an indication and is presented in equation 3-26.

\[ Y = (\phi K^\rho + (1 - \phi)L^\rho)^{\frac{1}{\rho}} \]

In this function, K is the amount of capital output, L is the amount of labour output, \( \phi \) presents the weight attributed to capital output and (1 - \( \phi \)) is the weight attributed to labour output, \( \frac{1}{\rho} \) is the elasticity of substitution between labour and capital, and Y is the total of goods and services. This production function allows that a lack of one production factor can be replaced by the other. An example where this difference manifest is the impact technological progress has on the production in a country. When a country automates processes, technology can replace jobs which alters the ratio of capital to labour. Depending on the nature of an economy and the run-time of a simulation, it does not always make sense to replace capital with labour in a model. If this is the case, a Leontief production function is more appropriate. The production function is given in equation 3-27. In this functions growth of the labour productivity (A) and the growth of Labour force (L) are assumed to behave according to function 3-28 and 3-28 respectively.

\[ Y = \text{Min}(K^\alpha, AL^\beta) \]

\[ L(t) = L(0)^{n^t} \]

\[ A(t) = A(0)^{n^t} \]

Due to inefficiencies, an economy often produces less than the full potential GDP. The difference between potential GDP and total GDP is based on the unemployment. Okun’s law states that for every percent of unemployment, this gap increases with one percent. The assumption that demand always meets supply was made by Jean-Baptiste Say. In the same work Say also mentions that the amount of goods one can purchase is equal to the amount of goods he produces and implies that a “general glut” cannot occur in any economy.

Together these assumptions are known as Say’s law. Say’s law is disputed as some economists claim that production can be stored in an economy, meaning demand does not necessary equals supply. This rebuttal to Say’s law is often heard from Keynesian economists.

3.4.2. Inflation

The sustained change in general price level for goods and services is known as inflation and is often measured in annual percentage change. The price level can be seen as a conversion rate between the
goods market to the money market. As general price levels increase, the value of a currency decreases with respect to goods and services. Both changes in money supply and money demand as changes in demand and supply for goods and services are mentioned as driver for inflation.

When one would only focus on the goods and services market, three mechanisms prevail regarding the cause of inflation. Cost-push inflation assumes that the value of a currency decrease as the cost of important, non-substitutable goods and services increases. According to this theory, such an increase in cost is possible due to a significant decrease in aggregate supply. When inflation occurs due to demand exceeding supply, it is often referred to as “Demand-Pull Inflation”. This is often seen in rapidly expanding economies, but can also be the result of increased exports, excessive spending of the government or expansionary policy by the central bank. The final reason for inflation is based on expectations due to past inflation rates. When inflation is expected to continue, a higher wage claim follows, which in turn leads to increased production cost. This self-fulfilling prophecy is called built-in inflation. These mechanisms are depicted in figure 5-2.

![Inflation mechanism](image)

Regarding the adjustment rate of prices, two theories prevail. In Keynesian economics, friction is assumed in markets which translates to products prices that do not adjust quickly to shifts in demand or supply. Prices are inflexible, while quantities are not. This becomes especially apparent during shocks, which impact employment and output. It is believed that during society-wide suffering of economic depression, a nation-wide desire to avoid risk prevents recovery, which is why stimulating behavior is desired. This stimulation can be either fiscal or monetary policy.

In classical economics friction in markets is almost non-existent which results in prices that quickly adapt, rather than quantities being adjusted. Therefore, shocks do not have profound impacts on the economy, which is why governmental guidance to support the economy is not deemed useful by this school. The markets clears itself. When activity is limited due to a depression, rational actors will take advantage and start producing as production cost are low.
Contrary to inflation changes due to shifts in aggregated demand and supply, inflation can also be intentionally driven or corrected by single actor. The European Central Bank (ECB) has the ability to target inflation levels. The ECB aims to stabilize prices in the Eurozone. As long-run growth can be accomplished by a clear and predictable policy, an inflation rate of 2% is deemed as ideal. Higher inflation is associated with more volatile levels of inflation. Different rates of adaptabilities to new prices levels between sectors can cause relative differences in price levels for the price and goods in those sectors. A low inflation causes the need to cut wages and as firms find it hard to do so, this results in a reduced demand for labour. An even more extreme situation is when inflation falls to the point that there is a risk at deflation, which is also undesirable. The positive correlation between inflation and interest combined with struggles associated with interest rates going below zero also factors in reluctance towards lower rates of inflation.

3.4.3. Unemployment

The unemployment refers to the amount of workers who want to work, but are unable to find a job. Three main groups can be identified as causes for unemployment. These are frictional unemployment, structural unemployment and cyclical unemployment. Workers that change jobs, re-enter the market or just recently entered the job market experience this kind of unemployment when they are not able to immediately find another job. This kind of unemployment is mostly temporary, almost always present in an economy and the number one reason for youth unemployment. Structural unemployment is involuntary and not as temporary as frictional unemployment. Advances in technology or outsourcing to cheaper countries make existing jobs abundant and are an important cause for structural unemployment. Changes in aggregate supply and demand cause cyclical unemployment. As demand falls jobs also become abundant. These jobs tend to return when aggregate demand increases. However, aggregated demand also depends on unemployment rates, as workers with a job have more income to spend. This negative feedback structure causes cycles in the economy and increased due to higher wage claims when demand for labor exceeds supply due to low unemployment.

The negotiation position of workers increases as unemployment levels falls which imply an inverse relation between unemployment and wages. When employment is high, workers can afford to neglect their job more before they are dismissed. Even if the worker would lose its jobs, they would be able to find a new one given the current state of the labor market. To keep workers from neglecting their job, more wage can be offered either to reward workers or increase the cost of workers when they would lose their jobs. Wages do not change instantaneously with unemployment as workers and employers do not react to the latent number of unemployment but rather to the amount of new positions in relation to the amount of potential candidates. Moreover, employers and employees do not automatically accept changes in wages only because the employment ratio changes. Again, are not reactive to the latent variable but to the variable they experience in their everyday live, which is why employees do not change their wages abruptly when changes in employment levels occur.

Classical economist consider full employment the standard situation. Any deviation from this situation are supposed to be temporary. While according to the classical view, everybody who wants to work for the current wage rate is can find a job, Keynesian economics states that involuntary employment can exist when demand for products is exceeded by supply. A note that somewhat bridges these views is that the classical definition of “willing to work”, depends on the amount of money they are offered to do their job. According to classical economists, people who do not get offered enough make their time worth the compensation, are not considered to be part of the workforce and therefore not unemployed.
4. Economic models

The creation of a model starts with the identification of the appropriate characteristics of the economic process, relevant to the problem, which are then taken as fundamentals (Kaldor, 1961). Kaldor coined the term “stylized facts” for these fundamentals, not only to stress that economists should focus on trends rather than small details, but also to warn theorists for the facts recorded by statisticians, as these facts are “always subject to numerous snags and qualifications and for that reason are incapable of being accurately summarized”. This idea was supported by the British statistician George Box, who wrote: “Simple evocative models are the signature of the great scientist so overelaboration and over parameterization is often the mark of mediocrity.” (Box, 1976) However, Box seldom let an opportunity pass to emphasize that “all models are wrong”, sometimes accompanied with the phrase “but some [models] are useful”.

Kwasnicki and Brenner identify three fundamental elements in an economic model: the set of abstract entities, the relations between them and homeomorphism allowing proper interpretation of abstract entities in terms of real phenomena (Kwasnicki and Brenner, 2012).

The choices of stylized facts and the embodiment of the fundamental elements as identified by Kwasnicki and Brenner eventually define the outcome of the model. This chapter aims to identify the stylized facts and the fundamental elements of several models that aim to capture the same causal mechanisms identified in chapter three.

