Preparing for a pandemic

- a theoretical perspective on the trade-offs of unconventional monetary policy

By:

Carl Sandström

LUND UNIVERSITY
SCHOOL OF ECONOMICS AND MANAGEMENT
Department of Economics

Supervisors:

Anna Grodecka-Messi, Lund University

Jakob Almerud, Konjunkturinstitutet

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Abstract

As the COVID-19 pandemic spread across the globe, unprecedented policy measures were implemented by central banks and governments to dampen the effect on the real economy. Alongside the spread of the pandemic, research regarding how to simulate similar effects of the virus on the real economy and how to formulate optimal policy began spreading at an equal pace. The aim of this thesis is twofold. It tries to contribute to this new strand of research by using a dynamic stochastic general equilibrium (DSGE) model with financial frictions to mimic the movements of key economic variables to how they moved during the outbreak of the COVID-19 pandemic. To simulate these outcomes, a time-preference shock to households' discount factor is applied, as well as a total factor productivity shock and a shock to the external finance premium. The second aim of this thesis is to evaluate how the European Central Banks' (ECB) previous unconventional monetary policy, in the form of funding-for-lending schemes, has impacted the resilience of the Euro Area economy when an adverse shock hit. The model-specific outcomes from this exercise indicate that the return to physical capital has been somewhat eroded following these unconventional measures from the ECB, thus making firms probability of default higher.

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Keywords: DSGE, financial frictions, monetary policy, pandemic, Euro Area, probability of default

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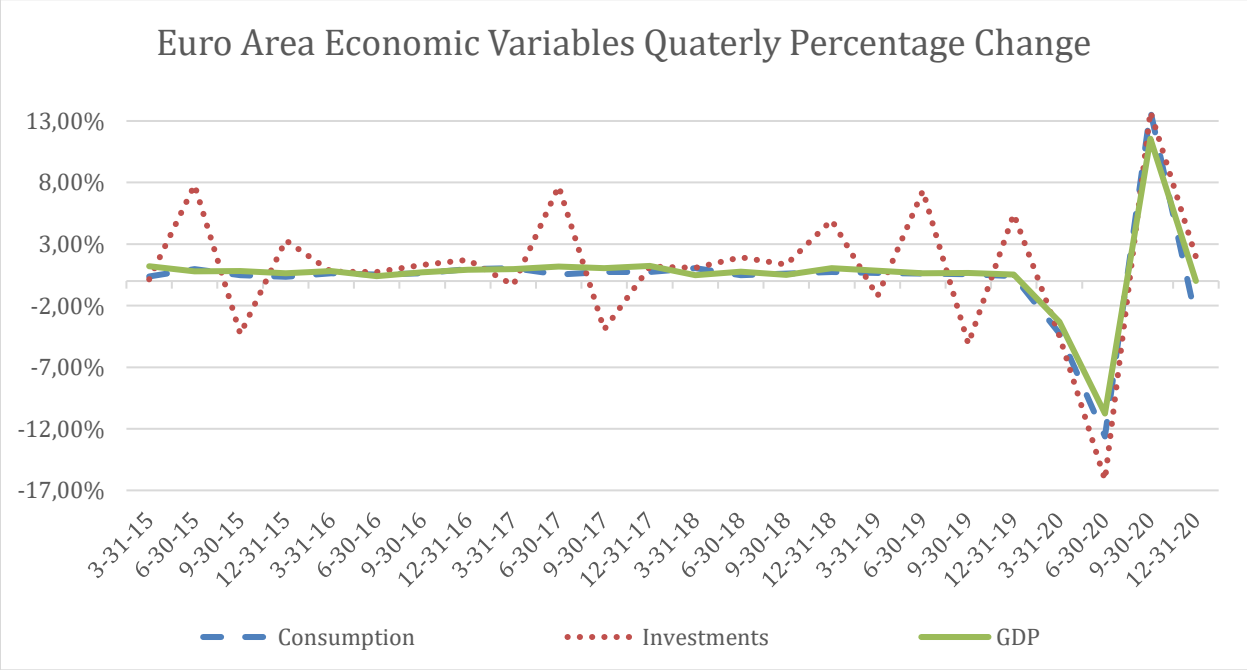
1 Introduction

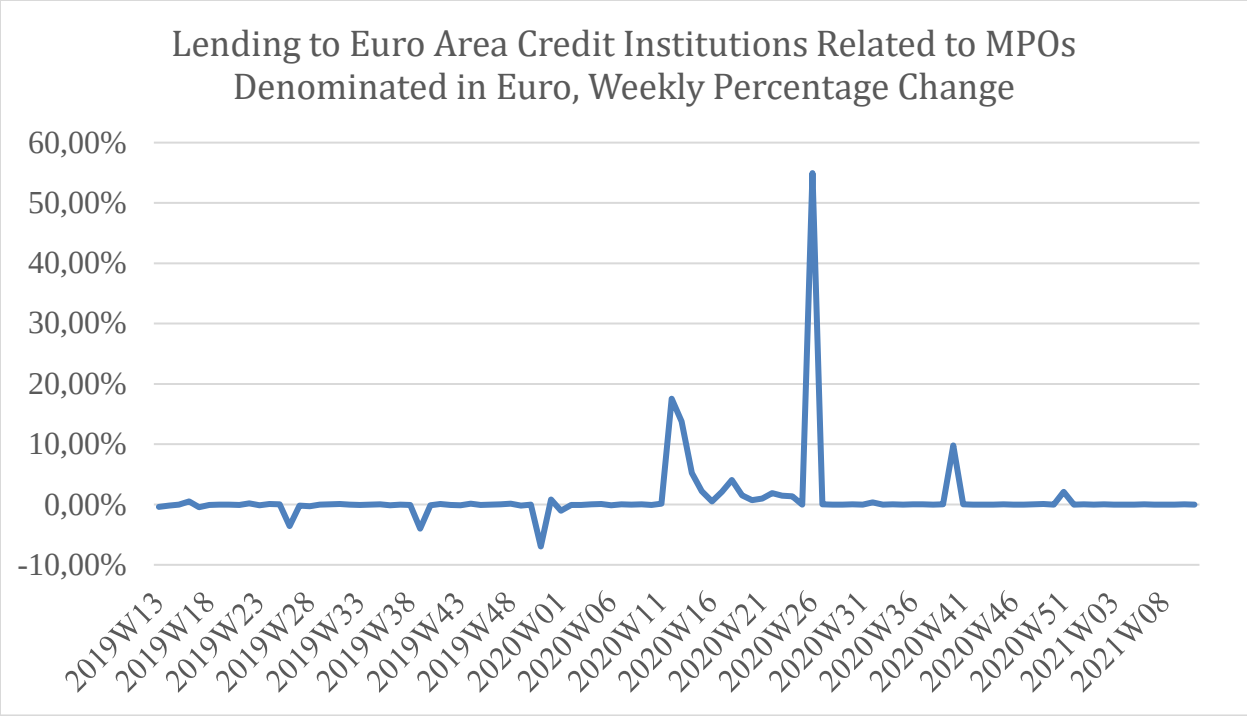
In the spring of 2020 when the COVID-19 pandemic spread across the globe, an almost unprecedented reaction both on the financial markets and in the real economy occurred. During these turbulent weeks central banks, like for example the European central bank (ECB) and the Swedish Riksbank, as well as governments tried to support the economy by implementing expansionary policy measures. Aside from lowering policy rates and increasing the amount of asset purchases, central banks conducted funding-for-lending programs, which gives favorable borrowing conditions to banks in exchange for them to expand the supply of loans to agents in the real economy.

"- Full alignment of fiscal and monetary policies - and a level playing field against the virus - is the best way to protect our productive capacity and employment, enabling us to return to sustainable growth and inflation rates once the coronavirus outbreak passes." Christine Lagarde, (2020)



Graph 1, source: ECB (n.df)

Ever since the outbreak of the pandemic, economists have tried different methods to capture the effect of the pandemic on the real economy. In this thesis, I will address this topic using a dynamic stochastic general equilibrium (DSGE) model. Researchers working with DSGE models have tried both conventional supply and demand shocks, as well as financial shocks, to try to capture the impact of the pandemic but with no concrete consensus reached among them. This is often due to the difficulty of the DSGE models to mimic the movements of all variables to what happened to actual economic data when the pandemic struck. Since central banks, through their role as liquidity supplier to banks, can affect the level of credit in the economy this thesis tries to capture the implications of their credit facilitation when an adverse shock hits the economy. So, in a nutshell, this thesis tries to examine, with the help of a DSGE model with financial frictions, how different levels of liquidity provision dampen or even amplify the reaction of the real economy to an exogenous shock. Since the Euro Area inhibits heterogeneity among its member states and that it has a common monetary authority, but individual fiscal authorities, a Euro Area model felt like an interesting choice to answer these kinds of questions. It turns out that relatively more generous funding provided by the central bank can have ambiguous effects on the propagation of the shocks in the economy. This shock's ultimate impact on the business cycle depends on the characteristics of the shock in question. In the model world, the distinction between different exogenous shocks is quite clear, which may not be the case in the real-world economy. The COVID-19 pandemic is an unprecedented event that does not fit traditional definitions of shocks in DSGE models, since it features both demand and supply characteristics. In situations like that, it is even more important to be able to evaluate a given policy under different circumstances, i.e. shocks. As this thesis shows, providing vast liquidity to the economy is far from being the best monetary policy strategy. As will be outlined below, past policy measures do have a strong impact on the resilience of the Euro Area economy, where structural issues as decreased firm productivity become apparent.



Graph 2, source: ECB (n.df)

This thesis is structured as follows: section two gives a brief overview of the ECB and its policy tools, as well as an overview of DSGE models. Section three goes over the literature regarding Euro Area DSGE models, financial frictions, and different aspects of productivity. Section four lays out the reasoning for the chosen shocks and motivation for why different lending arrangements are tried. Section five presents the model used in this paper by Poutineau and Vermandel (2015a). Section six presents the results, section seven analyses and section eight concludes.

2 The ECB and DSGE models

2.1 The ECB and Unconventional Monetary Policy

The European central bank is the central bank of the European Monetary Union (EMU), which conducts the monetary policy for its 19 members. Their main objective is to achieve price stability, but other important tasks include managing its currency reserve, promoting a safe payments system, and acting as a lender of last resort (ECB n.da). Common tools they have at their disposal include the deposit interest rate and more unconventional tools like asset purchases and forward guidance (ECB n.db).

So-called funding-for-lending programs are instruments that a central bank can use to ensure that the credit supplied by banks to households and firms is held intact when the economy is facing an economic downturn. This type of instrument provides longer-term funding from the central bank to banks at favorable interest rates. These favorable conditions are however conditioned on banks increasing their lending to firms and households (Johnson et al. 2020). Similar measures have been implemented by the ECB over the years. Targeted longer-term refinancing operations (TLTROs) have been used by the ECB since 2014. The favorable interest rates in these programs are linked to the amount of credit the banks supply to households and firms. So, the more loans the bank issue to these borrowers, the more attractive interest rate they receive from this program (ECB n.dc). After the outbreak of the COVID-19 pandemic, the ECB launched a series of expansionary measures to combat the adverse impacts. A package of collateral easing measures was introduced, effectively making it easier for more banks to receive favorable funding from the ECB (ECB n.dd). Also, another funding-for-lending program called Pandemic emergency longer-term refinancing operations (PELTROs) was introduced. This program aimed to provide further liquidity support to the euro area financial system at a time of tightening lending conditions (ECB n.de).

The simplified economic rationale behind implementing these expansionary measures was to stimulate economic activity during these stressful times. By making it easier for banks to receive favorable funding from the ECB, these measures aim at dampening the negative impact on consumption and investment from the pandemic. The idea is that more favorable borrowing

conditions for banks will expand their supply of loans to firms and households and hopefully pass on these favorable borrowing conditions, effectively incentivizing firms and households to borrow for consumption and investment spending. By using these stabilizing measures, the ECB hopes to dampen the effects on unemployment and price-level changes in the Euro area following the realization of the pandemic.

Andreeva and Garcia-Posada (2020) assess the impact of the TLTRO program implemented by the ECB on lending policies in the Euro Area. They find that the TLTROs reduce marginal costs for banks participating in the program, which led them to increase the supply of loans they provide. As TLTRO was launched to expand the credit supply in the Euro Area, Altavilla et al. (2019) report that this intended outcome was realized. They show that 84 percent of banks admit that TLTRO increased their borrowings to corporates and 35 percent says it impacted borrowings to consumer positively. Blattner and Swarbrick (2018) find that both long-term refinancing operations and asset purchases can act as complements and/or act as substitutes for conventional monetary policy to ease financing conditions when turmoil on interbank markets strike.

