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BACHELOR THESIS

Helicopter Drop of Money - Is It Feasible in Practice?

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Declaration of Authorship

I hereby proclaim that I wrote my bachelor thesis on my own under the leadership of my supervisor, that the references include all resources and literature I have used and that this thesis has not been used to obtain any other university diploma.

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Prague, May 11, 2016

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Bibliography reference

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Extent of the thesis

84 383 characters (with spaces)

71 895 characters (without spaces)

Abstract

The main goal of this thesis is to discuss the famous Milton Friedman's concept of Helicopter Drop of Money in context of its applicability in the real world as a possible solution to liquidity trap. For better understanding, the thesis briefly describes conduct of traditional and unconventional monetary policies. Key focus is put on describing assumptions necessary for the concept to yield desirable economic outcomes, and on detailed analysis of periods when zero lower bound on nominal interest rates is binding. Furthermore, roles of agents involved in execution of the concept, and important channels of transmission process are discussed from idealised theoretical view to real world possibilities of feasible execution. Additionally, practical experience with direct cash distribution in Australia, and with quantitative easing programmes in Japan and the USA are explained. The last part analyses effects of increased monetary base on CPI inflation, money multiplier M2, and GDP in Japan and the USA using vector autoregression.

JEL Classificiation	E31, E43, E51, E52
Keywords	Helicopter drop of money, quantitative easing, monetary base, liquidity trap, zero lower bound

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Abstrakt

Hlavním cílem této práce je diskuze známého konceptu vrtulníkového efektu Miltona Friedmana v kontextu jeho využitelnosti jakožto řešení pasti likvidity v reálném světě. Pro lepší pochopení tématu teze stručně popisuje způsob výkonu tradičních a nekonvenčních monetárních politik. Velká míra pozornosti je věnována popisu předpokladů nutných k tomu, aby koncept vedl k požadovaným ekonomickým výsledkům, a detailní analýze období, kdy nulová dolní mez nominální úrokové míry omezuje efektivitu tradiční monetární politiky. Další sekce se věnuje diskuzi rolí jednotlivých agentů zapojených do realizace konceptu a důležitých kanálů procesu transmise od ideální teoretické roviny po reálně aplikovatelné možnosti provedení. Dále jsou stručně popsány praktické zkušenosti s přímou distribucí hotovosti v rozvojových zemích a v Austrálii a s programy kvantitativního uvolňování v Japonsku a USA. Poslední část za použití vektorové autoregrese empiricky vyhodnocuje vlivy zvětšení měnové báze na peněžní multiplikátor M2, CPI inflaci a HDP.

JEL klasifikace	E31, E43, E51, E52
Klíčová slova	Politika vrtulníkového efektu, kvantitativní uvolňování, měnová báze, past likvidity, nulová dolní mez
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Bachelor thesis proposal

Author	Nela Gábrišová
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Proposed topic	Helicopter Drop of Money - Is It Feasible in Practice?

Preliminary scope of work

First formulated by Milton Friedman in Optimum Quantity of Money (1969), Helicopter Drop of Money is a concept based on distribution of extra cash amongst population in order to recover economy. According to Friedman, this tool should serve as a universal solution to economic recession, and its negative side-effect - deflation. He views the severe and long era of Great Depression as a result of reluctance of FED to inflate economy enough. Ben Bernanke admitted this FED's fault in his 2002 speech before the National Economists Club, and suggested solutions to avoid deflation in the future. Amid the 2008 financial crisis and its reverberating effects, there is a space for assessing monetary actions taken by central banks, such as quantitative easing, and comparing them to Helicopter Drop of Money.

Core hypotheses to be targeted

1. What constraints are there for realistic applicability of Helicopter drop of money?
2. Is there any practical experience with direct distribution of cash or cash equivalents?
3. Does an increase in base money in reality help to stop deflationary pressures?
4. What impacts did quantitative easing (QE) in Japan, and USA have? Is there an evidence to claim that changes in macroeconomic factors (especially CPI) are a result of increased monetary base?

Methodology

The qualitative research will be based on analysis of existing economic literature, and theories related to the topic and their critical evaluation. Particular focus will be put on examination of central banks' competences, rights, and constraints when it comes to need for such an atypical monetary measure as Helicopter Drop of Money is.

The quantitative part of research will be based on data from official institutions (IMF, US Department of Treasury, OECD etc.) and application of suitable econometric methods to test the relationship between the scale of monetary base (MB), money stock, CPI and GDP to find whether there exists any effect of an increase in the MB on the other economic variables, which is one of the key assumptions for functionality of Helicopter Drop of Money. The VAR methodology will be applied.

Preliminary structure of work

The output of this thesis should primarily show if a monetary lever, that theoretically enables central banks to resolve liquidity trap by depreciating the value of its own currency (which in the form of fiat money does not have any intrinsic value), could work in practice despite possible legal, logistical, political, and economic constraints.

1. Introduction
2. Theoretical background
3. Helicopter Drop of Money Concept
4. Practice from the real world
5. Empirical analysis of quantitative easing
6. Conclusion

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Acronyms

AD Aggregate demand

ADF Augmented Dickey-Fuller test

AIC Akaike criterion

BIC Schwarz-Bayesian criterion

BoE Bank of England

BoJ Bank of Japan

CB Central bank

CPI Consumer price index

d.f. degrees of freedom

DSGE Dynamic stochastic general equilibrium

FED Federal Reserve System

GB Government bonds

GDP Gross domestic product

HDoM Helicopter Drop of Money

HQC Hannan-Quinn criterion

JGB Japanese Government Bond

MB Monetary base

MP Monetary policy

NGO Non-governmental organisation

OLS Ordinary least squares

QE Quantitative easing

QQE Quantitative and qualitative easing

VAR Vector autoregression

VAT Value added tax

ZLB Zero lower bound

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Chapter 1

Introduction

The topic of Helicopter Drop of Money (HDoM) concerns unconventional monetary application. It was chosen with regards to reverberating effects of the 2008 financial crisis which has led many monetary authorities including the Federal Reserve System, Bank of England, Bank of Japan and European Central Bank to take extreme measures with no past empricial experience. Since HDoM is a purely theoretical concept based on strong assumptions, but potentially leading to sound macroeconomic impacts even in an economy in liquidity trap, there is a space for assessment of its practical applicability amid recent development.

There exist both advocates (Ben Bernanke, William Buiter) and opponents (Gary North, Scott Sumner) of the concept, but appart from theoretical review of existing models and discussion of their assumptions, validity and possible caveats, the work concentrates on assessment of options to implement cash distribution by the central bank directly or indirectly in the real world, and discusses what barriers would need to be removed.

The last part is devoted to review of applied monetary policies ressembling HDoM; direct distribution of cash or cash equivalents and quantitative easing in particular. QE programmes in Japan and the USA are then used as exemplars for evaluation of effects of monetary base increases on CPI inflation and other indicators, but they are not sufficient evidence for drawing conclusion that MB shocks always inflate economy.