4.1. Harrod Domar

The Harrod Domar model is a growth model that does not include technical advancement. The labour force and the capital stock constitute the main entities in the model. The extent to which the entities in the actual economy have their counterpart in the model is limited in detail, but could be interpreted by a high level of aggregation. A stock flow representation of the model is given in figure 4-1. Stylized facts of the Harrod Domar model include: figure 4-1

- Total production equals total demand and is either consumed or converted to capital stock
- Total savings are directly converted to investments
- One good produced in the economy, suitable for both consumption as investment
- Capital is always the limiting production factor
- No shortage on natural resources
Multiple relations between entities and state variables govern the behavior of the model. The total production is proportional to the amount of capital stock and given in equation 4-1:

\[ Y = \frac{K}{v} \]  

In which \( v \) is the capital-to-output ratio. The model is indifferent towards the destination of produced goods, as goods can be used to increase the capital stock and be used for consumption. The change in capital stock is given by equation 4-2

\[ \Delta K = s \times Y - \delta \times K \]  

In which \( s \) is the save rate and \( \delta \) is the deterioration rate. \( Y \) represents here both income and goods produced. Only when all produced goods that are not consumed, are employed to complement the total capital stock, an equilibrium can exist.

Even though the labour does not factor in the total production, the amount labour force is incorporated in the model and typically given by equation 4-3
\[ L = L_0 e^{nt} \]  

4-3

In which \( L_0 \) is the labour force at the beginning of the simulation and \( n \) the growth factor for the labour force. The results in a model with one sustainable growth rate, depending on the save rate and the capital-to-output ratio and given in equation 4-4.

\[ g = \frac{s}{v} = n \]  

4-4

Whether or not an equilibrium exists, depends on whether the natural rate of growth, which is a function of the labour force, is equal to the warranted rate of growth, which depends on the savings and investments of households and firms (Solow, 1956). When the sustainable equation 4-4 is not met, the consumption per person either collapses or explodes. This so-called knife-edge problem is a direct result of the fixed parameters in the model. As observed economies do not show this behavior, some additional parameters are desired to better reflect the causal mechanisms in an economy.

![Graph: Consumption per Capita](image)

Figure 4-2) Output of the Harrod Domar model with 1) \( \frac{s}{v} > n \), 2) \( \frac{s}{v} = n \) and 3) \( \frac{s}{v} < n \)

4.2. Solow-Swan

The Solow-Swan models bears a resemblance to the Harrod Domar model, yet differs from it by admitting that labour also factors into the total production. Total output is no longer proportional to the capital stock in the model. For this model, a neoclassical production function is used. Neoclassical production functions are functions that have constant returns to scale, have diminishing increasing returns to private input and satisfy the Inada conditions. Constant returns to scale refers to the fact that when the amount of capital and the amount of labour is multiplied by the same factor \( \lambda \), the result is that the total output is also increased by a factor \( \lambda \), as denoted in equation 4-5. The Inada conditions are described in equation 4-6 to 4-9.
\[ F(\lambda K, \lambda L) = \lambda F(K, L) \]

Increasing diminishing returns of a single production factor specifies that adding more of either labor or capital has always a positive effect on output albeit that the marginal output decreases with the production factor. This is shown for labor in equation 4-6 and capital in equation 4-7.

\[
\left( \frac{\delta F}{\delta L} \right) > 0 \text{ and } \left( \frac{\delta^2 F}{\delta L^2} \right) < 0 \tag{4-6}
\]

\[
\left( \frac{\delta F}{\delta K} \right) > 0 \text{ and } \left( \frac{\delta^2 F}{\delta K^2} \right) < 0 \tag{4-7}
\]

The Inada conditions indicate that when one of the production factors is totally absent, the small increase yields an infinite increase in production. However, when one of the production factors approximates infinity, marginal utility of adding more of that production factors approximates zero, as denoted in equation 4-8 and 4-9 respectively for both labor and capital (Inada, 1963).

\[
\lim_{K \to 0} \left( \frac{\delta F}{\delta K} \right) = \lim_{L \to 0} \left( \frac{\delta F}{\delta L} \right) = \infty \tag{4-8}
\]

\[
\lim_{K \to \infty} \left( \frac{\delta F}{\delta K} \right) = \lim_{L \to \infty} \left( \frac{\delta F}{\delta L} \right) = 0 \tag{4-9}
\]

The labour production is added to the income function and the Solow Swan model is depicted in Figure 4-3.

The stylized facts of the Solow Swan model are largely similar to those of the Harrod Domar model

- Total production equals total demand and is either consumed or converted to capital stock
- Total savings are direct converted to investments
- One good produced in the economy, suitable for both consumption as investment
- Capital and Labour are the only limiting production factors
- No shortage on natural resources
Contrary to the Harrod Domar model, multiple equilibria are possible. Capital stock continues to increase until the point where the total depreciation equals total investment, as shown in figure 4-4. This is the point where an equilibrium is reached and the model stabilizes.

Starting with a capital stock below the equilibrium capital stock results in investments that are higher than depreciations until the model reaches an equilibrium. This same equilibrium is also reached when capital stock is initially higher than in the equilibrium situation.
4.3. IS-LM

The IS-LM model combines the goods market with the money market. The investment-savings is in equilibrium when the amount of savings equals the amount of investments, depending on a given income and given an interest rate, as is exemplified in figure 4-6. The total spending is a function of consumption, investment, government expenditure and net import. Consumption typically rises with income, assuming a constant marginal propensity to consume, creating an upward sloping aggregate demand with income. The level of investments decreases with the interest rate, for this example the relation is depicted in figure 4-5. Investors and producers typically will only invest when the return on investment is larger than the cost of capital. When the cost of capital increases, less projects satisfy this condition and investments drop.

The 45° curve indicates all equilibrium points; points where income equals aggregate demand, depending on interest and income.
The liquidity preference and money supply part of the IS-LM model finds an equilibrium between the money supply and the money demand. Money is held for convenience, because it can easily and instantaneously be used for consumption. It comes, however, at an opportunity cost, as it could earn a higher yield if it were invested in less liquid assets. Typically, the demand for money decreases with the interest rate, as higher interest rates result in higher opportunity cost of holding money as depicted in figure 4-7. The money demand curve also responds to income, not depicted in figure 4-2, much like figure 4-6 does not show the sensitivity of investment to changes in interest rates.

The money supply is a product of monetary policy and money creating behavior of financial institutions, which in turn depends on confidence and regulation, which is also part of monetary policy. The intersection between the money demand curve and the money supply curve represents an equilibrium of the money market, depending on interest and income.
All the equilibria of both the investment and savings curve and liquidity preference and money supply are based on interest and income. When the curves are plotted in the same field, the equilibrium between the two lines of equilibria shows where the goods market is in equilibrium with the money market.

![IS-LM model](image)

*Figure 4-8) IS-LM model*

The interest and income sensitivity that determine both the equilibria lines IS and LM are denoted in equation 4-10 and 4-11.

\[
IS = - \frac{\delta I}{\delta Y} - \frac{\delta S}{\delta Y} - \frac{\delta I}{\delta i} - \frac{\delta S}{\delta i}
\]  
4-10

Where \(\frac{\delta I}{\delta Y}\) is the sensitivity of investments to income, \(\frac{\delta S}{\delta Y}\) the sensitivity of savings to income, \(\frac{\delta I}{\delta i}\) the sensitivity of investments to the interest rate and \(\frac{\delta S}{\delta i}\) the sensitivity of savings to the interest rate.

\[
LM = - \frac{\delta M^D}{\delta Y} - \frac{\delta M^S}{\delta Y} - \frac{\delta M^D}{\delta i} - \frac{\delta M^S}{\delta i}
\]  
4-11

In which \(\frac{\delta M^D}{\delta Y}\) is the sensitivity of money demand to income, \(\frac{\delta M^S}{\delta Y}\) the sensitivity of money supply to income, \(\frac{\delta I}{\delta i}\) the sensitivity of money demand to the interest rate and \(\frac{\delta S}{\delta i}\) the sensitivity of money supply to the interest rate.
Stylized facts in the IS-LM model include:

- Movements in output are driven by movements in aggregate demand
- Level of output and the interest rates are the only endogenous variables
- All produced goods are wanted, all the wanted goods are produced

A stock flow representation of the model is given in figure 4-9. Both the Income sensitivity and the interest sensitivity of the money supply are zero, as the money supply is an exogenous variable in this model.