2.2 Overview of DSGE models

Many of the major policy institutions have created their own DSGE models that feature national heterogeneities. Examples include the European Commission's QUEST 3 model that is used by, for example, Ratto, Roeger and in't Veld (2009), to analyse the stabilizing effects of monetary and fiscal policies within the Euro Area. Bokan et al. (2018) built upon the ECBs multi-country Euro Area model and finds, among other things, that the financial shocks and the national banking sectors can be the sources of business cycle asymmetries in a monetary union. These models developed by major policy institutions tend to fall somewhere between the open economy setup and the two-country economy setup strands within DSGE modelling of the Euro Area, where the distinction between these will be presented in the next section.

DSGE models are used to understand the co-movement of different economic time series over the business cycle by applying macroeconomic theory in the modelling (Del Negro and Schorfheide, 2013). The models describe how the decisions of the different agents in the economy affect the

aggregate outcomes and how the decision of one agent affects the other agent's decisions. As a concept DSGE is broad and includes both neoclassical growth models like in King, Plosser and Rebelo (1988) and New Keynesian models like in Smets and Wouters (2003) and Christiano, Eichenbaum and Evans (2005). DSGE models are often called “microfounded” (Sbordone et al., 2010) since the decision rules of households and firms often build upon assumptions regarding preferences and technology from microeconomic theory. This makes DSGE models with an accurate empirical prediction to have a strong theoretical underpinning. This kind of model has become one of the workhorse models for policymakers at central banks as well as in academia to evaluate the functioning of economies all around the world. A major critic of the DSGE framework is that it inhabits faulty microfoundations that do not capture accurately the behaviour of economic agents (Stiglitz, 2018). Chari, Kehoe, and McGrattan (2009) argue that economists working with these models should repel their urge to introduce parameters unsupported by microdata just because it makes the model better fit the aggregate time series of economic variables.

An example of another framework used for similar tasks as the DSGE is vector autoregression (VAR) models. This is a macroeconometric framework for forecasting and policy evaluation introduced by Sims (1980). The framework is an n-equation, n-variable linear model where each variable is explained by its own lagged values, but also on current and past values of the remaining n - 1 variables. This framework has a systematic approach to understanding the dynamics of several different time series and differs from DSGE models in that it does not build upon economic theory and reasoning, but rather statistical methodology (Giacomini, 2013).

In simplified terms the economy described in DSGE models is initially in its predetermined equilibrium, or steady state as it is often called, and different kinds of shocks are introduced to capture how the economy reacts to exogenous disturbances. The researchers often use the DSGE framework to generate impulse response functions (IRFs), which show how for example consumption and investment deviates from their steady state when the shock occurs. Examples of shocks include a shock to time preferences, which effectively alters the way consumers value consumption today versus in the future. Another frequently considered shock is productivity shocks, which makes firms and other agents more or less productive over the next couple of periods. A monetary policy shock is also often applied and means that an unexpected change in

the central bank policy creates deviations from the steady state for endogenous variables in the model (Del Negro and Schorfheide, 2006).

Efforts to create tractable models that match empirical outcomes led to nominal rigidities being introduced, which often means that goods and labor markets are not perfectly competitive. An example of how these frictions can arise is if the model includes Calvo-style frictions (Calvo, 1983), where economic agents can change prices and wages only by some exogenous probability in each period. This makes prices and wages become "sticky", which resembles real-world prices and wages. Another example of assumptions being used to enhance the modelling framework is habit-persistence in consumption as in Fuhrer (2000). This implies that consumption today depends positively on yesterday's consumption and leads to slower changes in consumption over time, something that finds support in both the finance and psychology literature as well as in economic data (Christiano, Eichenbaum and Trabandt, 2018). Furthermore, investment adjustment costs are another common assumption to create more realistic models. Similar reasoning applies here, i.e. it is costly to adjust the level of investment too much, thus investment changes slowly over time, which increases the empirical fit of the theoretical models (Eberly, Rebelo, and Vincent, 2012). Lastly, credit frictions have gained a lot of traction since the Global Financial Crisis (GFC), where the financial accelerator by Bernanke, Gertler and Gilchrist (1999) is a common choice. In simplified terms, the less money a borrower puts up as collateral for a loan, the higher the interest rate the borrower will be charged, which is reasonable since the banks take on more risk financing this project. Assuming profits and asset prices are procyclical, this so-called external finance premium will be countercyclical, which means that borrowing costs will increase, and thus the level of investment and production will decrease, when an adverse shock hits the economy.

3 Related Literature

3.1 Euro Area DSGE models

DSGE models have been widely used for modelling the Euro Area within policymaking circles, and due to the national heterogeneities within the area, three general strands have come to life. A two-country version where more core versus periphery issues can be analysed, the Euro Area as a closed economy and lastly the Euro Area as an open economy.

Relevant examples of a closed model setup include Smets and Wouters (2003). Their model incorporates, among other assumptions, habit formation in consumption and cost of adjustment in capital accumulation. Their main findings are that the productivity shock is only responsible for 10 percent of the variations in long-run output. They instead show that shocks to preferences, labor supply and monetary policy account for the largest shares of variation in output, inflation and interest rates. Adolfsson et al. (2007) modifies the closed economy setup of the model by Christiano, Eichenbaum and Evans (2005) to an open economy setup and estimate it on Euro Area data. Putting it simply, the open economy setup takes into account exchange rate fluctuations and trade with foreign countries. Their findings strongly support the need for assumptions like investment adjustment costs and habit persistence in consumption like those mentioned before. The authors' reason that extending benchmark closed economy models into open economy settings finds empirical support for making plausible assumptions around business cycle fluctuations, where this model can capture the dynamics of the real exchange rate quite well.

Examples of two-country models that are used to analyse optimal policy, aside from the model I use in this thesis, include Quint and Rabanal (2014). They use a two-country DSGE model of the euro area with nominal and financial frictions to study the interactions of monetary and macroprudential policy. They find that optimal monetary and macroprudential policies are welfare improving under housing demand and risk shocks, as these measures reduce the volatility of real variables by offsetting accelerator effects triggered by these shocks. On the other hand, when technology shocks hit the economy, macroprudential policies have the opposite effect and

amplifies the countercyclical behavior of the lending-deposit spread. This creates larger fluctuations of consumption, housing investment, and hours worked for borrowers, which reduces their welfare. They conclude that for successfully implementing stabilizing measures, one needs to identify the source of the house-price boom. Another example is Badarau and Levieuge (2011), who analyse how financial heterogeneity can amplify the cyclical divergences inside a monetary union that faces different shocks. They find that financial shocks that are transmitted differently in the two economies caused a further divergence to this already heterogeneous monetary union. They also find that a common monetary policy increased cyclical divergences. Thus, they provide some arguments for why taking part in the currency union is not always optimal for all countries in the Euro Area. Furthermore, Darracq, Kokk Sorensen and Rodriguez-Palenzuela (2011) find strong support for an active macroprudential policy as a good complement to monetary policy when shocks originating in the financial sector arise.

Interesting conclusions that are made when accounting for national heterogeneities beyond just a two-country setup is found in Albonico et al. (2019) paper. They find that the post-GFC dip in economic activity in Italy and Spain was mostly driven by positive saving shocks i.e. deleveraging, and by an increase in investment and intra-euro risk premia. Aside from that, the fiscal austerity in Spain and the productivity decrease in Italy have contributed to the economic downturn in those countries. Their results make them argue that euro depreciation, increased intra-euro risk premia and depressed investment had a large impact on the trade balance turnaround in Italy and Spain. The detailed results for different countries within the Euro Area stand in contrast to the existing literature that is mostly focused on either individual Euro Area Member States like in in’t Veld et al. (2014, 2015) for Spain, and Kollmann et al. (2015) for Germany, or the Euro Area as one economy like in Kollmann et al., (2016) and Giovannini et al., (2018).

3.2 Models with Financial Frictions

Since this thesis aims at understanding the impact of different lending arrangements on the real economy, and because the model used in this thesis has a rich setup of financial frictions, some of the most influential work on financial frictions is introduced below.

Christiano, Motto and Rostagno (2010) augment a common DSGE model with a banking sector and financial markets. They find that among other factors, agency problems in financial contracts are crucial for understanding business cycle fluctuations. Since the borrower knows more about its ability to repay the loan, asymmetric information exists and diverging incentives between the banks and the borrowers might exist. Since there is not always an easy way to align their incentives, these so-called agency problems might occur. Agency problems along with factors like changed perception of market risks can unleash and propagate turmoil in the financial sector out to the real economy, and the authors mean that these factors have a good way of explaining the outbreak of the GFC. More generally regarding financial intermediation, Ajello (2016) finds that shocks to financial intermediation that affects the spreads between interest rates were responsible for a large part of the volatility in output and investment, both before and at the start of the GFC. Moreover, Gerali et al. (2010) find that the stickiness of bank lending rates helps dampen the effects on both consumption and investment when a monetary policy shock is applied.

Villa (2016) provides a comparative analysis of financial accelerator mechanisms. This comparison takes place in a Smets and Wouters (2007) model where the first kind of financial friction is derived from the need for a state verification cost à la Bernanke, Gertler and Gilchrist (1999). This costly state verification means that in the contract between the lender and the borrower the lender can pay a monitoring cost, which makes it possible to evaluate the ability of the borrower to repay the loan. One of the first papers to theorize this costly state verification is Townsend (1979). The second setup of frictions exists within the financial intermediaries due to a moral hazard problem à la Gertler and Karadi (2011). In this model, banks can perfectly monitor firms but are constrained by how much funds they can receive from depositors, i.e. households. The moral hazard issue is that since the banker is considered as part of the household sector, and that the banker can terminate loans to firms, this might induce the banker to terminate loans and pay

large bonuses to himself. The model's incentive compatibility constraint with regards to deposits is however constructed such that this does not happen. Villa finds that the setup of the banking sector from Gertler and Karadi (2011) works much better at amplifying the shocks applied to the economy and that these frictions find larger support from both US and Euro Area data. The difference between these setups is derived from the fact that a change to net worth causes different outcomes for real activity, where Villa states that the financial accelerator mechanism from Bernanke, Gertler and Gilchrist (1999) is weaker than that of Gertler and Karadi (2011).

3.3 Monetary Policy and Productivity

The results of this thesis can be understood if one takes a look at the connection between monetary policy and productivity in the economy. There has been a lively debate on this subject and due to this and due to the connection to my results, I will present some arguments regarding this topic. Obstfeld (2018) argues that expansionary monetary policy has an impact on total factor productivity growth in the world economy, but if it is positive or negative is still up for debate. In short, the term secular stagnation can be explained as an economy facing low productivity growth, low inflation, and low interest rates, which can be a hard nexus to break (Summers, 2013). Obstfeld argues that the GFC amplified this nexus, but that the productivity slowdown is mainly a secular phenomenon. In theory, as interest rates become lower entrepreneurs' projects tend to become more profitable, leading firms to invest more. But given that financial markets inhibit imperfections, misallocation of capital occurs as the less credit-constrained firms can reap the benefits of lower borrowing costs easier. This leads to capital not being allocated to where it is most productive (Midrigan and Xu, 2014). Arguments for accommodative monetary policy thus amplifying this "zombie firm" problem stems from this. As borrowing costs go down it becomes easier for these unproductive firms to stay alive, which not only affects aggregate productivity negatively but also poses a financial stability risk. Caballero, Hoshi and Kashyap (2008), find evidence in Japan that zombie firms reduce "healthy" firms' profits, thus making them less inclined to enter and invest. Furthermore, they found that industries with a large share of zombie firms tended to have a depressed job creation and lower productivity than other industries. These issues, the authors argue, might have worsened the stagnation of the Japanese economy that started in the 1990s. Gopinath et al. (2017) illustrate that the decline in the real rate of interest leads to a

significant decline in sectoral total factor productivity in Spain. This is because as capital is misallocated to firms that have a high net worth, but are not necessarily more productive, this leads to downward pressure on productivity. They find similar productivity losses in Italy and Portugal, but not in Germany and France. On a more recent note, Cella (2020) investigates the bankruptcies that occurred in Sweden when the COVID-19 pandemic struck. The paper looks at numerous different financial ratios like firm leverage and interest payment coverage to gauge the financial health of firms in the sample. She finds that firms that filed for bankruptcy during the pandemic had a weaker financial standing than most of their competitors before the crisis, which is quite an intuitive finding.