Chapter 2

Theoretical background

To understand the concept of Helicopter drop of money and comparable monetary policies, it is first essential to comprehend what meaning money has in our lives, in what terms money is affecting economic situation from both microeconomic and macroeconomic perspective, and how agents influence the flow of money. This chapter will introduce main assumptions about money, money demand and supply, and relevant topics connected to the current economic situation such as liquidity trap and zero lower bound. Due to the limitation on extent, only brief explanations will be provided with references to sources where more detailed information and argumentation can be found.

2.1 Money and the demand for it

Generally, money is believed to play three main roles: to serve as a unit of account, to be a medium of exchange, and to store value.[1] Some modern New Keynesian economists, such as Galí (2008), Williamson (2008), or Woodford (2003) limit their approach towards money only to the function of a numeraire. Their models are based on so-called cashless economies, where money serves only as a unit of account, whose value is determined by household. The only monetary policy a central bank in such economy can apply is interest rate determination. No external money supply in terms of printing money exists. However, since the accounting function does

[1] Sanchez (2012)

not imply any need for holding money (prices can be stated without having any money), only the remaining two functions work as incentives for people to actually demand some cash. Therefore, for the purpose of evaluating Helicopter Drop of Money, which is based on external cash distribution, cashless approach will need to be relaxed, and determinants of demand for money will be defined.

J. M. Keynes himself in the renowned General Theory recognizes three main motives for holding cash. These are transaction, precautionary, and speculative motives. The transaction motive can be further divided into income and business motives, which both refer to need for money to bridge the gap between the collection of income and incurring costs from the household's or firm's perspective respectively. The concept of income-velocity of money depicts this need appropriately. Precautionary motive refers to cash held to cover unexpected expenditures, being it emergency or advantageous unplanned purchases.[2] The speculative motive is the most controversial one, because it reflects the investment opportunity trade-off between holding cash or different assets with higher rate of return. Speculative motive can be driven by or reflected in either changes in the rate of interest or in money supply (or both), which is one of many friction areas among economists when assessing monetary policies. [3]

The amount of money an agent (household or firm) desires to hold depends overall on a number of transactions they exercise, on their perceptions about potential risks or unexpected costs, and on a trade-off between foregone interest and liquidity. Most importantly, we need to note that it is of a greater significance what money can buy in real terms than what its nominal value is. Therefore, demand for money is mostly expressed in terms of real money balances as a function negatively dependent on the nominal interest rate (which is dependent on real interest rates and anticipated inflation), and positively dependent on output.[4] Figure 2.1 shows that if

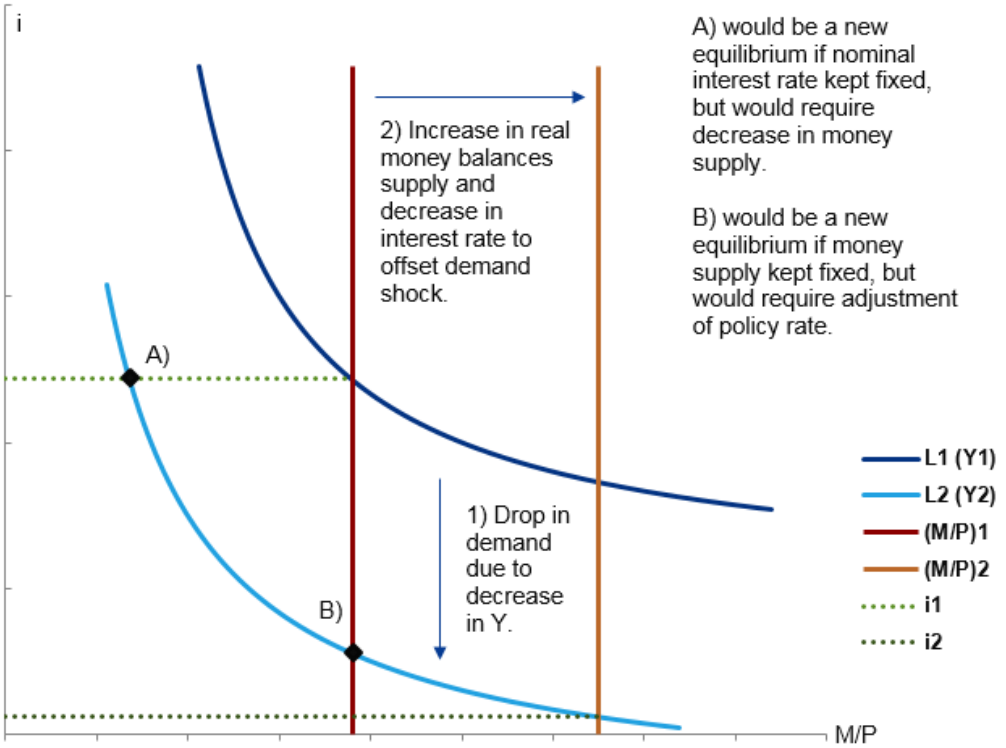
[2]Keynes (1936)

[3]While Keynes (1936) argues that the rate of interest is what corresponds to individual's mindset, and should be of a primary focus to reach equilibrium, Friedman (1969) opposes that interest rates are a reflection of monetary tightening or expansion through deflationary or inflationary monetary policy.

[4]Two key concepts describing the relationship between the amount of money, prices, and interest

a deman shock decreasing output occurs, the demand for real money balances curve (denoted L1 in the initial stage) shifts downward, initial equilibrium with interest rate i1 and money supply (M/P)1 is not sustainable anymore. A typical central bank's reaction would be a combination of decrease in nominal interest rate to i2 and an increase in money supply corresponding to it (M/P)2.

Figure 2.1: Demand and supply for real money balances



2.2 Fiat money and money supply

In today's world, most currencies have a form of fiat money, i.e. a form of bills, and in broader aggregate terms also electronic accounting records, with no intrinsic value. The content of this thesis will be limited to cover only economies using such currencies, because fiat money possesses two key features: cost of issuing it is negligible, and it has no intrinsic value. Thus, once initial fixed costs (such as

in nominal and real terms are the Quantity Theory of Money and Fisher Equation. For detailed description see Appendix A 6.2

printing press set-up) have been covered, a central bank can print money at basically zero marginal cost.[5] However, at the same time the value of money is well beyond central banks' control, since it is determined solely by people's expectations, and their belief in the persistence of the currency use. As stated above, for assessment of Helicopter Drop of Money, the power of determining money supply will be at least to some extent attributed to central banks as one of possible monetary policies they can use.