The model does not present physical entities, but captures their actions. Entities in the model are not specifically addressed as they are largely defined by their behavior, which is why the relations between their actions govern the model. The homeomorphism between the model and the real system can be found in the aggregated behavior that emerges when large groups of actors react to the same conditions, changing these conditions, which results in other groups reacting to new conditions. This cycle repeats until an equilibrium is reached. However, the equilibrium might in reality never be reached, as sensitivities to income and interest might not be constant through time and the same can also not be expected from the money supply, which is subject to monetary policy and confidence.

The fact that the model reaches an equilibrium after fluctuating around the equilibria can be explained by having another look at the model. Imagine an equilibrium in the goods market, while the interest rate is
too high for the amount of income to reach an equilibrium in the money market. Money demand is smaller than money supply and interest rates fall to the point where money supply meets money demand. This is represented in step one of figure 4-10. Now, the goods market is no longer in equilibrium, as investments create a demand for goods larger than the supply, increasing the income, while the interest rates remain the same, as is shown in step 2. This is followed by an increase in money demand, as money demand increases with income, with an increase in interest as result. This is depicted in step 3. The subsequent decrease in income due to a decrease in investments that comes with the higher interest rates, brings the model back to a state where the goods market is in equilibrium, but with a money supply exceeding demand due to a high interest rate. However, both interest rate and income are closer to their equilibrium values.

![Image](https://via.placeholder.com/150)

*Figure 4-10) Reaching an equilibrium in the IS-LM model*

This process assumes that one market is cleared while the other market is idle. In reality both markets function simultaneously, which raises the question whether the pace of market clearance has an effect on the process. If the money market were to clear instantaneous, while the goods market needs significantly more time to reach an equilibrium, the actual system would shift from an equilibrium in the goods market to an equilibrium in the money market, as depicted in step 1 of Figure 4-10, followed by a movement along the LM curve to the equilibrium.

The fact that the IS generally slopes downward is due to the fact that the terms \(\frac{\delta I}{\delta Y} = \frac{\delta S}{\delta Y}\) and \(\frac{\delta I}{\delta i} = \frac{\delta S}{\delta i}\) usually have the same sign. This is, however, not a given as Hicks (1937) and Modigliani (1944) have shown. Chang and Smyth experimented with the idea of multiple equilibria, stable and unstable, from a more mathematical perspective, but did take much effort to connect this to a real economy, explaining how the curves came to be in the first place (Chang and Smyth, 1972). The shape of both curves and the pace of market clearance impact the economy.

**4.4. Conclusion**

Box called the simple, evocative models the signature of the good scientist. However, comparing the relatively simple Harrod Domar model to its more elaborate counterparts, learns that at some level of granularity, there is room to improve a model by implementing more considerations and less stylized facts. The Solow Swan model offered more insight on growth limitations in an economy, but still excluded
a financial sector. This is crucial for performing monetary policy analysis, as was also recognized by Minsky, who said that the negligence of the financial needs of investing firms in investment theory amounts to nonsense (Minsky, 1986) and Keynes, who mentioned that the investment market can be congested through a shortage of cash (Keynes, 1937).

Both models assumed that investments equal savings, while in reality, it is possible to have greater investments than savings if necessary due to the fractional reserve banking system. The inclusion of the money market in the ISLM model is a step in the direction of monetary policy analysis by means of a model. However, the ISLM is mainly built to test effects of injecting money into the economy, leaving the question what the place is of other monetary policy tools in adequate monetary policy. It is worthwhile to pay attention to the pace of market clearance. This has effects on the outcome of a model and should be consistent with other parts of the model. The following chapter introduces a model with a financial sector, which is deemed necessary to bridge the gap between the physical economy, as portrayed by the Harrod-Domar model and the Solow-Swan model, and the goods market. Contrary to the IS-LM model, it will also include actors, to simulate the behavior described in chapter three.
5. Five sector model and its limitations

Based on theory summarized in chapter three and the application of chapter four, chapter five will be concerned with the creation of a model that can simulate a link between monetary policy and macro prudential regulation on one side, and price development, GDP development and employment on the other side. The initial conditions and actions of the five (groups of) actors that are described in 3.1 are ultimately responsible for the behavior in the system. However, it is due to the interaction between these actors on the financial market, the goods market and the labour market that the behavior of the key performance indicators emerges. This chapter guides the reader through the model first by explaining the behavior of the actors in the model and then by the emergence of these key performance indicators due to activity on the markets.

5.1. The behavior of the five actors in the model

The implementation of the five actors mentioned in 3.1, in the model, is addressed in this section. Actors are represented by their aggregated balance sheets. Stocks in the model are posts on the balance sheet and can represent either money, or something of monetary value, such as machinery, purchased debt or proof of equity investment. Generally, when money leaves one stock, it must enter another stock, and when money enters a stock, it must leave another stock. An exception to this rule is the money creation by the banks or the central bank. Banks can lend money they do not own as long as they comply with the regulations that apply in the simulation, money creation due to the fractional reserve banking system was already exemplified in section 3.3.2. The central bank can also create money, by buying debt, but limits itself in the amount of money that it creates every year. The rule that balance sheet must always balance, is an accounting identity implemented in the model and applies to the balance sheets of all actors. Inflows on one side of the balance sheet, must either be compensated by an outflow on the same side, or by a similar inflow on the other side of the balance sheet.

5.1.1. Consumers

As mentioned in 3.1.1, the group of consumers consists of a large, diffuse group from whose impact is impact is only felt by a great number of subjects in the group as the individual impact of a subject is negligible from a macroeconomic perspective. Although this also applies to the Dutch economy, the group of actors will be homogenous represented in the model, which means that every consumers earns the same wage and makes the same decisions. A representation of the consumers in the model is given in figure 5-1. As mentioned in 3.2.1, consumers need to fulfill some basic biological needs. Once these needs are fulfilled, consumptions increases with income, but the relative fraction of income that is consumed diminishes with income. This is also in line with the behavior described in 3.3.1, which is why the consumption in the model consists of a fixed component and a component that increases with income. This consumptions already includes the value added tax in the model.
There are approximately 7.5 million household that can roughly be divided in three equal groups: one-person households, multi-person households without children and multi-person households with children. Those households earn an average income of almost € 50,000, however, income is relatively high taxed in the Netherlands, leaving a disposable income around € 36,000. The aggregated household debt in the Netherlands is 276% of the aggregated net disposable income. This is quite high and in North West Europe only surpassed by Denmark. This is mainly due to full tax deductibility of interest payments on mortgages. The total values of mortgages from households in the Netherlands is relatively stable around € 650 billion, the remaining un-securitized consumer credit fell from € 20 billion in 2007 to € 6 billion in 2016. The average selling price of a residential property is in an upward trend and currently approximately € 250,000. This implies that on average the Dutch consumer owns 2/3 of this house. However, not only is a large part of the debt securitized, also has the average household total net worth grew to almost 700% of the average disposable income. The share of bond and equity decreased from more than 20% in 2000 to 7.5% in 2016. Total consumer deposits experiences an increasing trend, currently at € 342 billion. Total consumption expenditure in the Netherlands is fairly stable (per quarter) and around € 280 billion a year. Household savings as percentage of disposable income is steady around 6%. With respect to other European countries, Dutch consumers hold relatively little physical cash and since 2015 more than half of the number of transaction was cashless. This trend continuous and in absolute value, the share of cash payments is even less as the amount of cashless payments typically rises with the transaction amount involved. A stylized aggregated balance sheet of all Dutch consumers is given in table 5-1.