Since the zombie phenomena can be traced back to stabilizing economic policies that went on for too long, a concrete way forward for policymakers to alleviate this problem is not easily identified. McGowan, Andrews and Millot (2017) exemplify this problem by mentioning that government-backed loans to corporates with low-interest rates may have dampened the mass layoffs that would otherwise have occurred after the GFC, but as these programmes went on for too long, the credit facilitation became distorted and a misallocation of capital and labor to unproductive firms occurred, effectively lowering the productivity growth for the years after the crisis. Acharya et al. (2019) argue that through the launch of the Outright Monetary Transactions (OMT) program by the ECB, yields on periphery Euro Area bonds declined, effectively recapitalizing banks that held these bonds in large quantities. The authors however find that the increased lending was targeted towards lower-quality borrowers since banks hoped that this would induce corporates to improve their solvency situation and not force the banks to realize loan losses. Their findings are theoretically supported by the Bernanke and Gertler (1995) paper where they introduce the balance sheet channel as a positive realization of the credit quality of the borrowers. So, the issue with zombie lending stems from banks' shift in attitude towards risk and their incentives to evergreen loans, effectively misallocating credit, thus resulting in slower economic recovery. Also, Banerjee and Hofmann (2018) find a strong correlation between falling interest rates and the increasing share of zombie firms. The causal direction is however not clear since they argue that a larger share of zombie firms weighs negatively on productivity growth, which pushes down interest rates over the long run. So, the policy trade-off between increased investments and employment in the short

run and a higher degree of misallocated resources to unproductive firms in the long run is still alive.

However, in papers like Gamberoni, Giordano and Lopez-Garcia (2016), hard proof of capital misallocation due to expansionary monetary policy seems inconclusive and that this relationship has been hard to identify in data have been the main reasoning for why the productivity decline might be the result of something other than monetary policy.

4 Shocks and modelling for accommodative monetary policy

Since the outbreak of the COVID-19 pandemic, there has been a lively debate among economists on whether it is a shock to demand or supply or both. A consensus regarding this has not been reached and there is an abundance of papers examining this. What seems to be the thus far most reputed work on COVID-19 shocks in DSGE models is done by Guerrieri et al. (2020). They argue that the outbreak of COVID-19 is similar to what they call Keynesian supply shocks. Keynesian supply shocks are supply shocks that change aggregate demand even more than the initial magnitude of the supply shock. Furthermore, Eichenbaum, Rebelo and Trabandt (2020) found that households' decision to reduce consumption and hours worked dampens the severity of the pandemic but amplifies the size of the influenza-induced recession. Burriel et al. (2020) is another example of a paper looking at a demand shock, namely a time-preference shock to the households' discount factor. McKibbin and Vines (2020) try to mimic the reaction of COVID-19 by applying a shock to time-preferences, but also a shock to the equity risk premium and total factor productivity. Papers that look more to the supply side include Hürtgen (2020) who looked at a total factor productivity shock and Bosca et al. (2021) who found that the total factor productivity shock contributed most to the GDP drop in Spain following the pandemic. Examined shocks on the supply side but more focused on labor supply can be found in Mihailov (2020). Ideas regarding capturing the COVID-19 macroeconomic impacts through financial shocks are also present. Aside from applying more traditional supply and demand shocks, Angelini et al. (2020) wanted to account for the macro-financial linkages apparent after the outbreak of the pandemic. They used data on corporate bond rates to calibrate this financial shock. Furthermore, Baker et al. (2020)

apply what they call a disaster shock, calibrated based on the volatility of the U.S. stock market at the beginning of 2020. Outside the DSGE framework however, authors like Balleer et al. (2020) found through examining business survey data that demand disruptions had a larger impact in Germany than supply disruptions. The more dominant demand forces are shown through firms' higher propensity to decrease rather than increase prices.

To capture the effects of the pandemic in this paper three different shocks are tried. The first shock is a negative one to the household's time-preferences. The reasoning here is that households do not know for how long this pandemic will last, thus they decrease consumption and hence overall demand in the economy decreases. The second one is a negative shock to total factor productivity. The reasoning here is that as countries implemented lockdowns, disruptions to supply chains occurred, effectively causing disruptions for firms to conduct day-to-day business. The third shock is a positive one to the external finance premium. This shock can be interpreted as given the turbulence of the outbreak of the pandemic; entrepreneurs now require a higher rate of return to finance capital renting for intermediate good firms. They have become more risk-averse so to speak. Below the shock processes for the time-preference, total factor productivity, and external finance premium shocks are shown respectively. These exogenous disturbances follow an AR(1) process with both a country-specific and a common error term η.

$$\varepsilon_{i,t}^{\beta} = \rho\varepsilon_{i,t-1}^{\beta} + \eta_{i,t}^{\beta} - \eta_{t}^{\beta} \tag{1}$$
$$\varepsilon_{i,t}^{A} = \rho\varepsilon_{i,t-1}^{A} + \eta_{i,t}^{A} - \eta_{t}^{A} \tag{2}$$
$$\varepsilon_{i,t}^{Q} = \rho\varepsilon_{i,t-1}^{Q} + \eta_{i,t}^{Q} + \eta_{t}^{Q} \tag{3}$$

The shock processes can be found in the Macroeconomic Model Data Base software (Macromodelbase, n.d), that is described more in section six. The experiment conducted in this thesis is studying the evolution of the economy after these three shocks under different shares of illiquid banks in the economy. Since the response to the shocks from the ECB is endogenous in this model the experiment here focuses more on how these shocks propagate under different lending arrangements. So, the question is rather how previous unconventional monetary policy, in the form of expanded credit facilitation through funding-for-lending schemes, will impact the transmission of these shocks to the real economy. The study of the endogenous response of the ECB to these shocks is beyond the scope of this thesis. However, comparing the models' results

under different shares of illiquid banks can nonetheless provide us with interesting insights on the transmission of monetary policy in times of a crisis.

5 The model by Poutineau and Vermandel (2015)

In this thesis, I provide simulations with an already existing Euro Area DSGE model. To be able to account for the effects of different lending arrangements, the focus is on doing simulations with different shares of illiquid banks. What characterizes an illiquid bank and other model specifications is presented below. The model I have chosen is taken from the paper "Cross-border banking flows spillovers in the Eurozone: Evidence from an estimated DSGE model" by Poutineau and Vermandel (2015a). The equations presented below, and all the other equations in the model, can be found in the appendix (Poutineau and Vermandel, 2015b). I choose this model because I wanted to study the implications of previous unconventional monetary policy within the Euro Area when an adverse shock hits the economy. These implications are possible to study through the models' differentiation between liquid and illiquid banks. Aside from the models' rich financial frictions, it also inhibits detailed modelling over both the supply and demand side of the economy. Figure 1, which is taken from Poutineau and Vermandel (2015a), depicts an intuitive way of understanding how this model works. It shows how the two countries, core and periphery, both have a banking, production and household sector and how these sectors interact with each other. The banking sector consists of both liquid and illiquid banks, where the difference is that liquid banks have access to ECB funding, while illiquid banks have to rely on interbank funding for their activities.

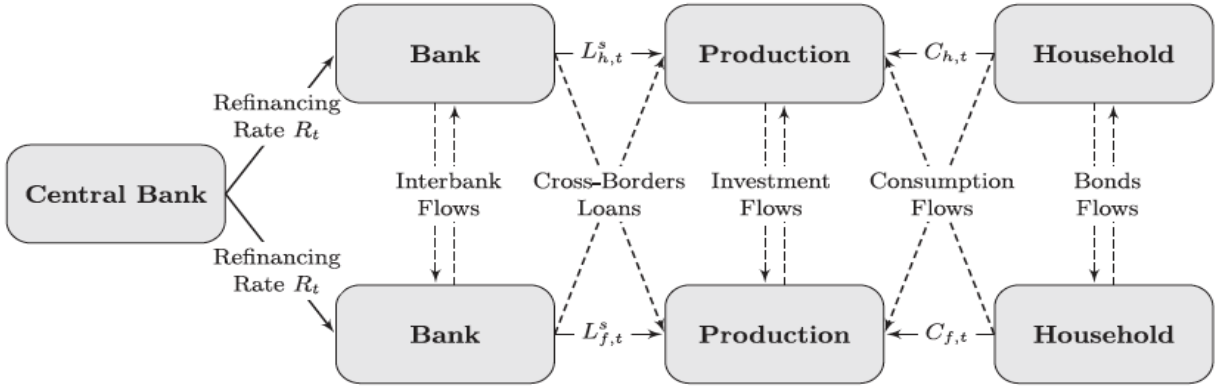


Figure 1 (adapted from Poutineau and Vermandel, 2015a)

5.1 Banking sector

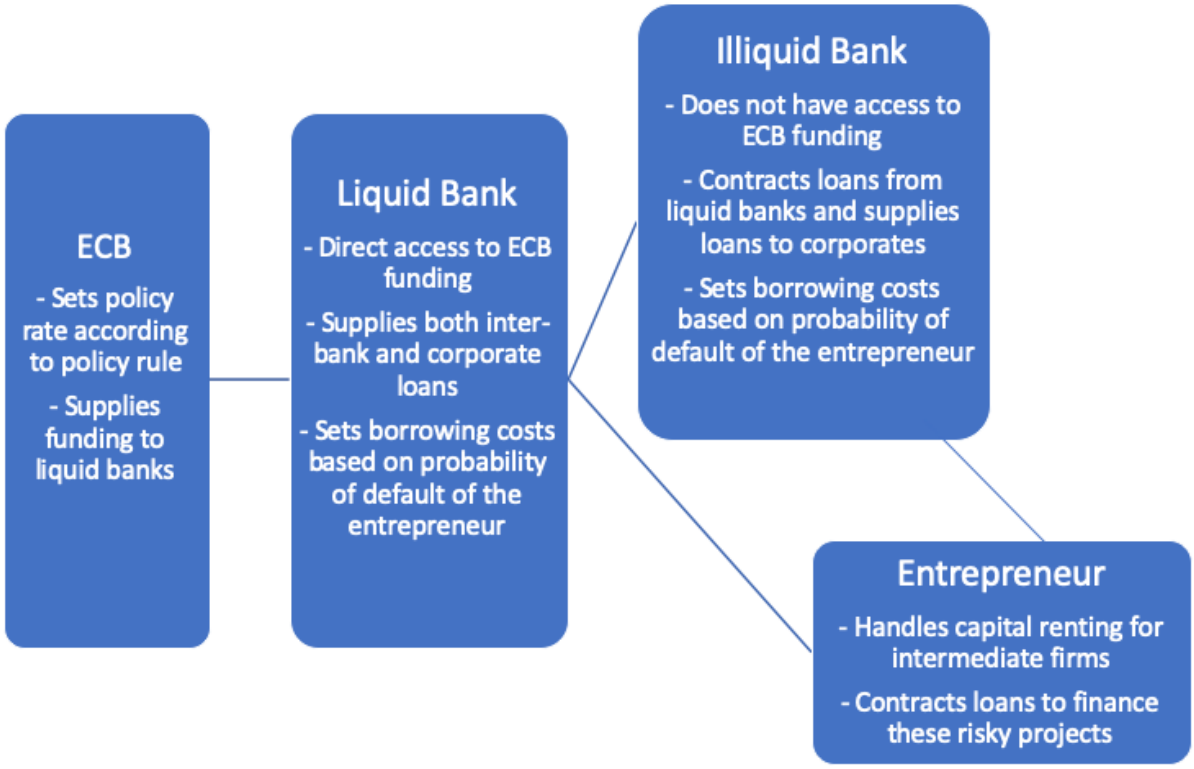


Figure 2, Source: own work based on author's description in Poutineau and Vermandel (2015a)

Both countries in this model have a banking sector that finances investment projects by supplying loans to both core and peripheral entrepreneurs. In this model, the heterogeneity of the banks gives rise to an interbank lending market. A share of banks, [0, λ], are illiquid and are dependent on interbank funding to finance its activities. The other share of banks, (λ, 1], are liquid and thus have direct access to ECB funding. As figure 2 depicts, liquid banks receive funding from the ECB and can supply loans to both illiquid banks and entrepreneurs, whereas illiquid banks need to borrow from liquid banks to be able to supply loans to entrepreneurs. The motivation for this assumption is supported by Gray et al. (2008), where the reasoning is that only a fraction of the credit institutions in the Eurosystem have direct access to the main refinancing operations of the ECB, while the rest are dependent on interbank funding. In this model, entrepreneurs and illiquid banks can borrow from liquid banks in both countries, thus giving rise to both a cross-border interbank lending market and a cross-border corporate lending market.