It is essential to draw a clear line between money supply (which is also referred to as stock of money) and monetary base (or the so-called high-powered money). Composing of currency in circulation and reserve deposits, the most liquid assets, monetary base is issued directly by the central bank in either its physical or electronic form, and appears directly on the CB's balance sheet liability side. Money supply measures M1, M2, and M3 differ in exact definitions in each country, but it universally holds that with increasing index, less liquid monetary aggregates are added to the components that are accounted for.[6] Unlike monetary base, money supply measures exclude deposits of financial institutions in the accounts in central bank, and only include money held by or accessible to public. While a central bank can directly determine monetary base by issuing currency, and setting reserve requirements, broader aggregates are influenced by further agents such as commercial banks and are affected by complicated monetary transmission mechanisms. It will be of a particular interest of this thesis to explain the role of each agent involved in determination of multiplication effect on monetary aggregates.

[5] Sanchez (2012), p.10

[6] M1 is a subset of M2 which is a subset of M3 (if M3 is defined). For instance, the Federal Reserve System only defines M1 and M2, while the Czech National Bank recognises three levels of aggregates M1 to M3. Precise definitions are stated in Appendix B 6.2

2.3 Traditional monetary policy inefficiency in a liquidity trap

Under normal circumstances[7] in regular cash economies, central banks take monetary operations to affect two main variables: the money supply, and the nominal interest rate; which should then directly or indirectly influence other macroeconomic factors from level of output through unemployment level to price level.[8] Observing the liquidity preference schedule, it is certain that the two variables cannot be controlled over simultaneously without causing disequilibrium, as they are interdependent, as visible in the Figure 2.1.

Typically, in recession the central bank would aim to cut its shot-term interest rates. To implement the decision, its monetary operations would be used. Ceteris paribus, such policy implementation would icrease the monetary base, which would in turn boost aggregate demand and in the long-run increase the price level. Further enforcement of the targeted interest rate can be done through setting the rates for lending and deposit services provided to commercial financial institutions.

However, once a recession hits the economy so hard that the nominal interest rates fall to or near zero (i2 in Figure 2.1), as has been experienced by Japan for over past twenty years, these conventional tools become inefficient, and the economy is said to be in a liquidity trap.

Liquidity trap concept is assumed to be first introduced by Keynes in the General Theory. However, as Sutch (2014) points out, there is no clear interpretation of what exactly he meant, because Keynes himself never mentioned this term. Liquidity trap was interpreted by Hicks in 1942 as the difficulty of reducing the rate of interest below a certain minimum level.[9] Further Krugman in 1998 defines liquidity trap as

> "[...] a situation in which conventional monetary policies have become impotent, because nominal interest rates are at or near zero: in-

[7] Meaning that an economy is not in any extreme state such as having nominal interest rates near zero.

[8] The relationships between these macroeconomic factors are theoretically described by the Fisher equation, Phillips curve, and AD-AS model. See Appendix A 6.2 for details.

[9] Sutch (2014), p.5

> jecting monetary base into the economy has no effect, because base and bonds are viewed by the private sector as perfect substitutes,"[10]

and then in 2013 comes with the interpretation of demand being so weak

> "[...] that even at a zero short-term interest rate spending falls far short of what would be needed for full employment. And interest rates can't go below zero (except trivially for very short periods), because investors always have the option of simply holding cash."[11]

From Krugman's definition it seems that liquidity trap is an equivalent to the zero-lower bound. With regards to Hicks, the difference would be that liquidity trap may occur even when there is a positive level of nominal interest rate, but the central bank is unable to reduce it, while the zero lower bound is such constraint that the interest rates cannot decrease any further, even though it might have been intentionally decreased to the zero level by the central bank. Nevertheless, in both cases, open-market operations lose its demand-boosting impact.

What plays a significant role in this situation is that additional cash in the economy is hoarded instead of spent. Some reasoning behind is in that financial intermediation by banks does not bring an increase in monetary aggregates. This argument is shared amongst others by Schwartz and Friedman (1971), who argue that the Great Depression occurred due to FED's inability to increase broader money supply M2,[12] and Krugman (1998), who points out problems of the Bank of Japan to increase monetary aggregates as Table 2.1 presents.

However, the most important role is played by expectations. If future economic shape is anticipated to persist in a bad state, little can be done to restart the economy. All of the aforementioned economists (Bernanke, Eggertson, Friedman, Keynes, Krugman, Sutch, Woodford) mention expectations of future macroeconomic development as both the reason why liquidity trap occurs, and the solution to it.

[10] Krugman (1998), p.141

[11] Krugman (2013)

[12] See Appendix B 6.2 for the definition of M2 by FED.

Table 2.1: Changes in MB, M2 and Bank credit (indexed)

Year	Monetary base	M2 plus certificates of depocit	Bank credit
1994*	100.0	100.0	100.0
1995	107.8	103.3	100.8
1996	117.0	106.5	100.6
1997	125.6	110.6	100.9

*base year

source: Krugman (1998), p. 175, data from International Financial Statistics

Therefore, unconventional policies including Helicopter Drop of Money and Quantitative Easing are very much based on creation of desirable expectations.

2.4 Unconventional monetary policy execution

The main idea behind a potential rescue of an economy at the zero lower bound, where all conventional tools have been depleted, lays in the Fisher equation.[13] Although nominal interest rates are at or near zero, the real interest rates can still be decreased, if inflationary expectations increase. Therefore, the primary task of unconventional monetary policy is to increase inflationary expectation. A desirable outcome is to decrease also long-term real interest rates in order to decrease profitability of holding non-cash assets and postponing spending, and to enhance current consumption and investment.

Nevertheless, the Fisher equation is more of an equivalence rather than a causal one-sided relationship and is much dependent on assumptions about price flexibility and expectations. The formula $r = i - \pi^e$ can be restated to express nominal interest rate as dependent on real interest rates and inflationary expectations: $i = r + \pi^e$.

A very pioneer analysis of assessment of monetary policy conducted at ZLB was carried out by Cochrane (2015). In his new-Keynesian model of economy at ZLB, there always exists an equilibrium real rate of interest, a so called natural rate of real interest. In an initial equilibrium with nominal interest rates stuck at zero, it is

[13] See Appendix A 6.2

of a negative value. People expect that the central bank sets nominal interest rate with regards to the natural rate of real interest, and central banks are assumed to follow a rule for policy setting of nominal interest inspired by the Taylor principle[14] in the form:

$$i_t = i_t^* + \phi(\pi_t - \pi_t^*). \tag{2.1}$$

At certain future time in a finite time horizon, the economy exits liquidity trap, and from that moment on nominal interest rate equals the natural real interest rate under the assumption of central bank leaving ZLB once inflation reaches zero.[15]

$$t < T : \pi_t = r \tag{2.2}$$

$$t \geq T : \pi_t = 0. \tag{2.3}$$

Therefore, even expected future real interest rate affects values of nominal interest rates which should be set to keep economy in equilibrium. In fact there occurs an autoregressive process of interest rates and an equivalent-like relation pointing to reversed causality in the Fisher equation. Although this particular interpretation is only valid in flexible-price economy, the autoregressive nature of these variables is a key feature for correctly setting up a model in the empirical part which will follow.