<table>
<thead>
<tr>
<th>Assets</th>
<th>Debt/Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits</td>
<td>325/650 Debt</td>
</tr>
<tr>
<td>Government Debt</td>
<td>100/850 Equity</td>
</tr>
<tr>
<td>Producer Debt</td>
<td>75</td>
</tr>
<tr>
<td>Producer Equity</td>
<td>200</td>
</tr>
<tr>
<td>House</td>
<td>800</td>
</tr>
</tbody>
</table>
5.1.2. Producers

The assumption that production and consumption occur at the same moment is valid only in a steady state. Only in this steady state is production time irrelevant. The typical factors of production are land, labour, capital and entrepreneurship. As mentioned in 3.3.1, capital is not necessarily homogenous and neither is labour. However, for the purposes of this work, they are treated as such. An abundance of land is assumed –yes even in the Netherlands-, preventing it from becoming a limiting factor. Even more, all cost pertaining use of land are attributed to “capital cost”. A good entrepreneur is able to optimize production with a given budget and is able to match output to demand. Aggregating all skill-levels of entrepreneurs, we assume an aggregated relation between the production and input of labour and capital. Equation 5-1 shows the relation between the capital output (K) and labour output (L), defined in 5-2 and 5-3 respectively and the production of goods and services (Y), as used in the model.

\[
Y = (\phi K^\rho + (1 - \phi)L^\rho)^{\frac{1}{\rho}}
\]

5-1

\[
K = \frac{C}{k}
\]

5-2

\[
L = N \times \lambda
\]

5-3

Where \(0 \leq \phi \leq 1\), \(0 \leq \rho \leq 1\), K is the worth of machines in Euro required to generate one Euro capital output per year, N is the amount of workers employed and \(\lambda\) is the labour productivity every workers yields per year. Producers want to know what the optimal combination of capital and labour is given a certain budget. If the price of capital and labour were the same, equal portions of capital and labour would be employed. Prices are usually expressed in \(\text{€ Good^\text{Year}}\), however, as desired production is expressed in \(\text{Good^\text{Year}}\), producers are interested in the prices of \(\frac{\text{€ Good}}{\text{Good^Year^\text{Year}}}\). This is a function of interest and depreciation. Depreciation and interest are much alike as they both can be thought of as yearly cost of capital. The interest represents opportunity cost and the depreciation is the cost that must be paid to maintain the amount of capital. These similarities also come back in their dimension, which is \(\text{\text{Year}^{-1}}\). The multiplication with the capital factor not only complement the dimension to the target dimension, but also can be seen as the amount of times those yearly cost have to be paid, to produce one good. This is expressed in equation 5-4. The labour cost per unit is equal to the wage rate divided by the labour productivity as is shown in equation 5-5.

\[
P_K = k \times (\delta + r)
\]

5-4

\[
P_L = \frac{w}{\lambda}
\]

5-5
Entrepreneurship does not enter the CES equation, but is considered in the model as producers want to optimize production given a certain budget (B).

\[ \text{MAX } Y = (\phi K^\rho + (1 - \phi)L^\rho)^{\frac{1}{\rho}} \]  

Subject to

\[ B = P_K * K + P_L * L \]  

In order to solve this problem so that it can be used in the model, we define the Lagrangian in 5.8 and its partial derivatives to the variables capital output and labour output and to the Lagrange multiplier. Those derivatives are set equal to zero in equation 5.9 to 5.11. Note that latter returns the budget constraint.

\[ L = (\phi K^\rho + (1 - \phi)L^\rho)^{\frac{1}{\rho}} + \lambda(B - P_K * K + P_L * L) \]  

\[ \frac{\partial L}{\partial K} = \rho \phi K^{\rho - 1} \left[ \frac{1}{\rho} (\phi K^\rho + (1 - \phi)L^\rho)^{\frac{1}{\rho} - 1} \right] - \lambda P_K = 0 \]  

\[ \frac{\partial L}{\partial L} = \rho (1 - \phi) L^{\rho - 1} \left[ \frac{1}{\rho} (\phi K^\rho + (1 - \phi)L^\rho)^{\frac{1}{\rho} - 1} \right] - \lambda P_L = 0 \]  

\[ \frac{\partial L}{\partial \lambda} = B - P_K * K + P_L * L = 0 \]  

In an attempt to solve this set of equations, equation 5.10 is divided by equation 5.9, the result is presented in equation 5.12.

\[ \frac{\phi K^{\rho - 1}}{(1 - \phi)L^{\rho - 1}} = \frac{P_K}{P_L} \]  

The result should be no surprise; equation 5.12 equals the slope of the production isoquant (LHS) to the slope of the budget line (RHS). Solving for L, which can be plugged in, 5.13 the budget equation.

\[ B = P_K * K + P_L * \left[ \frac{\phi P_L}{(1 - \phi)P_K} \right]^{\frac{1}{\rho - 1}} \]  

Solving for K and using symmetry-based reasoning to solve for L provides the desired amount of capital output and labour output, based on a given budget in equation 5.14 and equation 5.15 respectively. This
is known as Marshallian demand. Equation 5-14 and equation 5-15 are plugged back into the original production function. This presents the optimal output possible using perfect allocation with a given budget in equation 5-16.

\[
K^* = \frac{B}{P_K + P_L \cdot \left[\frac{\phi P_L}{(1 - \phi)P_K}\right]^{\frac{1}{\rho - 1}}}
\]

Equation 5-14

\[
L^* = \frac{B}{P_L + P_K \cdot \left[\frac{(1 - \phi)P_K}{\phi P_L}\right]^{\frac{1}{\rho - 1}}}
\]

Equation 5-15

\[
Y = \left[\frac{\phi B}{P_K + P_L \cdot \left[\frac{\phi P_L}{(1 - \phi)P_K}\right]^{\frac{1}{\rho - 1}}} + \frac{(1 - \phi)B}{P_L + P_K \cdot \left[\frac{(1 - \phi)P_K}{\phi P_L}\right]^{\frac{1}{\rho - 1}}}\right]^\frac{1}{\rho}
\]

Equation 5-16

At this point it is worth to take a moment to think about the value of \(\phi\). This value presents the weight attributed to capital output and \((1 - \phi)\) is the weight attributed to labour output. For the purpose of this work it suffices to assume that capital output and labour output contribute equally to production and since \(0 \leq \phi \leq 1\), \(\phi = 0.5\). Now 5-16 can be simplified to 5-17. Now, when \(Y\) is considered not the output produced, but the planned production, the amount of yearly budget required to meet planned production is given by 5-18.

\[
Y = B \left[\frac{\rho}{P_K^{\rho + 1}} + \frac{\rho}{P_L^{\rho + 1}}\right]^{\frac{1 - \rho}{\rho}} \cdot \left[\frac{1}{2}\right]^\frac{1}{\rho}
\]

Equation 5-17

\[
B = \frac{Y}{\left[\frac{\rho}{P_K^{\rho + 1}} + \frac{\rho}{P_L^{\rho + 1}}\right]^{\frac{1 - \rho}{\rho}} \cdot \left[\frac{1}{2}\right]^\frac{1}{\rho}}
\]

Equation 5-18

When producers do not optimize their production with the budget they have, but rather aim to attract the budget they need to meet their desired level of production, it is not the Marshallian demand that is important, but the Hicksian demand for capital and labour that drives the behaviour of the producer.

In order to derive the Hicksian demand, the budget in the Marshallian demand for capital (as given in equation 5-14) and for labour (as given in equation 5-15) can be substitution with the budget required to meet desired production when allocation of capital and labour is optimized. However, the \(K^*\) and \(L^*\) in the Marshallian demand formula’s represent the desired capital output and labour output respectively. In order to find the amount of additional desired workers and additional desired capital, two factors should be taken into account. First, how many workers and capital are required to yield such an output and second, how many workers and how much capital are already present. Taken these operations into
account, 5-18 is substituted in 5-14 and 5-15 and the result is multiplied by the respective production factor price after which the current amount of the respective production factor is subtracted to retrieve the desired amount of additional capital in 5-19 and the desired amount of workers in 5-20.

\[
\text{New Capital}^* = \left[ \frac{Y^* \frac{1}{2}}{P_K + P_L \left[ \frac{P_L}{P_K} \right]^{\frac{1}{\rho - 1}}} \left( \left( P_K^{\frac{\rho}{\rho - 1}} + P_L^{\frac{\rho}{\rho - 1}} \right)^{\frac{1 - \rho}{\rho}} \right) - K_{\text{Current}} \right] * P_K \tag{5-19}
\]

\[
\text{New Workers}^* = \left[ \frac{Y^* \frac{1}{2}}{P_L + P_K \left[ \frac{P_K}{P_L} \right]^{\frac{1}{\rho - 1}}} \left( \left( P_K^{\frac{\rho}{\rho - 1}} + P_L^{\frac{\rho}{\rho - 1}} \right)^{\frac{1 - \rho}{\rho}} \right) - L_{\text{Current}} \right] * P_L \tag{5-20}
\]

Where \(K_{\text{Current}}\) and \(L_{\text{Current}}\) are the current capital output and the current labour output respectively, and \(\text{New Capital}^*\) and \(\text{New Workers}^*\) the desired amount of new capital and workers. The implementation of these equations in the model is depicted in figure 5-2.