Both types of banks supply loans to both core and periphery entrepreneurs without discriminating based on country of origin. This means that the banks do not take into account the national viability of projects that the entrepreneur wants to finance. In this model, the banks' set the cost of borrowing for corporate loans according to the following log-linearized equation

$$P_{i,t}^{L} = E\left(\Omega_{i,t+1}\right) + E\left(R_{i,t+1}^{K}\right) + \mathbb{Q}_{i,t} + K_{i,t} - (L_{i,t}^{D} - (\zeta L_{i,t-1}^{D})) \tag{4}$$

Where $\Omega_{i,t+1}$ stand for the default threshold in the next period, i.e. the probability of default on entrepreneurs' projects in the next period. $R_{i,t+1}^{K}$ is the return to physical capital in the next period, $\mathbb{Q}_{i,t}$ is the shadow value of capital, $K_{i,t}$ is the capital stock, $L_{i,t}^{D}$ is the corporate loan demand, and ζ is a parameter capturing corporate loan demand habits. So, as we can see the cost of borrowing depends on the expectation of how profitable the projects by the entrepreneurs are.

Illiquid banks finance their operation through interbank loans, where interbank loan demand is subject to external habits similar to the ones that Guerrieri, Iacoviello and Minetti (2013) implement in the entrepreneurs borrowing constraint in their model. The rationale here is similar to that of the habits in consumption assumption, i.e. loan demand changes slowly over time and makes the model fit the data better. The equation for interbank loan supply looks as follows.

$$IB_{i,t}^{S} = (\tfrac{\lambda}{1-\lambda})(1-\alpha^{IB})IB_{i,t}^{D} + \alpha^{IB}IB_{j,t}^{D} + \alpha^{IB}\left(1-(2\varphi)\right)ToT + 2\varphi(1-\alpha^{IB})\alpha^{IB}\left(r_{j,t}^{IB} + E(\pi_{j,t+1}^{C}\right) - r_{i,t}^{IB} - E(\pi_{i,t+1}^{C})) \tag{5}$$

Where IB_t^S and IB_t^D is the interbank loan supply and loan demand respectively. λ is the share of illiquid banks in the economy and it is the parameter I change when conducting the exercise in this thesis. α^{IB} stands for the openness of the interbank market, which shows how willing liquid banks are to supply loans to foreign illiquid banks. ToT stands for the terms of trade of the core economy, r_t^{IB} is the interbank lending rate and π_t^C is the inflation rate. Lastly, the φ parameter captures the substitutability of interbank loans.

5.2 Entrepreneurs

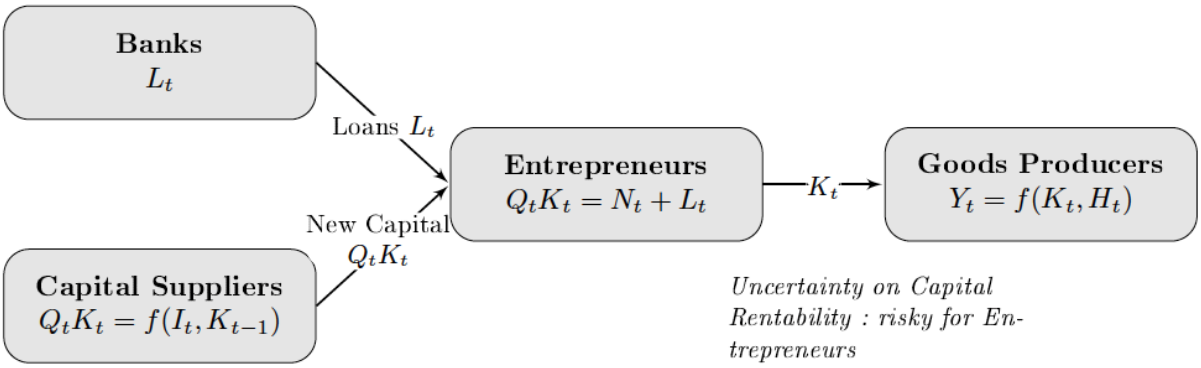


Figure 3 (adapted from Poutineau and Vermandel, 2015b)

As shown in figure 3, the role of the entrepreneur is to finance the capital renting for the intermediate good firms. These projects are financed by the entrepreneur's net wealth and by contracting corporate loans from the banking sector. The entrepreneur contracts loans from the banks to be able to buy capital from the capital suppliers. The distinction between the entrepreneur and the intermediate good firm is not crystal clear. Not completely correct, but for simplicity, the reader can think of the entrepreneur as the CEO of the intermediate good firm. He is not the firm per se, but he takes the most crucial decisions regarding the firms' production.

The investment projects undertaken by the entrepreneur are risky and have idiosyncratic returns. To model for this heterogeneity, the returns of the projects are modelled using a Pareto distribution. Since entrepreneurs cannot beforehand witness the value of their profitable project, this cannot be something to control for in a financial contract between a borrower and a lender, in contrast to the standard methodology first outlined by Bernanke, Gertler and Gilchrist (1999). This means that banks cannot consider the viability of the projects when they set the interest rate on the loan. To introduce a financial accelerator in this model, the authors take inspiration from De Grauwe (2010) and assume that the entrepreneurs make upward biased forecasts about the profitability of a given project. So, in this setting, the financial accelerator does not emerge from some moral hazard problem, but from overconfidence by risk-taking entrepreneurs. Since these overconfident entrepreneurs might not be able to produce the return they expect, a shock that affects the profitability of projects gets amplified through this mechanism. This optimistic expectation

assumption finds support from Bachmann and Elstner (2013), where overconfidence is found among German firms.

5.3 Households

In both the core and periphery economies there is a continuum of households who consume, save and work in intermediate good firms. They try to maximize a welfare index subject to their budget constraint. The income that the households receive comes from labor, interest payments from bond holdings and from owning the firms that pay out dividends. This income is spent on consumption, bond purchases and tax payments. Habits in consumption behaviour as described in section two are present here.

5.4 Labor sector

The labor sector includes several agents who demand and supply labor. The members of the household supply labor to intermediate good firms and receive a wage as compensation.
Intermediate good firms use this labor as inputs in their production function. Labor unions ensure that the optimal wage level in the economy is met.

5.5 Firms

There exist both intermediate good firms and final good producers in this model. The intermediate good firms face monopolistic competition and produce differentiated goods with the use of capital, labor and technology. The prices set by firms cannot be freely adjusted every period. Instead, the firms face a price stickiness à la Calvo (1983). The final goods producers create a bundle of consumption goods from the national intermediate goods and then sell this to households. In this model, firms face investment adjustment costs as described in section two.

5.6 Capital suppliers

Capital suppliers in this model act on a competitive market where they supply capital to entrepreneurs. The capital stock consists of depreciated capital from the previous period and investment goods, and it grows with the increase in investment minus the depreciation rate. The objective of the capital supplier is to choose the level of investment that maximizes his profits. The authors of this model follow Smets and Wouters (2007) and assume that capital needs one

period to be settled, i.e. for investment goods to become capital. The level of utilized capital in the economy is determined by the rate of optimal capital utilization and the capital stock from the previous period, which is often a standard assumption to be made.

5.7 Authorities

Furthermore, the model has national governments that finance government spending by taxing the labor income of households. The government also imposes proportional taxes on entrepreneurs' profits. The ECB conducts monetary policy based on a reaction function that takes fluctuations in prices and output into consideration as the following equation shows.

$$r_t = \rho^R r_{t-1} + \frac{1}{2}(1-\rho^R)\left[\phi^{\pi}\left(\pi_{i,t}^C + \pi_{j,t}^C\right) + \phi^{\Delta Y}\left(Y_{i,t} - Y_{i,t-1} + Y_{j,t} - Y_{i,t-1}\right)\right] + \varepsilon_t^R \qquad (6)$$

Where r_t is the policy rate and ρ^R is a autoregressive parameter. π_t^C stands for inflation and Y_t for output, where ϕ^{π} and $\phi^{\Delta Y}$ captures the weight ECB puts on changes in inflation and output respectively. ε_t^R is a monetary policy shock.

6 Results

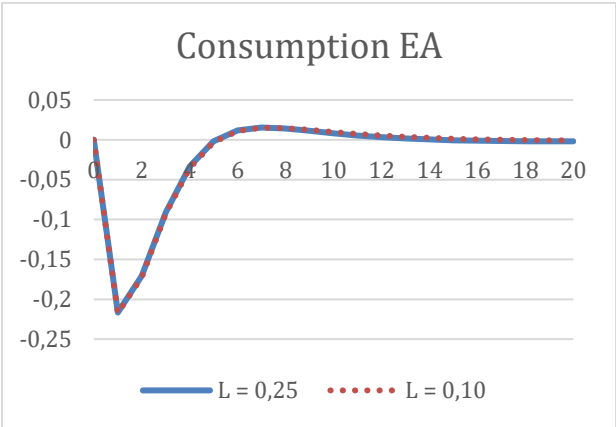
Presented below are the results from the time-preference shock, the total factor productivity shock and the external finance premium shock. To simulate the model results I have used the Macroeconomic Model Data Base (MMB) software, which includes a library of over 150 different macroeconomic models. This software can help the user with a comparison of results from different macroeconomic models (Macromodelbase, n.d). To simulate the results in MMB the user needs to connect it with the Dynare software in MATLAB. The Dynare software is used to solve DSGE and overlapping generation (OLG) models and can handle large and complex sets of equations (Dynare, n.d.). To emulate a more realistic outcome I altered the autoregressive parameters in the autoregressive shock equations. An assumption made here is that the shocks should not continue to affect the variables forever. This might be an invalid assumption, only time will tell, but at the writing moment, I have assumed that the initial shock effects of the COVID-19 pandemic will not have an impact on economic variables after 3 years. Thus, setting the autoregressive parameters in all three shock equations to 0.5 makes most of the variables go back to their steady state within 8 to 12 quarters. In contrast to the paper by Poutineau and Vermandel (2015a), since the COVID-19 pandemic is a global issue, the shocks that I use in this model hits both the core and the periphery economy equally and at the same time. The results presented below show the reaction of the whole Euro Area, which in this model means an average of the reaction between the core and the periphery. For each of the shocks, I first present the results with the benchmark calibration of all the parameters. The results of the benchmark calibration are depicted by the blue-filled lines in the figures below. After that, I present the results when the parameter for the share of illiquid banks is lowered, which acts as a proxy for the previous funding-for-lending schemes implemented by the ECB, and compare the results from the two different sets of calibrations. The results from the alternative calibration are depicted by the red-dotted lines in the figures below. The alternative value for the illiquid bank share is set to 0.10, in comparison to the benchmark calibration of 0.25. Since this is an exercise of theoretical nature, the exact value of the alternative calibration is not of crucial importance, focus here is rather that it is significantly different from the benchmark calibration and what implication that has on the model outcomes. The "λ" symbol and "L" is used interchangeably. The results from each shock are presented by impulse response functions. As previously stated, this shows how a variable deviate from its steady

state when the exogenous shock occurs. The reader can interpret each figure below as the variable's percentage deviation from its steady state after the exogenous shock hits.