In a more realistic scenario with the presence of price stickiness, Cochrane's analysis shows existence of multiple equilibria output gap and inflation paths during the liquidity trap solving the model under the same interest-rate path selection whose dynamics is dependent mainly on the assumption of how people expect that inflation will evolve once nominal interest rates return to positive values. This finding is essential, because the effect of monetary policy implementation presented by researchers is thus proved to be dependent not only on the manner of setting nominal interest rates, but also on the selection of equilibrium inflation path; more precisely on expectations of future inflation which defines the current equilibrium.

[14] See Appendix A6.2 for the description of the Taylor principle.

[15] Such choice of equilibrium inflation rate at the exit of liquidity trap is also advocated by Werning (WERNING, Ivan. *Managing a Liquidity Trap: Monetary and Fiscal Policy.* Massachusetts Institute of Technology. March, 2012, Accessible at: http://economics.mit.edu/files/7558)

The core caveat then lays in the impossibility of clearly defining expectations and central bank's equilibrium selection process.

The importance of inflation expectations in projection of policy effects is also stressed out by Woodford and Eggertson (2003). They conclude that if the central bank commits to keep nominal interest rates at zero even when macroeconomic conditions have improved, current demand during ZLB can be increased due to the fact that expected real interest rates in farther future are negative. The efficiency is, however, indivisibly linked to the central bank's commitment to apply inflationary policy once ZLB has ended. Similarly to Cochrane's findings, this underlies the importance of expectation channel in transmission mechanism. A credible depiction of expectations is key for a model's validity.

Generally, modern literature on monetary policy application at ZLB assigns high importance to expectation channel. With regards to the Great Recession asset price and credit channel also gained more focus, since too much stress put on interest rate channel, which used to be considered a traditional one, led to erroneous predictions about how economy would evolve and beyond doubt enhanced severity of the financial crisis. All of the transmission channels are interconnected, simultaneously affecting each other, and thus the overall outcome. This makes predictability of monetary policy a particularly difficult task.

Chapter 3

Helicopter Drop of Money concept

In the Helicopter Drop of Money concept an increase in the money supply which should rise expected price level,[1] thus increasing the expected inflation which consequently leads to real interest rate decrease, followed by the abovementioned increase in consumption and investment, hence affecting the economy's output. In the following section, detailed analysis of assumptions necessary for validity of this concept will be provided.

3.1 Friedman's formulation

In Quantity Theory of Money, Milton Friedman first introduced the theory of Helicopter Drop of Money. He bases it on the following twelve assumptions:

1. Population is constant, immortal, and unchangeable,
2. with given tastes.
3. Volume of physical resources is fixed, and limited,
4. with predetermined stable technological state.
5. Uncertainty and change are present.
6. There are competitive conditions on the market.

[1] Due to long-run money neutrality

7. Capital goods are infinitely durable, irreproducible, reusable,
8. and cannot be bought (sold).
9. No borrowing (lending) is possible.
10. The only possible forms of trade are money for service and service for service.
11. Prices can be freely changed by parties involved in the deal, but they are not perfectly flexible.
12. Only fiat money exists.

The demand for real money balances is expressed in terms of a multiple of nominal income which households wish to hold on average. In Friedman's demonstrative example, in equilibrium the income velocity $k = 5.2$, and annual nominal income $P \cdot Y = \$10\ 000$, hence weekly average real money balances:

$$\frac{M}{P} = \frac{k \cdot Y}{\#weeks} = \frac{5.2 \cdot 10\ 000}{52} = \$1\ 000. \tag{3.1}$$

If additional \$1 000 in cash is thrown from a helicopter, the available money balances suddenly double. However, if no additional income increase is expected, there is no incentive to change preferred amount of money balances holdings. Therefore, everyone wants to return to the original amount. Nevertheless, the initial equilibrium is never possible to occur again, for increased consumption by one person means an income for another. Due to this fact, any attempt to discard cash by increased spending fails. A new equilibrium would be satisfied at an annual nominal income of \$20 000, and weekly money balances of \$2 000 that are in circulation after the cash drop, but because of the fixed resources from assumption 3, output cannot grow. The only solution leading to a new equilibrium is thus an upward price adjustment.

As Friedman further explains, the transition process from old to new pricing is unclear, because the pace of price adjustment is dependent on distributional effects following the cash drop from helicopter. It can happen that certain individuals collect more money than others, and consequently have more power over the price determination.

3.2 Core assumptions of HDoM for real world application

In the real world, Friedman's assumptions 1 to 4, and 7 to 10 are far from realistic. Assumptions 5, 6, and 12 can be considered valid with an additional assumption that electronic money also represents fiat money. Price flexibility is generally regarded from the textbook point of view, as defined in Appendix A 6.2, with persistence in the short-run and long-run flexibility. A potential positive effect can be enhanced by increased output which is in reality possible, as physical resources are not fixed, though definitely limited.

A core model proving efficiency of Helicopter Drop of Money was developed by William Buiter (2003, 2014). He described three main assumptions that were not emphasized in Friedman's work. Paragraphs below are dedicated to elaboration on Buiter's assumptions.

In today's world, a relevant subject of attention is also electronic money which represents a higher ratio of fiat money than paper currency. Nordic countries are slowly heading towards the state of being cashless economies,[2] and worldwide number of electronic transactions has been rapidly rising, not to mention decreasing ceilings on payment volumes permitted to be made in cash. Helicopter Drop of Money could in fact be executed in form of electronic transaction which would add money in form of electronic records on people's bank accounts on a random basis. Buiter does not take into account electronic money in his seminar papers, but since it works as almost an equivalent of paper currency nowadays, same assumptions can be considered applicable for this particular case.

3.2.1 Non-pecuniary benefits of fiat money

A considerable issue with the use of fiat money is that it might not be a rate of return dominant asset. From a rational point of view, in such situation there would not

[2] In November last year, second largest bank in Norway abandoned use of cash. (*Norway's second largest bank abandons cash.* The Local [online], 2015-10-30. [cit.2016-03-15]. accessible at: http://www.thelocal.no/20151030/norways-second-bank-to-refuse-cash-from-monday)

be a pecuniary motive for holding cash, since another asset (certain security) yields higher return. However, in normal times away from ZLB, there are assets yielding higher return than money, and still people have not stopped holding money. Why is that? The reason is rooted in non-pecuniary benefits of fiat money, to be specific for instance in its medium-of-exchange role and liquidity. As long as fiat money remains a generally accepted medium for transactions, there will remain a motive to hold it, despite other assets granting higher returns. As Buiter stresses out, unless there exists such non-pecuniary benefit of holding cash, Helicopter Drop of Money cannot be efficient.