*Figure 5-2*) Implementation of investment and hiring strategy in the model
Like the other group of actors, the production sector is represented by its balance sheet, which is depicted in figure 5-3. As mentioned in 3.2.2, the funding structure is an important part of the corporate strategy. Although all producers in this model are aggregated into one sector, this sector will not just sell any amount of debt or equity when there is demand. In the model, producers will aim for a fixed debt ratio of 60% and will only sell debt or equity when the average cost of capital is lower than the expected return on assets. Acquired funds are used to purchase capital and pay wages. The total aggregated balance sheet of the Dutch producers, used in the model, is given in table 5-2.

<table>
<thead>
<tr>
<th>Producer</th>
<th>Deposits</th>
<th>Cash</th>
<th>Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000</td>
<td>645</td>
<td>3000</td>
<td>6645</td>
</tr>
<tr>
<td>2345</td>
<td>4300</td>
<td></td>
<td>6645</td>
</tr>
</tbody>
</table>

*Table 5-2) Stylized Aggregated Balance Sheet of the Dutch Producer sector in Billions*
5.1.3. Bank

In the model, the bank accepts all deposits from the consumers, the producers and the government. Money that flows in on the right side of the balance sheets (debt), also enters the left side as asset. However, when one of those actors makes a deposit because it just received money from another actor that had withdrawn money to make the transaction, nothing changes on the left side of the balance sheet.

Interest on bank deposit is compounding. This is translated to the model by directly transferring the interest, based on the current interest rate from the bank’s equity to the creditor’s bank account. The interest rate is not the only outflow from the bank’s equity, as the bank also pays dividend to its shareholders. The bank’s equity increases with the revenue it earns by charging interest and with the capital gains as a result of a value increasing of the producer equity it holds. The bank remunerates depositors with the same rate it receives from the central bank for storing deposits. While the bank maintains a fixed spread of 150 basis points between deposits and extended consumer credit, the return on the other earning assets depends on market conditions.

The total amount a bank can invest in earning assets, such as loans and investments, is based on the regulations imposed by the central bank. Section 3.2.3 describes in detail the amount of equity and high quality liquid assets a Dutch bank must hold under CRR I and CRD IV. However, due to the aggregated nature of this work, these regulations will be adjusted to fit in the five sector macro model. No difference will be made between tier 1 and tier 2 capital. Instead, the leverage ratio will be used in the model as restriction on the amount of solvability risk the financial sector as a whole can assume. As the aggregation of all financial institutions does not allow for individual stress tests, a reserve ratio that prescribes a minimum ratio of total high quality liquid assets to total assets, rather than a liquidity coverage ratio, will be used in the model. No additional risk precautions from the bank are taken into account. The amount that a bank can invest, while complying with the rules, is divided over the earning assets. Every time step, the bank reserves an amount for every earning asset, based on the expected return on that assets and
based on the amount that was cleared in the market of that earning asset in the previous round. A bank reserves the most funds for earning assets with the highest expected returns and the largest volumes traded in the previous time step. The initial aggregated balance sheet of the financial sector, used in the model, is given in table 5-3.

<table>
<thead>
<tr>
<th>Assets</th>
<th>Debt/ Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Cash</td>
<td>4075 325</td>
</tr>
<tr>
<td>Government Bonds</td>
<td>400 3000</td>
</tr>
<tr>
<td>Producer Debt</td>
<td>2150 750</td>
</tr>
<tr>
<td>Producer Equity</td>
<td>4000 7200</td>
</tr>
<tr>
<td>Consumer Credit</td>
<td>650</td>
</tr>
<tr>
<td></td>
<td>11275 11275</td>
</tr>
</tbody>
</table>

Table 5-3) Stylized Aggregated Balance Sheet of the Dutch Financial Sector in Billions

5.1.4. Government

As mentioned in section 3.2.4, the government raises funds by applying value added tax to consumer goods and services, and wage tax to income earned. The model assumes that loans for all workers are equal so it is not possible to apply different tax brackets to individual workers. Figure 5-5 shows the average income by age in Euro of Dutch workers in 2016. The averages incomes fall largely in the €20.142 – €68.407 interval. In this model, an effective income tax of 40% will be used. While the average income might not be the best indicator in a progressive tax system, the large tax bracket (€20.142 – €68.407) of 40.85% tax rate mitigates the error when a rounded 40% is used. While it is true that only 36.55% is paid over the first €20.142 earned, the average effective tax rate is increased by those workers that earn more than €68.507.

![Average income by age in Euro in 2016 (Statista, 2018)](image-url)
The dividend tax rate is currently 15%. In 2020, however, the tax rate will be abolished. In the simulation, a corporate tax rate of 5% and a VAT of 15% will be applied. Tax rates will not be adjusted during a single simulation.

The government is limited to a budget deficit, which states that the budget deficit cannot be greater than 3%. Also, the government is not allowed to have a debt rate of more than 60% of the GDP on its balance sheet. In order to prevent myopic government policy, the gap between the current debt rate and the limit can only be bridged by a third every time step. The initial balance sheets of the government are depicted in Table 5-4.

<table>
<thead>
<tr>
<th>Assets</th>
<th>Debt/Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits</td>
<td>580</td>
</tr>
<tr>
<td>Producer Debt</td>
<td>120</td>
</tr>
<tr>
<td>Producer Equity</td>
<td>100</td>
</tr>
<tr>
<td>Assets</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>800</td>
</tr>
</tbody>
</table>

*Table 5-4* Stylized Balance Sheet of the Dutch Government in Billions

5.1.5. Central Bank

The central bank will perform open market operations when the economy falls below a certain capacity threshold. This means that it enters the government bond market and the central bank will start purchasing bonds from all parties that offer bonds. The limit to the maximum amount of bonds bought per year varies per run. Expectations are that this shifts the abundance from the supply side of government debt to the demand side of government debt in the debt market. This comes with a suppressing effect on the bond rate, which in turn will cause lower opportunity cost for consumers.

The central bank imposes a similar limit to the maximum amount of corporate bonds bought, which will also vary per run. The central bank can buy these bonds from every party that is selling. Again, producer bonds can also be bought from other parties, as long as they are offering. Section 3.1.4 mentions...
that profits forms the central bank are distributed via national central banks to the government. This is also the case in the model. Figure 5-6 depicts the representation of the central bank in the model. During new asset purchase programs, the size of the balance sheet increases. The sum of the new discount loans, open market operations and quantitative easing equals the amount of new currency in circulation. The total amount of currency in the economy is diminished when banks store money at the central bank and when debt possessed by the central bank matures. While the central banks takes the market interest rate for government and corporate bonds, the interest rates with which the banks charge and remunerates banks respectively for lending money from and storing money by the central bank is set by the central bank in to control these amounts. In short, in an asset purchase program the bank determines the amount to control the rate, while the central bank sets rates for bank to control the amount stored or lend. However, in the simulation there is a minimum and maximum for both rates. There is a fixed spread between these rates during a simulation.

5.2. Markets
The markets are the place where the actors interact with one another. Three main markets are identified: The financial market, the goods market and the labour market.

5.2.1. Financial Markets
The money market and the capital market constitute the financial market. The financial market in the model connects those who wish to convert their cash to return yielding assets to those who are in need for new funds. There are four markets in total: the consumer credit market, the government bond market, the producer bond market and the producer equity market. Their names are derived from actors that initially offers debt. However, after actors bought debt, they are obligated to hold it to maturity, but can resell that debt if they are in need for cash themselves. Figure 5-7 shows the producer debt market. Actors first indicate their interest in buying or selling debt, this results in the total debt demand and total debt supply. When total debt demand is greater than total debt supply, the total demand cannot be fulfilled and actors receive that portion of debt from the total debt market equal to the portion of debt they contributed to the total debt demand. The same mechanism applies when debt supply is in abundance.