Parameters	Value Benchmark Calibration	Value Alternative Calibration	Description
λ	0.25	***0.10***	Share of illiquid banks
β	0.995	0.995	Discount factor
χ	0.07	0.07	Portfolio adjustment cost
δ	0.02	0.02	Depreciation rate
α	0.25	0.25	Capital share
N/K	0.40	0.40	Net worth to capital ratio
H	1/3	1/3	Share of hours worked per day
G/Y	0.24	0.24	Spending to GDP ratio
IB/L	0.20	0.20	Interbank funds to lending ratio
BK/L	0.10	0.10	Bank capital to lending ratio
RL - R	0.02/4	0.02/4	Loan spread

Table 1, (adapted from Poutineau and Vermandel, 2015a)

6.1 Time-preference shock



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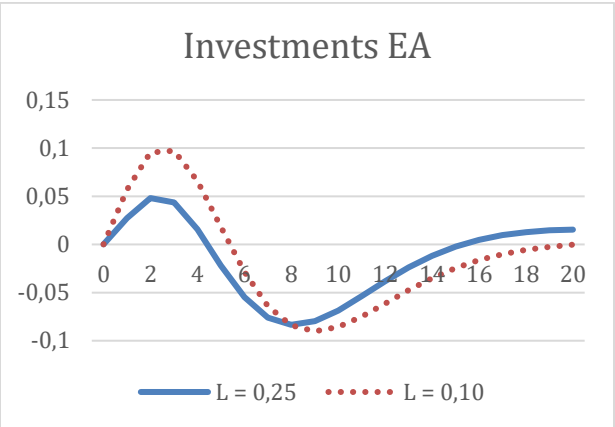

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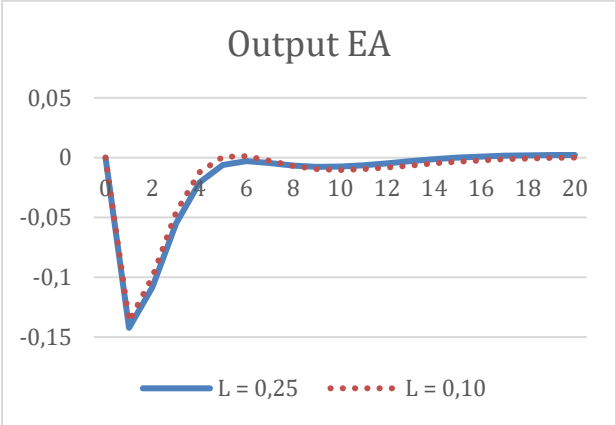

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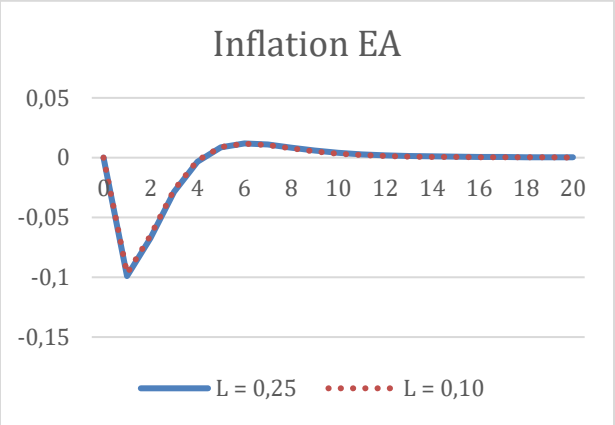

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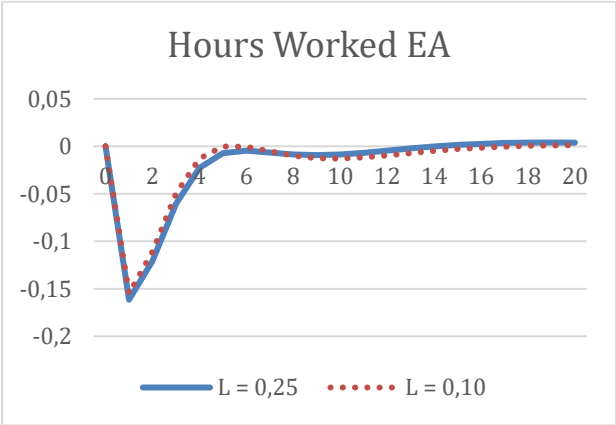

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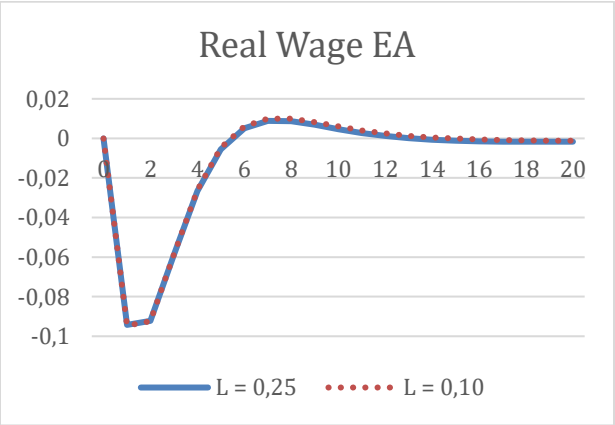

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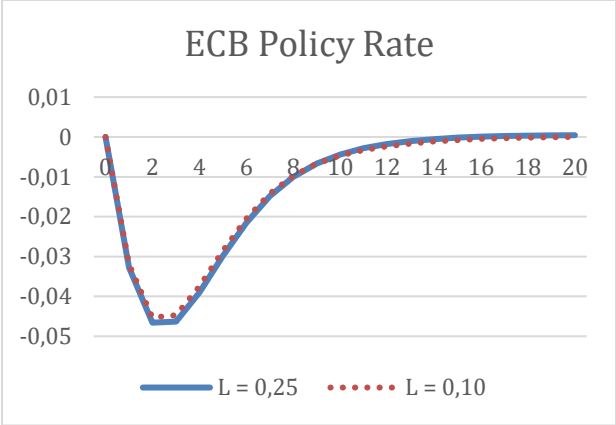
Figure 4 a)-f), impulse response functions to a time-preference shock

The time-preference shock changes the way that households value consumption today versus tomorrow, making them prone to alter their current level of consumption. Based on the reasoning of the standard Euler equation, if the discount factor decreases in value, either marginal utility today must decrease, which means consumption today increases or marginal utility tomorrow must increase, meaning consumption tomorrow decreases (Obstfeld and Rogoff, 1996). I would argue that here we see an increase in tomorrow's marginal utility, effectively decreasing consumption over the first few periods. Since this shock to the discount factor acts as a proxy for lower demand in the economy, we can see from figure 4a), and by support from Smets and Wouters (2003) model, that a negative time-preference shock lowers consumption due to this lower demand from households. This is reasonable since agents know that their consumption will have a higher value for them in the future since they might become unemployed. Thus, they decrease consumption in the first few periods. This discount factor also affects the way agents in the economy value investments. This shock makes agents prone to invest as it temporarily increases the return to physical capital in the economy. Because this is a negative shock, agents reason that investments will yield lower returns in the near future, thus they invest now to reap the benefits from this more productive level of capital before this negative shock affects the return to capital too much. In line with Smets and Wouters (2003) we see a negative relationship between consumption and investment when a preference shock hits. Since they found that investment gets crowded out during a positive preference shock, the opposite happens here, and we can see an initial increase in investments in figure 4b). But as this is a negative shock to overall demand in the economy, eventually investments decrease. As consumption decreases more than investments increase, and that consumption stands for a larger share of the output, we see that output decreases here. As this decrease in demand does not require the current level of capacity in production, hours worked decreases. Due to this shock, the real wage level goes down in the economy. Since both the cost of capital and the real wage fall, firms' marginal costs decrease. This forces firms to lower their prices to keep making profits on the goods markets, and we start seeing deflationary pressures as in figure 4d). The ECB combats the lower inflation by lowering its policy rate, as its policy rule reacts to the lower inflation rate.



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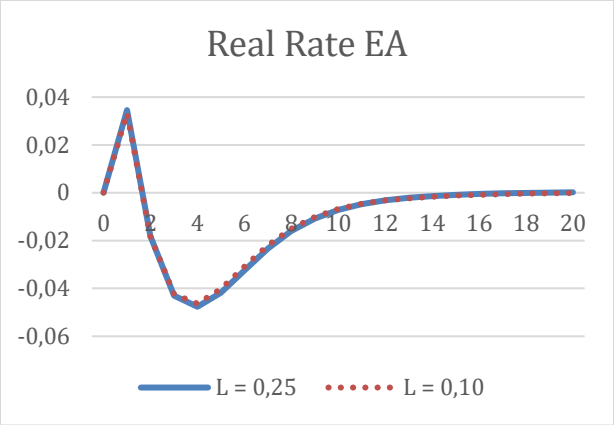

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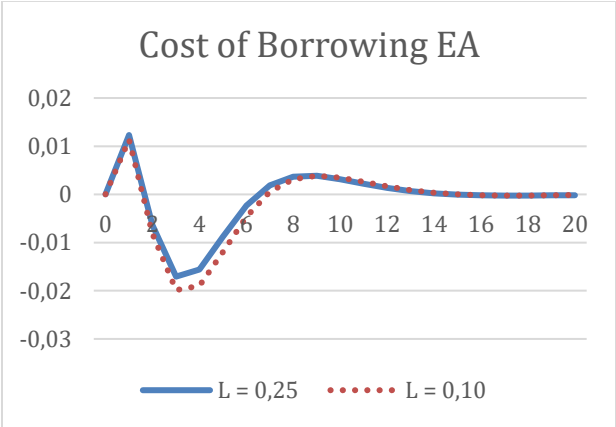

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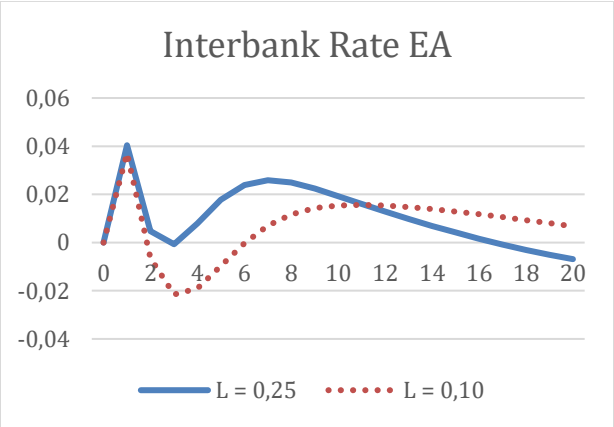

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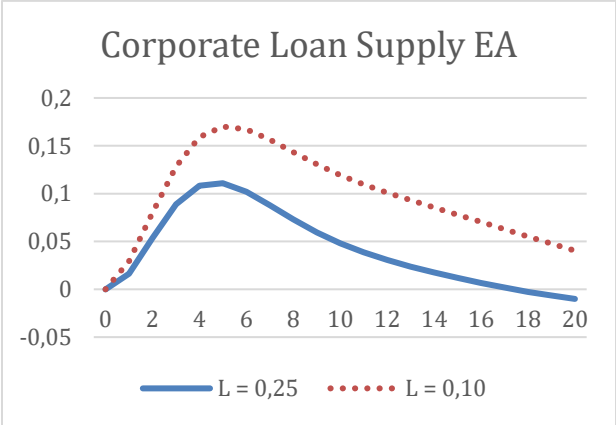

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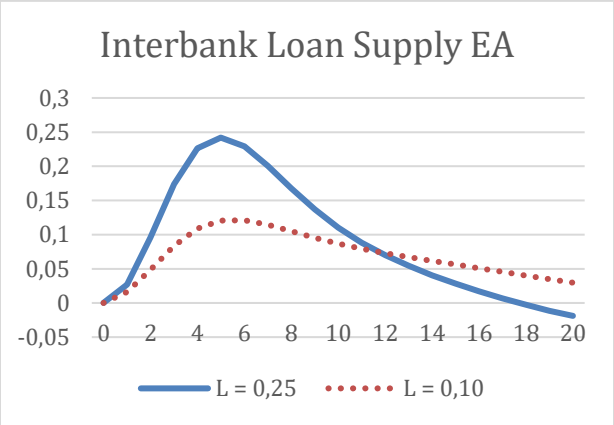

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Figure 5 a)-f), impulse response functions to a time-preference shock

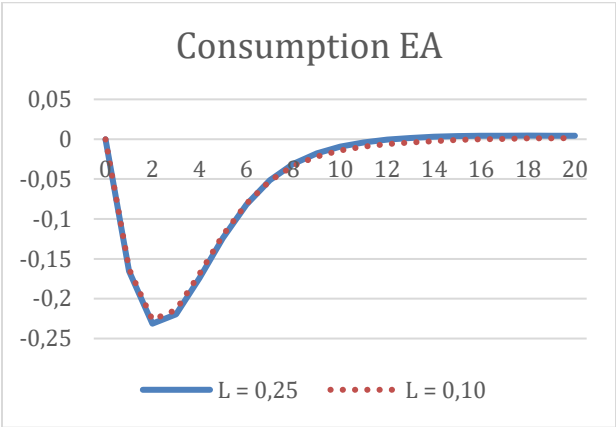
As can be seen in figure 5, since inflation goes down, we see in figure 5b) that an initial spike in the real rate of interest occurs, making the cost of borrowing for corporates higher. But as ECB steps in and lowers its policy rate borrowing costs eventually decreases since the real rate of interest decrease. Since we in the beginning see increasing investment, corporates will demand more loans to finance these investments. Hence the supply of corporate loans expands to accommodate this increased demand. Since the initial spike in real interest rates occurs due to lower inflation, an increase in the interbank rate occurs. But as ECB lowers the policy rate, the interbank rate falls as well. Since the ECB lowered rates after a little delay liquid banks start to contract more loans from the ECB since they are cheaper now. Liquid banks do this to supply both illiquid banks and corporates for loans to finance the initial increase in investments, hence we see an increase in interbank loan supply. But as time goes on investment decreases, thus a lower supply of corporate loans is demanded, which spills over to lower demand and effectively a lower supply of interbank loans.