From a perpective of legislation, non-pecuniary benefit of fiat money as a transaction method is in fact rather a must than a pure benefit. Due to legal tender status of national currencies which is defined by legal acts in most developed countries,[3] there exists an obligation to accept fiat money payments. Although private businesses can set restrictions on cash payments (such as declining acceptance of coins or bills of value higher than a certain ceiling), they still must accept at least some form of fiat money. The assumption of fiat money carrying non-pecuniary benefits is thus certainly accomplished in modern economies and valid for confirmation of HDoM concept.

3.2.2 Positive price of money

Further necessity for a successful application of HDoM is a positive price of money. Although it may a priori seem a valid assumption, it is again worth emphasising that fiat money has no intrincis value, and thus holds a positive value only due to social convention and general belief that it will remain generally accepted in exchange for other assets. There might under certain circumstances occur a stiuation when equilibrium price of money is zero. This issue is studied for instance by Starr (1974) who summarises:

> "If we say that money is accepted because it is accepted, then we

[3] e.g. in the US legislation the Coinage Act of 1965, Section 31 U.S.C. 5103 "Legal tender", or in the Czech legislation Act on circulation of bank notes and coins 136/2011 in the Collection of Law

> must agree that if money were not accepted then it would not be accepted because it would not be accepted. When the price of money is zero there will be no unsatisfied demand for money; there is an equilibrium in which the price of money is zero."

Briefly summarized, HDoM is reasonable only when fiat money has positive value, otherwise, people would have no incentive to even collect it, nor the possibility to exchange it for consumer goods, hence consumer demand would definitely not be boosted. In the current state of economy, this assumption is valid, and at least for certain time can be claimed to remain valid due to persistence of social conventions, and also due to the legal tender status explained in the previous Subsection 3.2.1.

3.2.3 Permanence and irredeemability of the transaction

The most essential assumption which Buiter (2003, 2013) presents is irreversibility of the monetary base increase induced by the cash drop in the sense that once the cash was granted to the public, it must not be expected to be taken back any time in the future. Practically, this means that in an intertemporal model used for the demonstration of feasibility of the concept, an assymetric approach to solvency constraint of households and the state in relation to the base money appears. As Buiter points out, even when this assymetry is introduced in the model of Eggertson and Woodford (2013), who consider monetary base increase ineffective in the symetric model version, the outcomes become supportive for the concept to be efficient.

In a simplified formulation, this assumption requires money to be an asset for its holder, but not a liability for the issuer. From the accounting perspective, liability side of the central bank's balance sheet includes issued money in circulation. However, this liability only means that any time, CB must be able to exchange a bill of certain value for another bill of exactly the same value. Since marginal cost of printing new money is zero, it cannot "be expected to result in an outflow from the entity of resources embodying economic benefits," which is an International Financial Reporting Standards definition of a liability. Therefore, despite in contradiction with

accounting practice, Buiter's assumption are realistic from the practical perspective.

Still, it is of a great importance where the newly issued money appears on the asset side of CB balance sheet, because direct distribution to the public from CB is not legally allowed, usually government securities would be bought for the currency, as further discussed in the Subsection 3.3.1.

3.2.4 Other practical issues

Buiter (2003) further refers to an existence of a satiation point of real money balances demand, similarly to Friedman's explanation of people's desire to hold real money balances compatible with their permanent income regardless of unexpected extra cash which they wish to dispose in the long-run. In contrast to Friedman, Buiter recognises the stance of individual agents who do not realise that a general disequilibrium is created at the moment of cash receipt in aggregate terms.

> "The fact that the private sector as a whole cannot dispose of base money at its discretion is not a constraint that is internalised by the individual household. Each individual household believes and acts as if it can dispose of its holdings of base money at any time, at a price in terms of goods and services given by the reciprocal of the general."[4]

This is an important microeconomic aspect of the concept, for individual behaviour is affected and in discord with the expected aggregate result.

A drawback of Buiter's analysis is an assumption that every household earns exactly the same wage, and receives the same amount of cash from the helicopter. It is vital to recognise income inequality amongst households, since different income groups tend to adjust consumption differently with respect to additional income as further described in the Subsection 3.3.3, and to consider a possibility of unequal distribution of the newly generated cash.

[4]Buiter (2003), p.2

3.3 Agents involved and fesibility constraints

There are three main parties involved in execution of Helicopter Drop of Money: the fiat money issuer, the distributor of cash, and recipients of cash. While the first party in all economies is represented by the central bank, the remaining two differ with regards to type of cash transfer transaction, and manner of its execution.

3.3.1 Central bank

Central bank is the only authority issuing currency and independence from the government is legally granted to the central bank in terms of conducting monetary policy. If HDoM in its literal sense should be executed, the central bank would have to employ someone to be responsible for a random flight and cash-bombing over the country's area; something which is, in reality, completely beyond competence of the institution. Therefore further in the text, figurative sense of helicopter money distribution will be considered.

Theoretical way of HDoM execution by Central bank

Under idealised conditions, the easiest option for the CB would be to make electronic transfer payment directly to bank accounts of individual citizens. In order to do this, there would have to exist a central register of individual bank accounts that the CB would be able to use. Considering some people do not own bank accounts, either cooperation with a state institution (such as offices of Social Security Administration or possibly public post offices) to deliver physical cash to those who do not own bank accounts, or creation of bank accounts for all non-owners on the expense of CB would be necessary. This possibility would probably carry high administrative costs especially in the initial phase of setting-up a proper distribution scheme. When the processes are fixed, it could work efficiently at almost no additional operational costs.

Practical constraints

From legal perspective, the goal number one that the central bank should seek to attain is price stability. Every additional goal can only be pursued as long as price stability is ensured, and solely by the means exhaustively defined in a corresponding state legal act. As far as current legal setting worldwide is concerned, any form of direct distribution of cash to citizens by CB is not defined. Therefore, a practical conduct of HDoM must be indirect.

Thus, what seems most appropriate, and is also most discussed in existing studies, is cooperation of CB with the government by the means of government bonds issuance and acquisition of GB by the central bank for newly printed money. In this case, we talk about monetisation of governmental debt which is a combination of monetary and fiscal stimulus, where the CB can only guarantee the amount of cash inflow, but not that a chosen target group is hit which is a matter of fiscal policy chosen by the government as discribed in the following Subsection 3.3.2. In order for CB to have control over the recipients of the cash, there would have to exist some form of a formal governmental pledge that the obtained cash is used in a manner that targets recipients chosen by the CB. Practical issues arising in such scenario are inexistence of any formal legally defined governmental pledge towards CB, and the legal prohibition of monetary financing. CB is neither allowed to provide any form of loan to governmental and public institutions, nor to acquire any of their loan instruments including GB in initial public offering.

Acquisition of public sector securities in secondary market is possible, yet must not be misused as circumvention. Further option of pushing money to the circulation is by decreasing minimum reserve requirements as described in the Sections 2.2, and 2.3. However, both of these measures involve other third parties (commercial banks, security holders) as the primary receivers of the cash, and all later cash circulation is dependent on their behaviour. It may be hoarded or further provided to households. Hence, it cannot be viewed as a real equivalent to HDoM concept.