Debt demand and supply are not matched to one another, but an abundance of one variable moves the cost of capital in that market towards a price that brings demand and supply closer in the next time step.
The price of producer debt, for example, is a sigmoid function with the lower asymptote at the minimum desired return of a bank and the maximum asymptote equal to the return on investments of the producer, with the ratio of debt supply to demand on the x-axis.

5.2.2. Goods market
One good is produced in this system that is both suitable for consumption and for capital stock expansion. Total demand is the sum of consumer consumption, government expenditure and investment. There are two possible pricing mechanisms in the model. In the classical mechanism, pricing can drop indefinitely when demand remains low while the Keynesian pricing mechanisms prevents the price from dropping eventually according to the idea that wages are sticky and producer offer their products against average fixed cost. When demand exceeds supply, production is increased and prices rise in the classical mechanism. In the Keynesian mechanism, it is possible that even when the demand drops, the prices remain stable due to the sticky wages and prices. The weights between the increase in production and the increase in price as result of demand exceeding supply are determined by the long run aggregated supply, which is determined by the amount of capital in the model and the total available workforce. The stock flow representation is depicted in figure 5-8.

![Figure 5-8] The goods market and pricing mechanism

5.2.3. Labour Market
The demand for labour is a product of planned production, capital price, labour price, current capital and current labour. The CES production function determines the marginal productivity of labour, which is compared to the cost of labour and the cost of capital. The cost of labour, wage, is determined by means of the Philips curve and directly depends on the unemployment level. The wage mechanisms is shown in figure 5-3.
The wage is subject to the employment fraction. The rationale that a low level of unemployment causes a strong negotiations position for workers is translated into equation 5.21, based on the work of Steve Keen (Keen, 1995).

\[
    w(\lambda) = \frac{\phi}{(1 - \lambda^2)} - \varphi
\]

The values Keen uses for \(\varphi\) and \(\phi\) in his work are 0.000641 and 0.0400641 respectively. Figure 5.4 visualizes the asymptotic relation between unemployment and change in wage rate.

5.2.4. Social Accounting Matrix

The social accounting matrix offers an insightful overview in value streams between different actors. The five actors are listed in the top column, followed by their value streams in the columns underneath.
positive sign indicates an inflow, while a negative sign marks an outflow. Flows are not limited to monetary value movement, but also constitute goods and labour.

<table>
<thead>
<tr>
<th>Value Stream</th>
<th>Consumer</th>
<th>Producer</th>
<th>Bank</th>
<th>Government</th>
<th>Central Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage</td>
<td>+W</td>
<td>-W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>-C_{\text{Consumption}}</td>
<td>-C_{\text{Investment}}</td>
<td>+C_{\text{Government spending}}</td>
<td></td>
<td>-C_{\text{Government spending}}</td>
</tr>
<tr>
<td>Interest</td>
<td>-I_{\text{Credit}} + I_{\text{Debt}} + I_{\text{Equity}} + I_{\text{Deposit}} + I_{\text{Bond}}</td>
<td>I_{\text{Deposit}} - I_{\text{Debt}} - I_{\text{Equity}}</td>
<td>+I_{\text{CBDeposit}} + I_{\text{Credit}} + I_{\text{Debt}} + I_{\text{Equity}} + I_{\text{Bond}} - I_{\text{Deposit}} - I_{\text{CBDiscount}}</td>
<td>I_{\text{Deposit}} - I_{\text{Bond}}</td>
<td>+I_{\text{CBDeposit}} - I_{\text{CBDiscount}}</td>
</tr>
<tr>
<td>Tax</td>
<td>-T_{\text{Wage}} - T_{\text{VAT}}</td>
<td>-T_{\text{Profit}}</td>
<td></td>
<td>T_{\text{Wage}} + T_{\text{VAT}} + T_{\text{Profit}}</td>
<td></td>
</tr>
<tr>
<td>Funds</td>
<td>+D_{\text{Consumer}} - D_{\text{Producer}} - E_{\text{Producer}} - D_{\text{Government}} - D_{\text{Deposits}}</td>
<td>+D_{\text{producer}} + E_{\text{producer}} - D_{\text{Deposits}}</td>
<td>+D_{\text{CBDeposit}} + D_{\text{CBDeposits}} - D_{\text{producer}} - E_{\text{producer}} - D_{\text{Government}} - D_{\text{Consumer}} - D_{\text{Deposits}}</td>
<td>+D_{\text{Government}}</td>
<td>+D_{\text{CBDeposits}} - D_{\text{CBDiscount}}</td>
</tr>
</tbody>
</table>

Table 5-5) Social accounting matrix

5.3. Limitations of the model

Currently the model depicts all actors that consist of a group as homogenous. In reality, multiple profiles with different behavioral characteristics can be identified. The effects of income tax to stimulate equality can be measured if this was incorporated in the model.

The model operates in a vacuum; there is no interaction or cooperation with other economies. Another interesting question is the effects of national policy on international trade. The incorporation of cross-border flows of goods, capital and labor could test the effects of bilateral trade agreements and obstacles on a national economy.

In this model, the total production is estimated by a constant elasticity of substitution function. The production chain in the model remains a black box, while Hayek argued that this was a vital point in economic performance analysis. However, no small addition to this model could test how artificial low interest rates result in distorted price signals that cause unwanted investments. While this is an interesting question, the required research into the value chain and changes thereof are not included in this research.

Soft variables such as confidence and certainty play an important role in the economy but not yet in this model. One might find that agile corrections in policy measures create an optimal effect if soft variables are left out, while in reality, regulatory certainty and announcements factor in the success of monetary policy.
6. Impact of monetary policy and macro prudential measures on the Dutch economy from a Keynesian and Classical perspective

This section presents the impact of different monetary policies in the classical structure of the model. First, the interpretation of several scenario's given in table 6-1. This tables shows the definition of “low”, “medium” and “high”. This ordinal scale was chosen to describe the values for six policy variables.

6.1. Scenario Construction

The minimum marginal lending rate represents the lower bound value that the central bank will charge other banks on overnight loans during the simulation, the maximum value is given by the max marginal lending rate. The corridor width represents the constant difference between the marginal lending rate and the deposit facility rate. The latter is the rate banks receive for storing money at the central bank and is in the simulations always lower than the deposit facility rate. The value of the corridor width ranges between the two most frequently used corridor widths (Bindseil & Jablecki, 2011).

The maximum outstanding open market operations and quantitative easing amounts are expressed as function of the total GDP. The ratio open market operations to GDP in the medium scenario equals portion of total outstanding assets at the end of fiscal year 2017 to the total European GDP (ECB, 2017). Note that these values are maximum values and the central bank in the model will only conduct an expansionary monetary policy in the economy when it deems that this is necessary. The same applies to the maximum portions of corporate debt purchases by the ECB, denoted in the table as “max QE size”.

<table>
<thead>
<tr>
<th>Scenario's</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min marginal lending rate</td>
<td>-0.015</td>
<td>-0.005</td>
<td>0.01</td>
</tr>
<tr>
<td>Max marginal lending Rate</td>
<td>0.015</td>
<td>0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Corridor width</td>
<td>0.05</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Max OMO Size</td>
<td>1/50 GDP</td>
<td>1/10 GDP</td>
<td>GDP</td>
</tr>
<tr>
<td>Max QE Size</td>
<td>0</td>
<td>1/20 GDP</td>
<td>½ GDP</td>
</tr>
<tr>
<td>Macro prudential policy</td>
<td>Loose</td>
<td>Easy</td>
<td>Tight</td>
</tr>
</tbody>
</table>

Table 6-1) Monetary policy scenario interpretations

The reserve ratio and the leverage ratio are both covered under macro prudential policy. The reserve ratio can be seen as a simplification of the liquidity coverage ratio and is better suited for the aggregate level of this work. The values of the reserve ratio and the leverage ratio move in the same direction, depending whether a tight, easy or macro prudential policy is uphold. Values pertaining to these scenarios are given in Table 6-2. Note that both values represent minimum values and that banks are allowed to have higher reserve and leverage ratios.
Macro prudential policy

<table>
<thead>
<tr>
<th></th>
<th>Tight</th>
<th>Easy</th>
<th>Loose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserve Ratio</td>
<td>0.3</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Leverage Ratio</td>
<td>0.5</td>
<td>0.05</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 6-2) Macro prudential policy value interpretation for the reserve ratio and the leverage ratio.