In the alternative calibration where the share of illiquid banks is reduced, a lot of the mechanisms that drive the movements of the variables are the same. But some differences do occur. When the share of illiquid banks is reduced, we can discuss the impact of different lending arrangements that the ECB has provided through its previous unconventional monetary policy. Given this change, there are now more banks that have access to ECB funding. Since there are now fewer banks that rely on interbank funding, there are more banks that can finance the corporate loans from loans from the ECB. So quite naturally interbank loan supply does not increase as much. This makes the interbank interest rate lower than in the benchmark calibration, effectively lowering bank's marginal costs to supply corporate loans. Since banks operate in a competitive market, this depresses the banks’ lending spread over the real rate, i.e. they need to lower borrowing costs for corporates to be able to attract them. So, because of this we see decreased borrowing costs when we model for this expansionary measure by the ECB. Because of the lower borrowing costs, entrepreneurs have an easier time to finance the capital renting for intermediate good firms, which makes the supply of corporate loans go up. Because of the lowered borrowing costs, we can see, as in figure 4b), a clear increase in investments compared to the benchmark calibration.

A more general overview shows us that consumption and inflation follow very similar patterns as we alter the share of illiquid banks. We can also see that output and number of hours worked fall less when we decrease the share of illiquid banks. This dampened fall in output can be derived from the increase in investments following the previous expansionary measures by the ECB. Thus, in this case, the looser credit conditions from previous unconventional monetary policies make the economy more resilient to a negative time-preference shock.

The time-preference shock is a typical demand-side shock used in the DSGE literature. But does it capture well what happened to the Euro Area economy when the pandemic struck? Consumption, output, inflation and hours worked all behave similarly, but the main difference is what happens to investments. Investments actually fell during this period, as can be seen in graph 1, which indicates that this behavior of locking in the profits and getting out before the profits went down did not happen in real life. This, I would argue, is the major reason why the time-preference shock does not capture the dynamics of the COVID-19 outbreak. Another dimension for why this shock is not suitable is that even though the unconventional measures by the ECB acts to stabilize the economy when the shock hits, it is built upon theoretical reasoning rather than empirical outcomes. The reason for this more accommodative lending arrangement to stabilize the economy builds upon investments initially increasing, which did not happen in real life. This disconnect between the model and real-life makes assessing the impact of previous unconventional monetary policy somewhat unrealistic.

6.2 Total factor productivity shock



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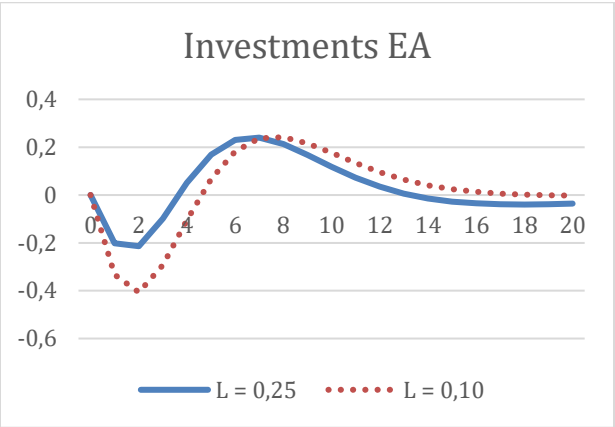

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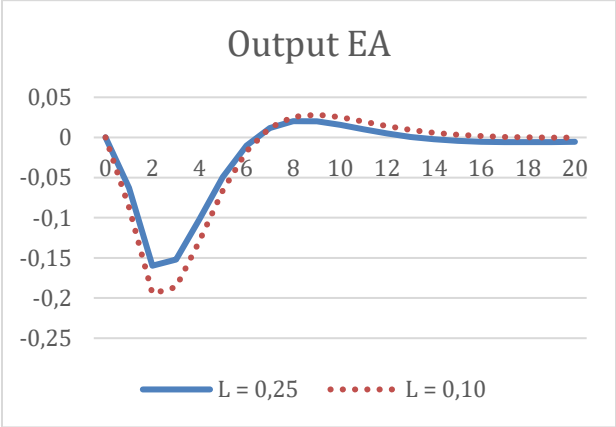

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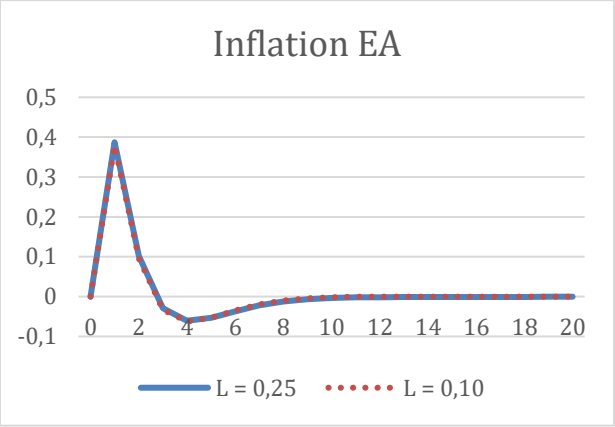

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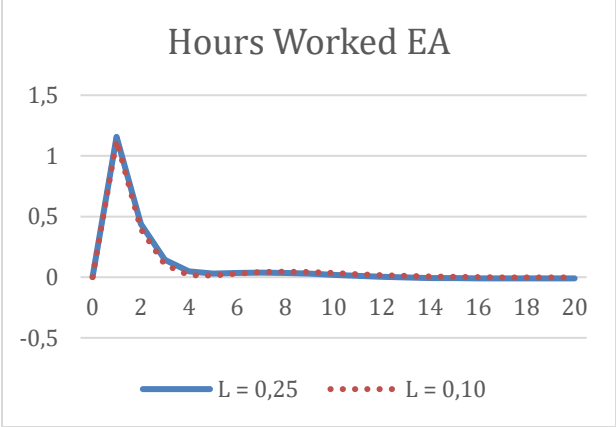

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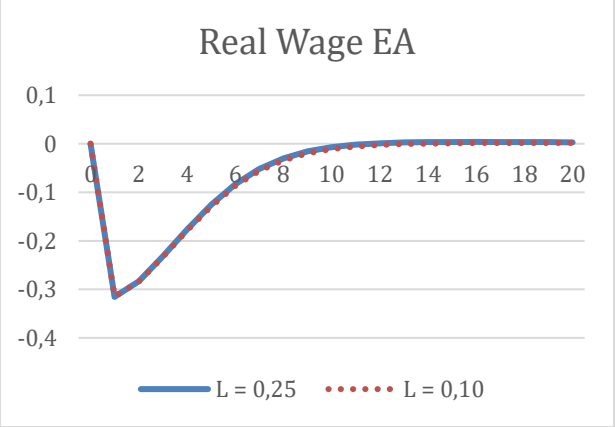
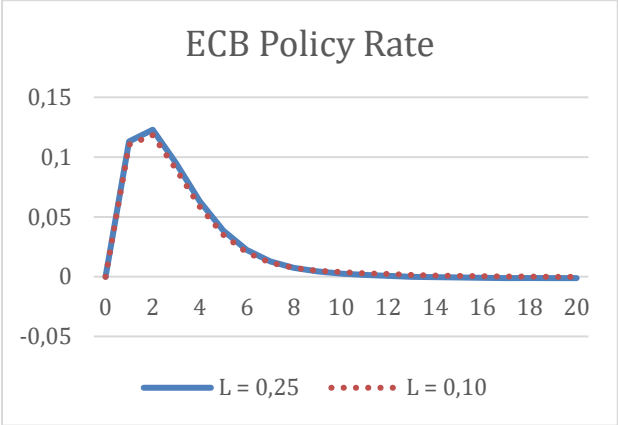


f)

Figure 6 a)-f), impulse response functions to a total factor productivity shock

The second considered shock affects the supply in the economy. This total factor productivity shock hits directly into firms' marginal costs, and the corresponding impulse response functions can be seen in figure 6. Since this shock makes firms less productive, their marginal costs increase. This leads to a higher rate of inflation because firms need to increase prices to keep making profits on the goods market. The lower real wage in this case is explained by the fact that workers, due to this shock, now are less productive. A lower real wage, in combination with a higher real rate of interest, pushes the household's consumption down. Similarly, as in Gali (1999), we see in figure 6e) a negative relationship between productivity and hours worked, hence hours worked increases after this shock. This shock goes directly into output as well, thus output decreases since firms are now less productive. Alongside all of this, the ECB increases the policy rate to combat the inflationary pressures that arise from this shock.

A negative total factor productivity shock lowers investment, which is in line with Smets and Wouters (2003). Since overall productivity has decreased, supplying capital to firms will be less profitable as their productivity has decreased. Since firms are less productive, they will face higher borrowing costs to finance their activities. We see in figure 7c) that borrowing costs increase, and that can be explained by two different mechanisms in the model. The first one is due to ECB raising its policy rate. This increases the real rate of interest in the economy, which forces banks to increase their real loan rate to keep making profits from supplying loans, which eventually puts upward pressure on borrowing costs for firms. The second reason is due to this shock lowering the return to physical capital. This in turn increases the default rate of the entrepreneur's projects. And since expectations of default rates are something that affect how banks' set the borrowing costs for corporates, the borrowing costs increases here. These increased borrowing costs make supply and demand for corporate loans go down since loans are more costly now. Entrepreneurs will contract fewer loans to finance the capital renting for intermediate good firms, so these increased borrowing costs explain why we see a fall in investments. After some time, the effect of ECBs' gradual decrease of the policy rate is seen as borrowing costs decrease. Also, since entrepreneurs contracted fewer loans after this negative shock, their leverage has decreased, hence making the expected default rate decrease, which also has a lowering effect on borrowing costs. This increases corporate loan supply and demand and is the reason why we start to see an increase in investments after a while.



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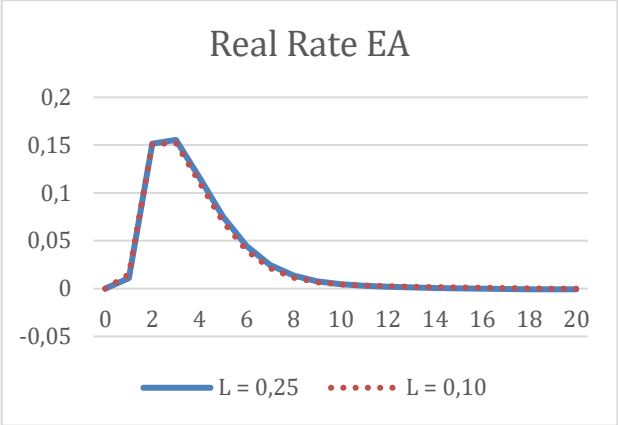

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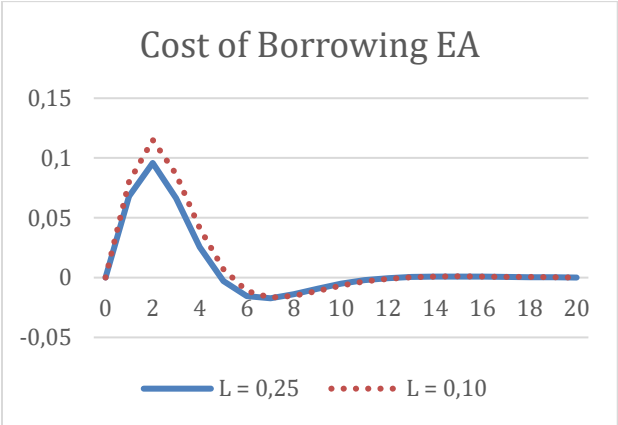