Under current framework, there is not a possibility that the CB conducts HDoM on its own. However, if institutional and legal changes were made, specific tools for execution of the policy could be created. An essential part of the policy applica-

tion would be rooted in communication of CB intentions towards citizens, so that the commitments are credible and not expected to be revesersed, thus increasing inflation expectations.

3.3.2 Distributors of cash

Government

If HDoM is conducted in cooperation with the government as described above, then further development is dependent on applied fiscal policy. The government can grant a lump-sum tax cut either globally or for a selected group of recipients, or using its offices or another middleman (e.g. a NGO) it can distribute cash grants to the desired target group. Also, a combination of providing cash to public and increasing government spending can yield positive results with a possible positive externality of job creation. Other alternative fiscal solutions such as negative taxation could also be implemented, but would require legislative changes, thus would probably be subject to political opposition disagreement.

A threat of inefficient policy execution is significant here, because the government is under a pressure of political lobby, and can take steps leading rather to gain voters' confidence instead of leading to long-term economic stability which in short-term may require unpopular steps. On the other hand, if done in a sensible manner and in close, though not formally defined, cooperation with the central bank, distribution of cash by the government can be conducted efficiently. An important aspect is the irreversibility of the transaction as defined above.

Commercial banks

In case of purchase of commercial banks' assets or descrease of minimum requirements, banks enter the monetary process as a middleman, and an issue with intermediation occurs.

Under the circumstances of commercial banks holding a lot of bad assets and facing liquidity problems, cash provided via securities acquisition by CB can be a very helpful tool reviving staggered banking intermediation and credit provisions to

private sector. If banks service more loans to individuals as a result of such CB's applied measure, then the policy might yield similar positive inflationary effect as direct cash distribution amongst people. However, since debts have to be repaid, the permanence assumption for HDoM functioning is broken in this case.

If a situation, when banks have sufficient liquidity, but are reluctant to provide better lending conditions to private sector, arises, providing more cash in the system is inefficient. In such case, cooperatin with government as a distributor is a more sensible decision.

Other agents

A role of third parties such as non-governmental organisations hired by the government to ensure cash distribution is minor. This middleman system of distribution is employed mostly in third world countries where people often do not have bank accounts and governmental offices are not easily reachable as a possible contact point for public.

3.3.3 Recipients of cash

The end recipients in the concept should be households. They play an essential role in determining how economy evolves with respect to their consumption behaviour. Additional one-time income should lead households to consume more than regularly as economic theory expects, hence increasing the level of output and in long run also the price level.

One theoretical aspect is a positive income effect which shifts the households' budget constraint up, allowing for more consumption. Another aspect is the demand for real-money balances according to whose logics households want to dispose the additional money to return to their original desired volume of real money balances held, so they spend it on consumption instead of saving it. Thrid motivation for enhanced current spending stems from trustworthiness of CB monetary policy. Unless monetary base is expected to be contracted in the future, inflation expectations rise, thus creating an incentive for increased current spending, because in the intertemporal consumption model, future consumption becomes more expensive.

However, it is also of a high importance to differentiate income groups, since low-income households generally have higher marginal propensity to consume than the high-income, meaning that a bigger share of the additionally received cash is spent by the poor than by the rich. Therefore, the definition of target recipients have a significant impact on the overall efficiency. Providing cash to the poor can be expected to yield larger effects than to the rich. Since most people without bank accounts belong to the population of low-income group, creation of an appropriate scheme for provision of grants to this group is a cornerstone.

Despite the fact that in the original Friedman's model cash was distributed on a random basis amongst population, in the real world rather fairness of the distribution would matter. According to the income group differences, for best possible efficiency, it would be meaningful to establish a system of distribution biased against the rich. However, set-up of such a scheme would be complicated, firstly for the CB does not have access to information on individual's income, secondly for it might create an image that CB provides privileges to certain group which surely does not correspond to its objective mission. If the distributor's role was assigned to the government, then the option of unequal cash distribution amongst recipients could be achieved easier, since political decisions are not even expected to treat everyone equally. Altogether, under the CB execution, everyone should obtain an equal amount of fiat money with no difference and no exclusion, while under the government's execution, providing privileges to certain group is posssible, but the target recipients should be chosen carefully with regards to all the aforementioned aspects of consumer behaviour.

Due to the demand-side nature of this form of monetary boost, HDoM can only work as a solution to demand-shock triggered recessions.

3.4 Discussion of the concept in existing literature

In the existing literature, both supportive and opposing stances towards HDoM can be found.

Criticism flows mainly from those economists who view inflationary monetary policies as risky ones, because there is a threat of overshooting inflation target and creating hyperinflation. For instance Scot Sumner (2010) approves that HDoM in its real direct distribution sense works as a tool to increase aggregate demand, but the policy effects are likely to get beyond CB's control and cause hyperinlation which would then have to be prevented by monetary base decrease, i.e. reverse of HDoM, hence it is not a sustainable policy.

Nevertheless, in reality, if the volume given out to public is limited and known to be only a one-time event, creating hyperinflation in an economy that has long been on the verge of deflation is rather improbable. Furthermore, when inflation finally appears, traditional policies become again available, and the CB has space for reaction using its regular monetary tools. It is worh emphasising again that proper communication of the policy strategy and target are an essential part of the policy exectuion to avoid insecurity in public about the future price-level evolution. This negative stance thus rather seems to be a fear based on historical experience with hyperinflations in the 20^{th} century.

From perspective of the Austrian economic school, as expressed by Gary North (2013) execution of HDoM via central bank purchases of government securities does not ensure a uniform rise of prices, but rather creates market distortions due to sequential nature of spending (from government to companies to individuals). The only sure thing accoring to North is that the government spending increases. The major counter argument for the Austrian school would be that in the right HDoM course, the cash would be handed directly in hands of individuals, not government, which is in exact accordance with their approach that individual preferences matter more than aggregation, and exaggerated public spenging is a waste.

As far as supportive materials are considered, it is important to notice that

Bernanke's speech (2002), for which he gained a nickname "Helicopter Ben", relate money-financed tax cut which is not exactly HDoM. Also Cochrane (2011) explains helicopter drops as a fiscal operation that should be communicated in a manner preventing possibility of Ricardian equivalence (without expectation of future pay-back by increased taxation or any other contractionary fiscal policy). He states that helicopter drops [...]

> "[...] are instead a brilliant psychological device to dramatically communicate a fiscal commitment, that this cash does not correspond to higher future fiscal surpluses, that there is no "exit strategy", and the cash will be left out in public hands, unlike other economically equivalent actions taxpayers may have grown accustomed to."[5]

Buiter's (2014) model which has been discussed above considers both possibilities of execution - in cooperation with the government and directly from the central bank, so they are closer to the Friedman's concept than any other studies. Moreover, Buiter shows that HDoM in form of non-monetary public debt acquisition by the CB is efficient if held as a perpetuity even under presence of Ricardian equivalence, because if consolidated CB and government intertemporal budget constraint is to be satisfied, future public spending has to increase or there must be a future tax cut not the other way around.[6] Also Tyler Cowen (2014) justifies that there is no Ricardian motive for public to save the newly obtained cash.