The tested scenarios are concatenated ordinal values from table 6-1 and table 6-2 to elucidate both the impact of individual policy measures and combination of policy measures.

Table 6-3) 4 different model scenario’s

The so-called “warm-up” period, caused by initial value problems, was removed from the simulation to present the outcomes after they stabilized. Oscillations at the start of the simulation are not due to simulated economic disturbance, but due to values not perfectly adjusted to one another. The graphs in this chapter, are accompanied by numerical data in appendix I to appendix IIII, respectively for scenario I to scenario IIII.

Figure 6-1) IVP problem for employment in a classic structure simulation
6.2. Scenario I – Reference scenario
The first scenario can be seen as a reference scenario, as all variables are set to the most common or currently occurring values. The corridor width is set to "high", as the low and the high value represent most common values.

![Figure 6-5a) GDP development in the reference scenario](image1)

In the classic simulation, the economy performs constantly better than in the Keynesian simulation. An important factor in this difference in performance is the employment rate. A higher participation rate among the same population, does not only increase labour output itself, but also yields additional cross effects with capital output. Figure 6-6 shows mechanism that determines the amount of desired workers and desired addition to the capital stock. Equation 5-20 and 3-1 are the underlying formulas in this mechanism. When there are more workers employed, it is also beneficial to investment more in capital stock.

![Figure 6-6) Hire and investment mechanism](image2)

The low participation grade is a consequence of wages, that don’t move downward in the Keynesian simulation. The downward sloping price, is a consequence of staggering demand, as a consequence of the
lower employment rate, as this has not only a decreasing effect on consumer consumption, but also demand for capital stock. Figure 6-4 shows the planning, construction and depreciation of capital stock. The total amount of deprecated capital stock, and thus the amount that must be replaced, increases with the total amount of capital stock. When demand in other sectors of the economy does not fall, higher capital stock results in a higher demand for new capital stock. Higher demand for capital stock due to a higher capital stock base, in combination with the cross effects from a higher employment, explains why a higher employment results in a higher demand. However, there is another mechanism that drives total GDP. When employment is higher, more workers earn income and more workers consume. Even tough wages are higher in the Keynesian simulation, the total income and therefor consumer spending, in the classic simulation is higher.

![Diagram showing planning, construction, and depreciation of capital stock.]  
*Figure 6-7) Planning, construction and depreciation of capital stock*

![Graph showing employment scenario comparison.]  
*Figure 6-2b) Employment in the reference scenario*
Figure 6-2c) Price index in the reference scenario

In the reference scenario, the economy performs constantly better than in the Keynesian simulation. An important factor in this difference in performance is the employment rate. A higher participation rate among the same population, does not only increase labour output itself, but also yields additional cross effects with capital output. Figure 6-6 shows mechanism that determines the amount of desired workers and desired addition to the capital stock. Equation 5-20 and 3-1 are the underlying formulas in this mechanism. When there are more workers employed, it is also beneficial to investment more in capital stock. The removal of the warm-up period creates a gap between the GDP’s.
The low participation grade is a consequence of wages, that don’t move downward in the Keynesian simulation. The downward sloping price, is a consequence of staggering demand, as a consequence of the lower employment rate, as this has not only a decreasing effect on consumer consumption, but also demand for capital stock. Figure 6-7 shows the planning, construction and depreciation of capital stock. The total amount of depreciated capital stock, and thus the amount that must be replaced, increases with the total amount of capital stock. When demand in other sectors of the economy does not fall, higher capital stock results in a higher demand for new capital stock. Higher demand for capital stock due to a higher capital stock base, in combination with the cross effects from a higher employment, explains why a higher employment results in a higher demand. However, there is another mechanism that drives total GDP. When employment is higher, more workers earn income and more workers consume. Even tough wages are higher in the Keynesian simulation, the total income and therefor consumer spending, in the classic simulation is higher.
Figure 6-4) Planning, construction and depreciation of capital stock

Figure 6-2b) Employment in the reference scenario
6.3. Scenario II – Tight macro prudential regulations

The second scenario simulates a reality where the central bank puts emphasis on macro prudential policy, while it is relative austere in stimulating the economy. This scenario was included to test the effects of macro prudential policy without an abundance of expansionary policy. With respect to the reference scenario, in this scenario the central bank will only employ asset purchase programs in a very limited form, while being strict on macro prudential regulation. The central bank will not engage in the purchase of corporate debt and total government debt on the balance sheet of the central bank will not exceed 0.02 times the current GDP.

In the classic simulation, the economy performs constantly better than in the Keynesian simulation. An important factor in this difference in performance is the employment rate. A higher participation rate among the same population, does not only increase labour output itself, but also yields additional cross effects with capital output. Figure 6-6 shows mechanism that determines the amount of desired workers and desired addition to the capital stock. Equation 5-20 and 3-1 are the underlying formulas in this
mechanism. When there are more workers employed, it is also beneficial to investment more in capital stock.

![Diagram of the hire and investment mechanism]

Figure 6-6) Hire and investment mechanism

The low participation grade is a consequence of wages, that don’t move downward in the Keynesian simulation. The downward sloping price, is a consequence of staggering demand, as a consequence of the lower employment rate, as this has not only a decreasing effect on consumer consumption, but also demand for capital stock. Figure 6-4 shows the planning, construction and depreciation of capital stock. The total amount of deprecated capital stock, and thus the amount that must be replaced, increases with the total amount of capital stock. When demand in other sectors of the economy does not fall, higher capital stock results in a higher demand for new capital stock. Higher demand for capital stock due to a higher capital stock base, in combination with the cross effects from a higher employment, explains why a higher employment results in a higher demand. However, there is another mechanism that drives total GDP. When employment is higher, more workers earn income and more workers consume. Even tough wages are higher in the Keynesian simulation, the total income and therefore consumer spending, in the classic simulation is higher.
Figure 6-7) Planning, construction and depreciation of capital stock

Figure 6-2b) Employment in the reference scenario
6.4. Scenario III – Scenario with tight macro prudential regulation

The second scenario simulates a reality where the central bank puts emphasis on macro prudential policy, while it is relative austere in stimulating the economy. This scenario was included to test the effects of macro prudential policy without an abundance of expansionary policy. With respect to the reference scenario, in this scenario the central bank will only employ asset purchase programs in a very limited form, while being strict on macro prudential regulation. The central bank will not engage in the purchase of corporate debt, total government debt on the balance sheet of the central bank will not exceed 0.02 times the current GDP.

Figure 6-8a) GDP development in scenario II

The results depicted in Figure 6- show that an austere monetary policy other and tight macro prudential regulation might not have a negative impact on the employment in the Dutch economy. The Keynesian simulation still shows concerning low levels of employment, but this is not different from the reference scenario. The low level of unemployment is not a direct consequence of tighter monetary policy. Despite the low participation rate, the GDP development keeps on track and this scenario closely resembles the...
reference scenario. The resemblance with the reference scenario indicates that strict macro prudential measures do not have much effect on the performance of the economy. This also implies that the multiplier effect, which is based on the reserve ratio, is not as strong as expected. This applies to both the classic and the Keynesian simulation. The market interest rates, the rate that producers pay on their debt, is lower in the reference scenario than in this scenario, which means that the multiplier effect is offset by a reduced amount of market operations by the central bank. This is good news for policy makers aiming for a more stable financial sector, as macro prudential regulation can be applied without economic stagnation as consequence of this tighter regulation.

![Figure 6-5b) Employment in scenario II](image1)

![Figure 6-5c) Price Index in scenario II](image2)

### 6.5. Scenario III – Asset Purchase Program scenario

The third scenario simulates a central bank that employs a large asset purchase program, if economic conditions demand it, which constitute both ample open market operations and quantitative easing, rather than interest rates to adjust the economy. This is reflected not only by allowing for high amounts
of debt and bond purchases, but also limiting the difference between the maximum and minimum interest rates. Prudential regulation resembles the standards set after the financial crisis of 2007 to 2009, similar to the reference scenario.