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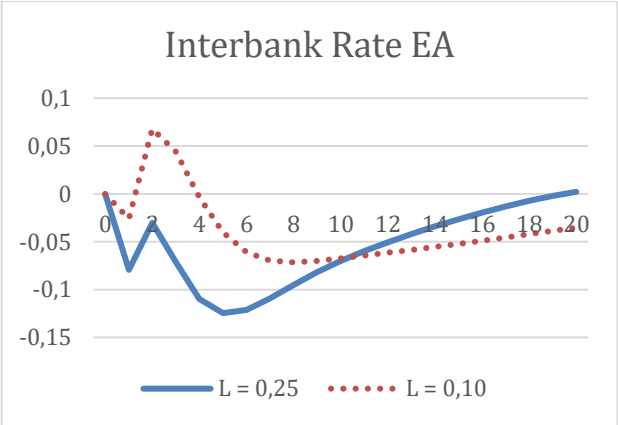

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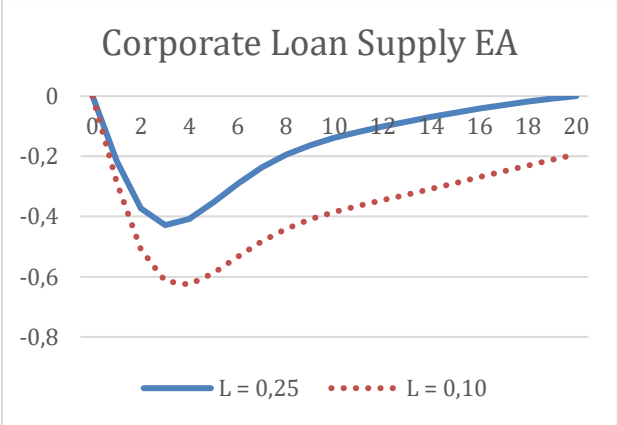

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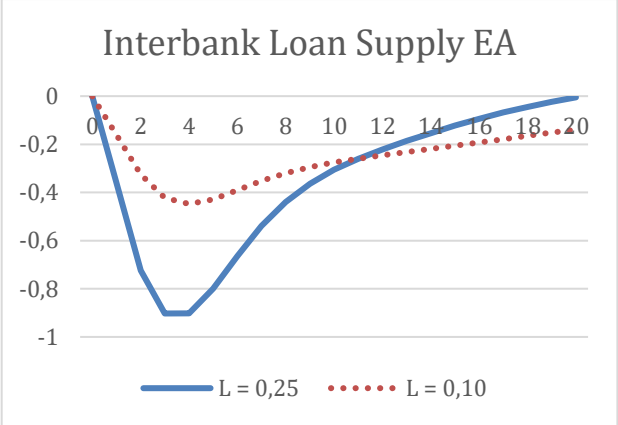
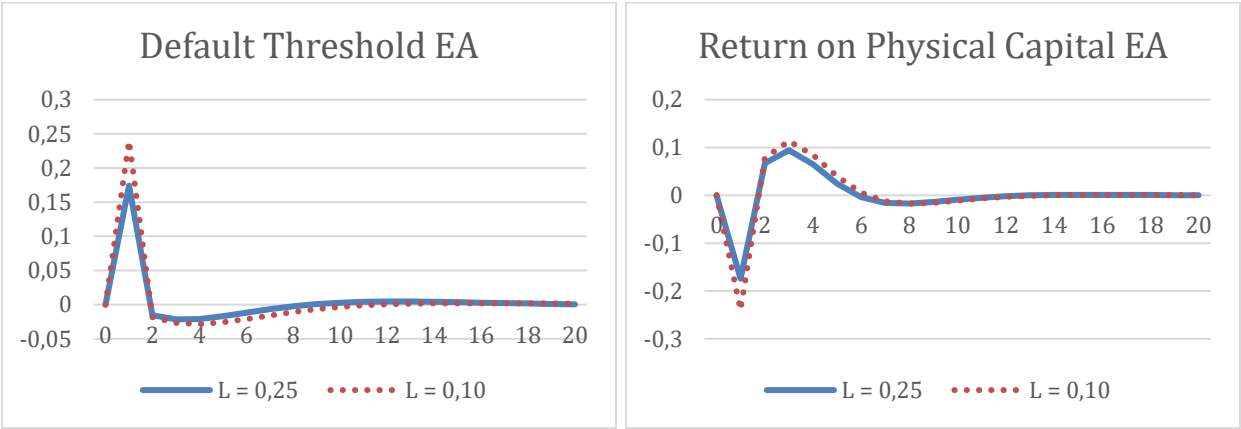


f)

Figure 7 a)-f), impulse response functions to a total factor productivity shock

The corporate lending market affects the interbank lending market quite significantly. The interbank rate movement is affected by the real rate and supply of interbank loans. Since interbank loan supply are for illiquid banks to finance corporate loans, when corporate loan supply falls, interbank loan supply falls since fewer interbank loans are demanded now. This fall in interbank loan supply has a stronger effect than the real rate on the interbank interest rate, hence we see an initial fall in the interbank interest rate. After some time, the real rate is the dominating force, hence the interbank rate increases some before falling again.



a) b)

Figure 8 a) and b), impulse response functions to a total factor productivity shock

If we now take a look at what happens when we model for the accommodative lending arrangements by the ECB, some differences in the results emerge. We see no difference in consumption, hours worked and inflation. Since inflation is very similar, the real wage and the real rate acts almost the same as before. So, the dynamics are found when looking at figure 8b), on the rate of return on physical capital. Since unconventional monetary policy has been, by some researchers, accused of keeping unproductive firms alive and effectively lowered the rate of return on capital, similar results are found in this simulation. If more banks have access to ECB funding, credit is easier to access, which decreases banks marginal costs. This in combination with even more favorable interest rates if they lend more to corporates induces banks to lend money to unproductive firms. When these unproductive firms stay alive, the required rate of return is kept down and the economy will be less resilient to an economic downturn. So, when this negative shock hits the economy, the fall in the rate of return on physical capital falls more when we model

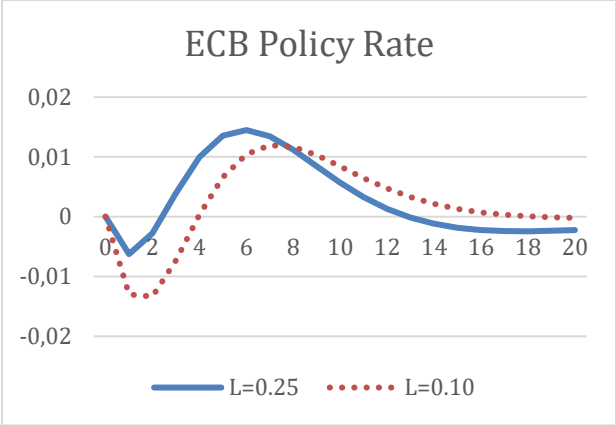
for the unconventional monetary policy. Since there is a negative relationship between the expected return on physical capital and the default rate of entrepreneur's projects, as capital returns go down more in this case, the default rate becomes higher. Because of this, upward pressure on borrowing costs occurs, and is the reason why borrowing costs increase more here than in the benchmark calibration. These increased borrowing costs push corporate loan supply and demand down because entrepreneurs now have a harder time financing capital renting to intermediate good firms with these higher borrowing costs. Due to this, interbank loan supply also falls since it follows the decreased demand for corporate loans. Interbank loan supply however falls less since there are fewer illiquid banks left in the economy. The interbank rate follows the same pattern as before but differs in magnitude.

The total factor productivity shock is a typical supply-side shock in the DSGE literature and has been used by some researchers to capture the dynamics of the "COVID-19"-shock. In this model it does show some similarities since consumption, investments and output all fell like in real life, which can be seen in graph 1. However, there are some contradictions in the results. First and foremost, this shock creates inflationary pressures and makes the ECB increase its policy rate, which goes heavily against what happened in real life where policy rates were left unchanged. Also, an increase in hours worked is the opposite of what happened since lockdowns prevented people from working, and the following increase in unemployment that occurred did not exactly increase the number of hours worked. The movement of these three variables makes the total factor productivity shock unsuitable to be regarded as the "COVID-19" shock that hit the Euro Area. To summarize, these more accommodative lending arrangements from before lead to increased borrowing costs, which depressed investments and led to a larger drop in output. At the center of this is the decreased return to physical capital and its implications on the firm's probability of default, something that will be discussed more in detail in the next section.

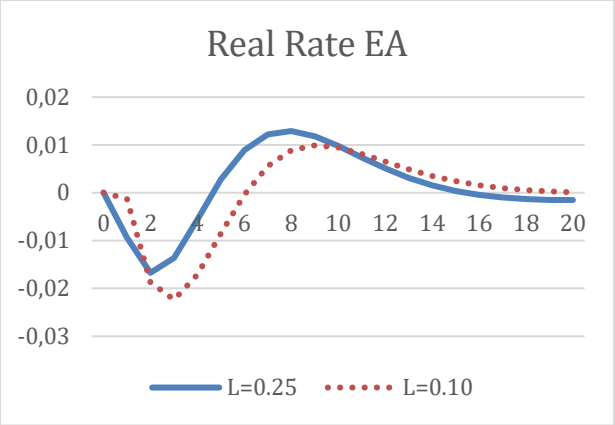
6.3 External finance premium shock

Figure 9 a)-f), impulse response functions to an external finance premium shock

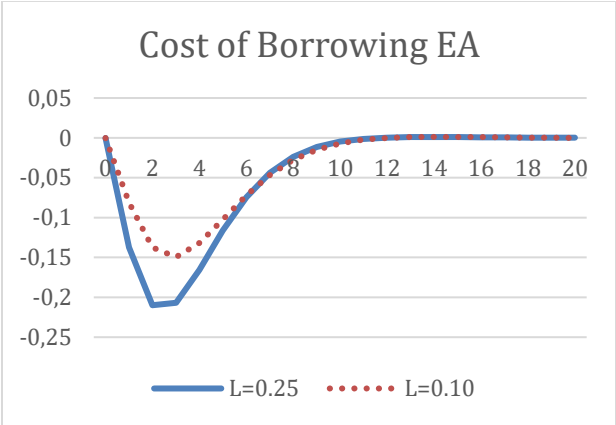
The external finance premium shock can be seen as entrepreneurs now requiring a higher rate of return for them to handle the capital renting for intermediate good firms. This is reasonable since the outbreak of the pandemic caused agents to be more cautious, or risk-averse so to speak. Some of the outcomes from this shock are shown in figure 9. Entrepreneurs require this higher premium since they see that return to physical capital falls when COVID-19 starts to spread. The lower return to capital leads to lower profits for entrepreneurs and a higher default rate. So quite naturally, this lower level of return to capital leads to investments falling. We see that return to capital increases a lot in the next period, and this is due to this increased external finance premium. One could argue that since this pandemic did not really destroy capital like for example an earthquake would, return to physical capital bounces up quickly again when agents in the economy start realizing this. This large drop in investments leads to output decreasing as well. Since output decreases, firms get rid of both capital and workers, thus hours worked falls here. We also see that since investments go down, the cost of capital goes down here, making firms' marginal costs decrease, which puts downward pressure on inflation. However, given the quick bounce back of investments due to this shock, the cost of capital increases, pushing marginal costs up, which creates inflationary pressures. This increased inflation puts downward pressure on real wages and makes them decrease. We also see a fall in consumption, albeit a small fall. The ECB initially lowers its policy rate to combat the deflationary pressures. This makes the real rate of interest fall as well. Since this shock lowers investments drastically, demand and supply for corporate loans fall. As shown in figure 10c), this puts downward pressure on the cost of borrowing since banks need to lower the interest rate to attract entrepreneurs to contract loans. This lowered level of corporate loans spills over to the interbank market, effectively lowering the supply and interest rate on the interbank market.