Key implication of all reviewed studies is that if HDoM should be functional and supported by broader spectrum of economists, the following conditions should be met:

1. CB should to be able to execute the operation either directly on its own or in cooperation with the government granting a tax cut to citizens, not via government spending;

2. CB must convince public it is ready to act "irresponsiby" for a necessary time-span, but at the same time ensure it is capable of settling down the

[5] Cochrane (2011), p.16

[6] See Buiter (2013), p. 20-23 for further detail

effects ought they be more extreme than desired using other operations than contracting monetary base (which would be a reversed operation to HDoM).

In recent years, unorthodox renowned economists have conveyed a message it is time to start eliminating legal and moral barriers that make HDoM and other unconventional tools impossible in practice. Adair Turner (2015), former Financial Services Authority chairman, strongly supports establishment of monetary framework which would allow for injecting money in hands of consumers or governments directly. Similarly, Oxford professor of economics John Muellbauer (2014) argues that handing out cash to households is in CB's independent inflation mandate. In relation to the feasibility constraints, it would mean either legalising monetary financing, primary issued securities purchases by the CB or creating a direct distribution scheme.

Chapter 4

Practice from the real world

This chapter reviews worldwide experience with direct cash distribution programmes and quantitative easing. It is of a particular interest to examine existing distribution schemes, and whether the objectives of the schemes are similar to what HDoM targets. The Section on quantitative easing 4.2 provides comparison to HDoM concept and summarises QE application in Japan and the USA.

4.1 Distribution of cash or cash equivalents

Research conducted in the scope of the thesis shows that the existing worldwide experience with distribution of cash or its equivalents has been limited to fiscal stimulus packages provided by local governments or international bodies and their agencies. Direct cash distribution that would happen as an incentive of central bank has not yet been exectuted in the world.

Mostly, direct cash distirbution programmes that would target higher share of population than just a small selected group are associated with developing countries facing poverty problems and lacking social security systems or to after-disasterous areas. The main target in such background is quite different from HDoM desired boost of demand and escape from deflation trap. Programmes mostly aim on fighting poverty, and helping to achieve at least basic self-sufficiency of inhabitants. There exists extensive literature covering impacts of aid and direct transfer schemes to the poorest and most vulnearable on local economies. For instance Hanlon et al. (2010)

or Guy Standing (2007) cover how low-income households operate with cash, and that efficiently conditioned transfers and geographical selection might have multiplicative effects even in the long-run. According to these papers, it is also essential to select proper type of tansfer, since cash for work or food voucher schemes may cause distortions rather than improvement of the situation.

A quite unique example of a developed country having used nation-wide cash grants as a tool to stimulate demand is Australia. In 2009, Australian government implemented a stimulus programme of providing one-off grants totalling to $ 42 billion (1% of GDP) to over 50% of population in order to boost demand and prevent further recession. Although between 2009 and 2010 year-on-year inflation rose from 1.8% to 2.9% and GDP growth increased from 2% to 2.4%,[1] a medium-term impact seem to be worse than short-term. As DSGE analysis conducted by Li and Spencer (2014) shows, in 2009, after the policy application, output overshot its potential, but then a negative fiscal shock in 2011 stemming from reduction of the government debt (originally increased to finance the stimulus) brought output below its potential for more than a year. This parallel again points to the necessity of functional cash stimulus to be irreversible and seen as a net asset without future liabilty.

4.2 Quantitative easing

Quantitative easing is an unconventional monetary policy rooted in central bank's balance sheet inflation which is financed through creation of new base money. Willem Buiter (2008) brought in taxanomy differentiation between quantitative and qualitative easing. In most cases they are conducted simultaneously as quantitative and qualitative easing (QQE). What distinguishes them is that quantitative is based on central banks' balance sheet increase leaving proportional asset composition stable, while qualitative easing also means a shift towards riskier assets or assets with different liquidity (longer maturity for instance), thus providing not only excess liquidity to banks, but also alleviating their portfolio from bad assets with the hope

[1] data source: OECD Statistics

for money multiplication effect to occur, as banks can afford to provide more loans.

4.2.1 How QE resembles HDoM

QE in its right sense means a delivery of newly issued cash to banks or other private companies, whose assets are bought by central bank on the secondary market. Central bank's balance sheet liability side is increased by the newly issued money in circulation and asset side rises by the securities acquired. If those assets are held constantly as a perpetuity, rolled-over every time at their maturity or replaced by acquisition of new ones, we can talk about permanent monetary base increase which resembles HDoM. Although cash is not directly distributed to public, monetary base increase influences accessibility of cash to private agents mainly through credit channel and interest rate channel. As discussed in the Section 3.3.2, the impact on broader monetary aggregates is dependent on how much intermediation of credit is revived.

Four major examples of QE application from the real world practice are programmes conducted by FED, Bank of Japan, Bank of England and European Central Bank. From these, the cases of Japan and the United States were selected for further analysis. Firstly, they represent two most extensive programmes so far conducted in the world. Bank of Japan was the very first central bank to ever apply quantitative easing, and currently is conducting already third round of QE. Thus there exists space for comparing success of each round, and projecting possible impacts of the ongoing round. The FED's QE on the contrary was already terminated in October 2014, hence we can observe where the economy got after the expected monetary transmission period of four to six quarters. Secondly, financial systems of Japan and the US differ in their nature which is beneficial for the analysis, as it thus covers differences in market settings. While the Japanese financial system is bank-based (similar to continental European conditions), and monetary policies are aimed mainly on lending to banks, American system is more stock-based, so the programmes include more bond purchases than direct lending to banking sector (similar to conditions in the UK). Thirdly, the ECB asset purchases that can be sorted as QE were only initiated last year in March (the prior easing was not based on monetary

base increases), so due to the lenght of monetary transmission period, hardly can we observe real effects of the policy yet. The British example constituted two rounds from which the initial one was pure qualitative easing without the quantitative part. Private asset purchases by BoE were sterilised by selling Treasury securities from its portfolio, and the monetary base remained relatively stable. Only the second round can be considered quantitative easing financed through money issuance and increasing monetary base.

4.2.2 QE in the USA

Development of macroeconomic indicators in 1990s

During the 1990s, American economic expansion was the strongest since the boom in the 60s. Especially unemployment at around 4% and stable real GDP growth of over 4% were considered a huge success combined with government spenging surpluses and inflation within policy desirable borders; from 1992 to 1999 it fluctuated only between 1.55% and 3.03% as Table 4.1 shows.