**Figure 6-9a) GDP development in scenario III**

**Figure 6-6b) GDP development in scenario III**
While the asset purchase program seems to work in a Keynesian environment, results from a classic perspective cast doubt over this approach. While the employment is not lower than in the reference scenario, GDP performance much less than in the reference scenario. Even though the economy recovers harder from shocks in a Keynesian environment, it is the classic simulation that fails under this approach.

The disappointing performance in the classical simulation can be explained by a lack of investment, which, in turn is caused by high interest rates during the simulation. The asset purchase program is unsuccessful, because producers don’t issue debt when their internal rates of return cannot fall below the market interest rate. The mechanism that determines the interest rate in the market is depicted in figure 6-10. The interest rate is a sigmoid function with the return on assets from producers as maximum and the discount rate plus a desired spread as minimum. The market interest rates moves from the floor to the ceiling with the demand-supply ratio. When the interest rate desired by the bank (or other creditors) is higher than the return on assets, producers will not sell their debt.

Investments falls, which reduces demand for capital stock. An asset purchase program the size of a full GDP without adjusting interest rates to complement this expansionary monetary policy has potentially adverse effects on the economy.
6.6. Scenario III – Monetary policy by interest rate manipulation

In this scenario, the central bank only considers adjusting the interest rate to conduct expansionary and contractionary monetary policy. The central bank does not fund governments and corporates directly. Banks are still allowed to borrow money from the central bank. However, the central bank maintains a high spread and fluctuates interest rates according to the state of the economy. With respect to the reference scenario, fluctuations in interest rates set by the central bank increases, while asset purchase programs are less intense.

The scenario where the central bank focuses on interest rate manipulation, rather than asset purchases, creates a scenario that sees a particular poor performance in GDP development in the classic simulation. When the price of the simulation of the classic model structure is considered, the notion of a bubble occurs. In the past, central banks have been accused of causing bubbles by keeping interest rates too low too long. These accusation are in line with the observation of the interest rate development; in the simulation of the classical model structure, the central bank keeps the deposit facility rate at a minimum. This is a reaction, however, to an underperforming GDP that can only by countered by a low interest rate.
in this scenario. As long as the interest rates are lower than the expected return on assets for a producers, the producers will invest in both workers and capital stock. Figure 6-12 shows that an increase in capital stock results in a higher expected future GDP, which, in turn, results in a higher desired output and therefore capital stock. This positive feedback loop is not sustainable in the long term and suddenly producers own more capital stock than they can use to produce. The same feedback loop causes investments and total GDP to fall. This comes with unemployment, as less workers are needed to produce the lower GDP level.

![Figure 6-12] Future GDP estimation and desired output

![Figure 6-8b] Employment in Scenario IIII
The causal frameworks that connect monetary policy the physical parts of the economy must be taken into account by policy makers and inadequate monetary policy damages the economy. Scenario II shows that tight macro prudential measures do not have a particular harmful effect on the economy. It lies outside the scope of this work to verify their stabilizing function, but if this would be the case, there does not seem to be much of a trade-off between stabilizing the economy and slowing it down. Scenario III and IIII show that asset purchase programs should be accompanied by adjusted interested rates (and vice versa), to yield the desired effects.
7. Policy Analysis and Recommendations

The impact of macro prudential regulation and monetary policy on the Dutch economy was tested on a stock-flow representation of the Dutch economy. The results are presented in chapter six and converged to multiple conclusions:

- Macro prudential policy has little effect on the macro economy. It is possible that macro prudential policy alone has a suppressing effect on the employment. However this can be fixed with stimulating the economy with balanced monetary policy, as is depicted by both the Keynesian and classic simulation in the second scenario.

- A considerable asset purchase program without concomitant interest rate adjustments might have a devastating effect on the economy. An underperforming GDP development and lagging employment were recorded in the classic simulation as a result of an intense asset purchase program without significant interest rate adjustments. While the classical structure simulation recorded a healthy economy under the same circumstances, this cannot qualify as a robust policy.

- Relying solely on interest rates to stimulate the economy might cause a bubble. While this phenomenon did not appear in the Keynesian structure simulation, multiple aspects of a bubble were present in the classic structure simulation, including the devastating effects after the burst.

- The effects of open market operations and quantitative easing increase with properly adjusted interest rates.

- Maintaining the deposit facility rate between -0.015 and 0.01, while keeping a corridor between the deposit facility rate and the marginal lending rate of 200 basis points and limit the size of asset purchase programs to a tenth of the gross domestic product yields the best results regardless the economic perspective.

However, those assumptions were made to the best knowledge of the author, yet remain a trade-off between capturing the essence of each concept and being able to translate those concepts into a model.
8. Reflections

Although the combination of asset purchase programs and lower interest rates had an interaction effect in the simulation, components not included in the simulation could weaken this conclusion. Hayek argued that projects with lower return on assets are only temporary feasible due to the distorted market signals. The conclusions in the previous chapter were based on simulations where all goods and producers were alike. The model does not allow for differentiations between innovative producers and producers that are not able to adjust their supply to the demand in the market. A similar concept applies to the workforce. In reality, it is possible to have both unfilled vacancies and job seekers at the same time. Efforts to close this gap, be it by improving infrastructure or access to education, can also have an advantageous effect on the employment.

Soft variables as confidence are hard to qualify and not taken into account in this work. However, they play an important part in the real economy. The central bank often engages in forward guidance, proclaiming the direction of the economy, which is also hard to measure, yet has a tremendous effect on the economy as it offers certainty and stability given that the central bank earned the trust of the other actors in the economy.

Currently the model considers the Dutch economy as an isolated state that does not interact with foreign countries. This excludes import and export of goods, capital and workers. Inclusion of these aspects cover an important step towards reality and allow the model and its handler to analyze exchange rate strategies and the effects of import tariffs.

GDP development, price levels and unemployment where the key performance indicators chosen to measure the impact of monetary policy and macro prudential regulation. While these indicators are fairly objective, they do not grasp the full well-beings of the population. Economic growth does not always equal higher livings standards and a decline in employment could also mean that people are satisfied with their current living standards and opt to work more part-time. A happiness index could reflect truer economics goals and include amount of free time, education and health. Such an index was left out of the scope of this research on purpose, as these objectives are not included in the mandate of the central bank.

A word of advice to those readers that are triggered to use this work to build their own model and apply their own perspectives: before one starts to build an economic model, one should ask the question whether the model is going to be a demand-side model or a supply side model. The answer to this question often depends on the run time of the simulation. Supply side models are often associated with longer run times, while short term models often demand-side models. It would be truly interesting to incorporate capital theory in a model demand side model where lower interest rates and asset purchase programs do not only increase the amount of GDP, but also affect the quality of the value chain.

However, multiple causal mechanism of both demand-side models and supply-side models are already incorporated in this study, which did yield elucidating results. The effect of strict macro prudential measures have little effect on the economy. It was outside of the scope of this research to determine the effect on the stability of the financial sector, but given that liquidity and leverage issues were identified by other studies as the culprit of the financial crisis and given that from two perspectives these measure had but little impact on the economic performance, I would advise policy makers not to hold back on imposing these measures on financial institutions. This study also indicates that asset purchase programs should be accompanied by setting the right interest rates. When one looks at the results in chapter 5, one
might tend to say: “the central bank should have intervened at that point”. Of course it is possible in reality to adjust monetary policy on the fly, but one of the functions of the central banks is to radiate calmness and prevent uncertainty. Therefore it is important to consider and announce what options the central banks is going to employ in advance and when this is these options are determined on forehand, make sure that the planned asset purchase programs are accompanied by interest rate adjustments.


CRR / CRD IV (Basel III) – Reinforcing the resilience of the banking sector BearingPoint supports the European financial community with experienced consultants and the development and implementation of Basel III solutions. (2018), (Basel III), 2014.


ECB 2017 (2017) Europese Centrale Bank Jaarverslag


Giovannoni, O. (2014). What do we know about the labor share and the profit share?, (part II).


### Appendix I – Reference Scenario Values

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