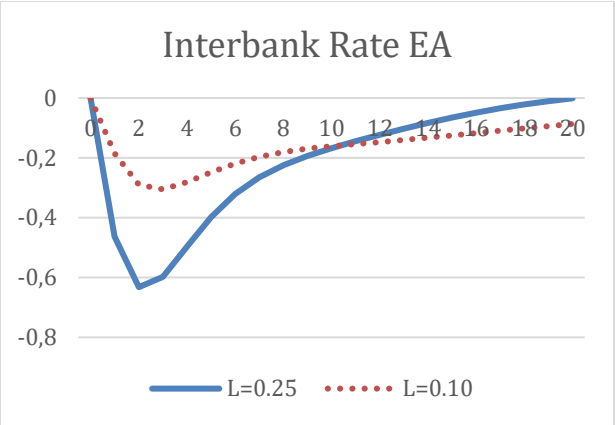
a)



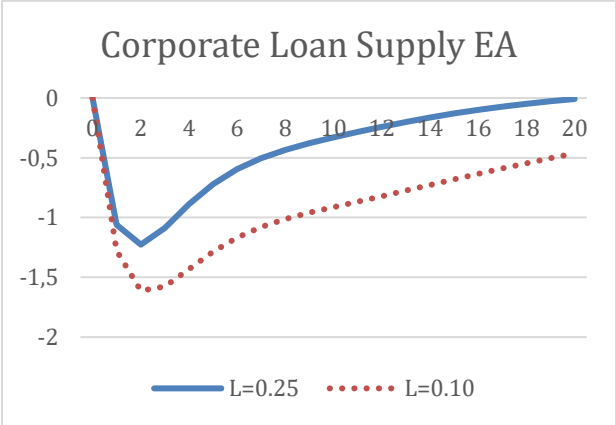
b)



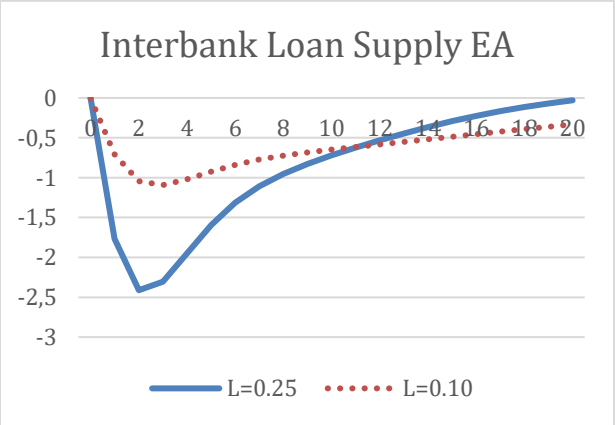
c)



d)



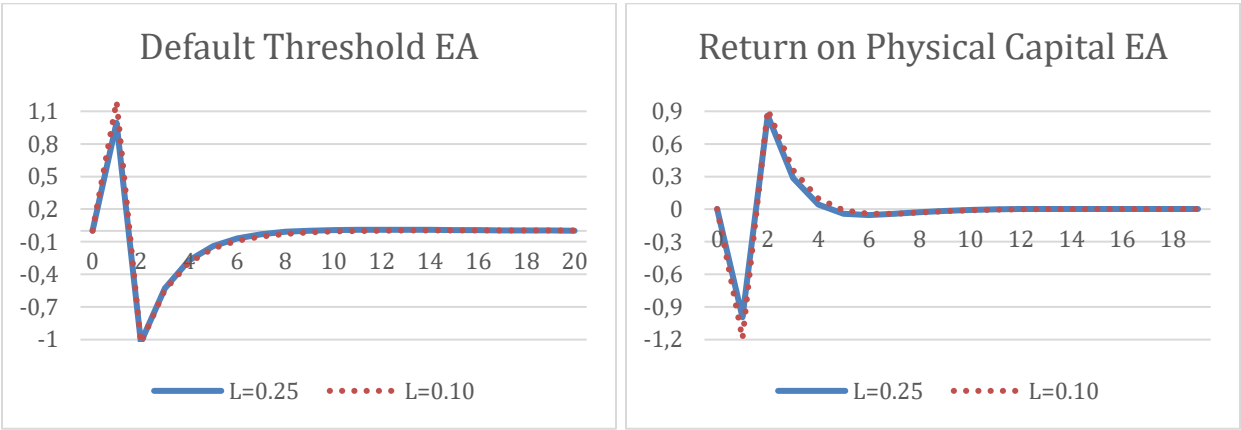
e)



f)

Figure 10 a)-f), impulse response functions to an external finance premium shock

When taking into consideration the previous accommodative lending arrangements by the ECB, changing dynamics to investments once again occurs. Similarly to when the total factor productivity shock is applied, we see in figure 11b) that return to physical capital falls more in this case. This is because since credit has been given away easier before the crisis, in general firms are less productive since these so-called zombie firms have stayed alive. This is why we see return to capital fall more than before and we also see that firm default rates are higher now. Entrepreneurs know this and see that their profits will decrease in this environment. This makes them inclined to reduce investments significantly compared to the benchmark calibration. Because of this, we see an even larger drop in output. Given the same reasoning as in the benchmark calibration, hours worked now also falls more. Given the larger output drop, a larger amount of labor and capital is reduced, which makes the cost of capital decrease more in this case. This leads to lower marginal costs for firms, and thus a lower level of inflation than before. The real wage falls due to the lower level of hours worked, i.e. households must comply with a lower real wage to be able to get employment. The ECB lowers its policy rate more in this case to combat deflation. But given these changes in the policy rate and inflation, the real rate does not fall as much as before, thus we see a smaller drop in consumption compared to the benchmark calibration.



a) b)

Figure 11 a) and b), impulse response functions to an external finance premium shock

Due to the lower level of investments, a lower level of corporate loans is contracted, thus the supply falls here. This spills over to the interbank market, so supply there also falls, but since a larger share are now liquid, the supply does not fall as much as before. Same reasoning with the

interbank rate, it falls but not with as much. The interesting thing here is with borrowing costs for corporates. We saw that the real rate of interest does not fall as much so this makes borrowing cost not falling as much as before. But the significant part of why borrowing costs decrease less is because the probability of default is higher in this case, so banks cannot lower the borrowing costs as much here because this default rate is instrumental in setting the borrowing rate. This has contractionary effects since a lower cost of borrowing would stimulate a recovery better. But it does not fall as much since firms are less productive with this accommodative monetary policy stance.

The external finance premium shock has not been as widely used as the other two shocks when trying to capture the effects of COVID-19. I chose to include it since it is a shock that originates within the financial sector and builds upon expectations, which is a good complement to the other two shocks. With this shock consumption, investment, output, hours worked, and inflation falls, albeit the fall in consumption and inflation is very small. This is in coherence with what happened in real life and makes this shock an interesting jumping-off point. But of course, the very small decrease in consumption is the main drawback of using this shock as we know that consumption decreased significantly in the spring of 2020. Similarly, to the total factor productivity shock, we see an amplified fall in investments when we take the accommodative lending arrangements by the ECB into consideration. The same rationale exists here, i.e. that return to physical capital is eroded and leads to more firm bankruptcies during this crisis. This again shows that this previous monetary policy stance has made the Euro Area economy less resilient to strong economic downturns, where output in this case falls even more than in the benchmark calibration.

7 Analysis

As stated in the result section, there is no unambiguous answer to the question on which shock represents the COVID-19 shock the best. All the previous literature on this subject, and my results, seem to agree with this. With that said, however, all of the applied shocks above do simulate a few similar features and are thus to some degree relevant for analysis regarding the outbreak of the COVID-19 pandemic.

When assessing the impact that previously implemented unconventional monetary policy, in the form of funding-for-lending schemes, has on the Euro Area economy, the decision of how to classify the COVID-19 shock is quite important. When assessing the funding-for-lending schemes through the lenses of the time-preference shock, it seems that such an expansionary monetary policy makes the Euro Area more resilient to negative shocks. Through the expanded credit facilitation, firms seem to be more willing to take on risk in the form of increased investment during the initial phase of an economic downturn. This however is contradictory to what actually happened to investments, which can be seen in graph 1, as the economic consequences of the pandemic started to become apparent. As the whole argument for a more resilient economy with this expansionary lending arrangement relies on investments initially increasing to dampen the fall in output, this disconnect between the model and real-life does not bode well for justifying unconventional monetary policy. When we look at both the total factor productivity shock and the external finance premium shock, the long-term stability risks from the unconventional monetary policy need to be considered. Most of the negative impact from the previous unconventional monetary policy can be derived from the lower return on physical capital, which effectively means a higher probability of default on entrepreneur's projects. The expansionary lending arrangements during the years before COVID-19 were implemented to stimulate economic activity in the short run but seem to, according to this model, have eroded the economy's productivity over the long run since adverse shocks hit harder with these looser borrowing conditions. Several papers in the literature regarding monetary policy and productivity, like Acharya et al. (2019), argue that these looser credit conditions led to an increasing share of unproductive firms staying alive and distorting the efficient allocation of capital and labor. As the share of these so-called zombie firms increases the economy becomes less resilient to negative shocks, which poses a systemic risk in

the future. As Caballero, Hoshi and Kashyap (2008) show, Japan has come a bit further down this road of secular stagnation, and its implications are more apparent than in the Euro Area or North America. The model results I have simulated might indicate a similar road ahead for the Euro Area to what happened in Japan, where the "zombification" of the Euro Area economy seems imminent. One must however always weigh these longer-term stability risks against the short-run alleviation that unconventional monetary policy provides to the economy. It is hard to assess how the state of the economy would have been during a negative shock without these measures, but that it did dampen the fall in output and employment in the short run is something that few would argue against.

Moving on and assessing the impact of the economy, taking these unconventional monetary policies as given, what implications do the expansionary (or even unconventional) fiscal policies during the spring of 2020 have on the economy? If we assume that the model results regarding lower productivity hold for the real-life economy, unconventional fiscal policy was necessary as large-scale firm bankruptcies would otherwise have occurred. But the question remains, how do we tackle this productivity decline, and could it have been justified to let some firms go bankrupt? Here we face the same short-term alleviation versus long-term aggravation dilemma as in the monetary policy case. On the one hand, financial aid to firms dampens the rise in unemployment and saves firms that are productive but might not have survived this unprecedented shock, on the other hand, these unconventional fiscal policies only further amplify the zombification of the world economy. In practice of course the choice of saving jobs instead of long-term productivity is a given for any publicly elected official, but from a more theoretical point of view, this issue bears discussion. Firm default on a massive scale would be devastating to the world economy but it might be an opportunity to tackle some of the structural issues that have plagued most developed economies for many years. Many of the authors that blame unconventional monetary policy for the productivity slowdown argue that capital and labor are misallocated to unproductive firms and that the barriers of entry in many industries keep this misallocation alive. With a more selective approach to which firms the government saves with its programs, we might be able to tackle some of these misallocations and put the world economy onto a trajectory towards higher productivity. As Cella (2020) states, it was the financially weak firms that filed for bankruptcy during the outbreak of the pandemic. An idea would be for fiscal authorities to assess, based on ratios like

firm leverage and interest payment coverage, which firms are viable and thus worth saving. Making the financial aid conditioned on financial health might be a controversial proposal, but it might tackle some of the structural issues at play during this so-called secular stagnation. Another aspect worth considering is that if unconventional measures from both monetary and fiscal authorities become standard as soon as we enter a recession, the problems that decreased productivity implies are only postponed and will affect future generations even harder. Similar to climate change, is it really fair of us to put solving these issues in the hands of the next generation?

These are of course extremely difficult issues to tackle and a single solution does not exist. According to this model, the secular phenomena of low productivity is not tackled by expanded credit facilitation to banks, but rather aggravated. A way forward to at least combat the zombification of the economy might be improved coordination between monetary and fiscal policy since both of these have a hard time solving these issues on their own.

8 Conclusions

This thesis aims at shedding some light on the impact of the ECB's previously implemented unconventional monetary policy when an adverse shock hits the economy by altering the share of banks that have direct access to ECB funding. As presented in this thesis, unconventional monetary policy does bring consequences, both intended and unintended. While alleviating the pain from an economic downturn in the short run is important, also examining the aggravated problems that follow from these measures is crucial for the well-being of future generations. I hope this thesis has shed some light on this trade-off and at the same time contributed somewhat to the discussion of whether COVID-19 is a shock to the supply or the demand side of the economy or even a shock to expectations formed within the financial sector. An obvious limitation of this thesis is the lack of analysis with regards to the heterogeneity between the core and the periphery economies in this model when the shocks are applied. To not take this into consideration was an active choice to limit the thesis. Furthermore, the results I produce are contingent on this specific model. Because of this, more robust results would have been produced if I had simulated the same shocks on a few other similar models. The reader should keep in mind that the results I present might not hold in other models.

Potential venues for further research include more detailed modelling of both monetary and fiscal policy-rules within a DSGE framework, in order to study optimal policy mixes during a severe economic downturn in more detail. Also, including a macroprudential authority and its interaction with monetary and fiscal authorities might yield interesting results. More specifically within two-country DSGE models over the Euro Area, shedding some light on the heterogeneity between the core and periphery during an adverse shock like this could be interesting. Furthermore, the connection between the productivity slowdown and the behaviour of financial intermediaries is an interesting field of research, albeit somewhat explored. However, the unprecedented policy measures taken after the outbreak of COVID-19 will probably be the topic of future research within this field.

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