This era of low volatility is known as the Great Moderation. It remains a subject of debates, whether the outstanding performance was caused by improved monetary policy implementation under Greenspan's FED administration such as defining policy interest rates according to the Taylor rule[2], combined with enhanced independence of FED, and well conducted fiscal changes by the Federal government (systematic tax cuts and increases, budget agreements), or can only be attributed to good luck and combination of positive coincidences.

Post 2000 development

The first decade of new millenium then turned to be harsh time for the States for numerous reasons. The beginning of 2000s is associated with burst of the dot com

[2]see Appendix A 6.2

Table 4.1: US economy in Great Moderation

Year	**GDP growth (%)**	**CPI (y-o-y, %)**	**FED funds rate (%)**
1990	5.67	5.39	8.10
1991	3.25	4.25	5.69
1992	5.92	3.03	3.52
1993	5.19	2.95	3.02
1994	6.25	2.61	4.20
1995	4.86	2.81	5.84
1996	5.69	2.93	5.30
1997	6.28	2.34	5.46
1998	5.58	1.55	5.35
1999	6.29	2.19	4.97
sources:	OECD Statistics (GDP, CPI)		,
	St. Louis FRED Economic Research (FED funds rate)		

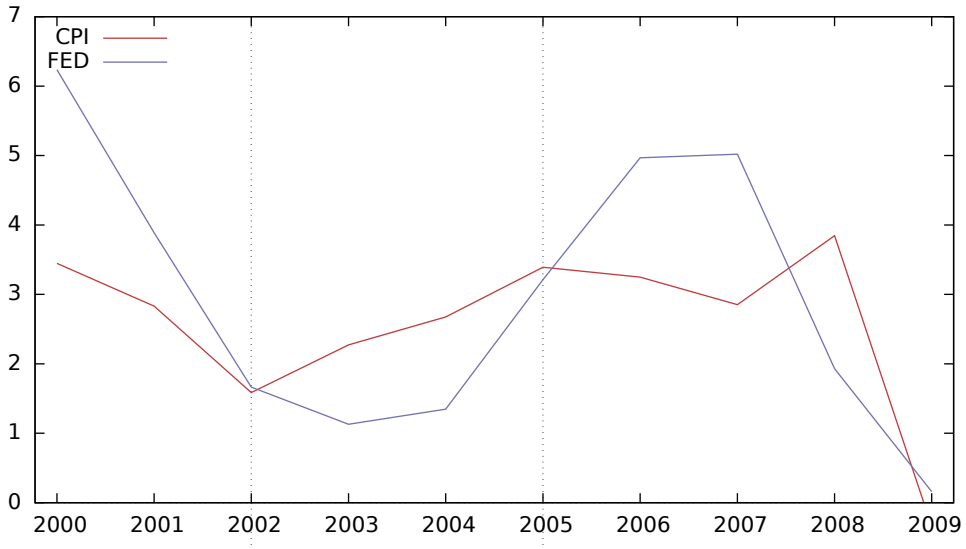
bubble. Loss in market values of numerous ICT companies led to drop from March 2000 peak of Nasdaq Composite index at 4 573 to as low as 1 321 in January 2003 (i.e. write-off of 71% market value; Dow-Jones dropped by 31% during this time).[3] The 9/11 attacks did not help to improve the disillusive atmosphere in the economy after the optimistic development in the 90s, nor the supply side shock caused by rising oil price level. The well-known subprime mortgage bubble then was a final step to a meltdown of financial system.

Figure 4.1 represents evolution of CPI and policy interest rate after 2000 in the States. One of the issues with policy application is that FED did not follow Taylor's rule before the market collapse. Despite CPI inflation rising from 1.59% in 2002 to 3.39% in 2005, FED fund rates only increased from 1.67% to 3.21%, far less than one to one proportionally to CPI. Apart from reluctant monetary policy, lack of market regulation and monitoring played its role, as it practically enabled financial institutions to hold only inefficient capital reserves against potential risks, and the rating agencies to assign good ratings to risky collateralized financial instruments.

[3]Index values retrieved from *Yahoo! finance* on 2016-4-24

More detailed explanation of the reasons of crisis is provided e.g. in The Financial crisis inquiry report(2011). Further text studies FED's attempts to recover economy using QE.

Figure 4.1: Evolution of inflation and policy interest rate (%)



Three waves of American QE

Following the bankruptcy of Lehman Brothers in September 2008, QE was initiated under Ben Bernanke's administration in October 2008. Despite the fact that in past FED had implemented various rescue programs through asset facilities for lending money, this time it was the first case when the monetary base was expanded. Past programs were conducted via sterilised purchases of assets, i.e. backed by sale of short-term Treasuries as in the above-explained case of BoE. The so-called QE1 Program had two waves (initiated in October 2008 and in March 2009) and by its means, the monetary base was almost doubled. Table 4.2 presents y-o-y changes in MB, M1, M2 and consumer credit in the fourth quarter average volume of each year. After QE1, consumer credit was rather declining, and effects on M2 aggregate were very small compared to the extent of MB incerases. After an increase in inflation at the end of 2009 through the first half of 2010, another declining tendency occurred in 3Q 2010, so a second round of easing (QE2) was announced, and MB increased

by 39% by the end of 2011 which supported growth of M2 by almost 10% and consumer credit (denoted CC in Table 4.2) by 7%. Both QE1 and QE2 were executed as operations targeting volumes. This changed with the final, third round (QE3) announced in September 2012 which committed to a pace of purchases as linked to macroeconomic conditions instead of total volume, and ended by a final USD 15 billion purchase in October 2014 with inflation below target (at annual average of 1.7%), but with improved labor market conditions (which are not a primary focus of this study though).

Table 4.2: Evolution of monetary indicators and consumer credit during QE in the USA

Year	**MB** ($\Delta\%$)	**M1** ($\Delta\%$)	**M2** ($\Delta\%$)	**CC** ($\Delta\%$)
2008	69.76	11.47	8.36	2.10
2009	41.04	10.04	5.44	-3.69
2010	-0.59	7.80	3.41	0.51
2011	32.11	18.90	9.76	6.86
2012	0.91	12.72	7.63	5.92
2013	38.53	8.22	6.07	6.08
2014	7.05	9.76	5.77	7.12
2015	1.16	6.06	5.80	6.86

source: St. Louis FRED Economic Research

As far as the asset composition of FED's balance sheet is concerned, first novelty was an establishment of Maiden Lane LLC I-III facilities to bail-out Bear Stearns, and American International Group. At the peak in January 2009, they totalled to $73.7 billion in FED's assets. Liquidity and credit facilities were increased in volumes more than 16 times between July and November 2008, and in 2009, mortgage-backed securities were added to the portfolio in total volume of over $900 billion by the end of the year. With the second round of QE, no significant qualitative changes were not made, but monetary base was further expanded, which also holds for QE3. All in all, the most remarkable qualitative change was in high-volume acquisition

of mortgage-backed securities. The next chapter analyses the policy application empirically.

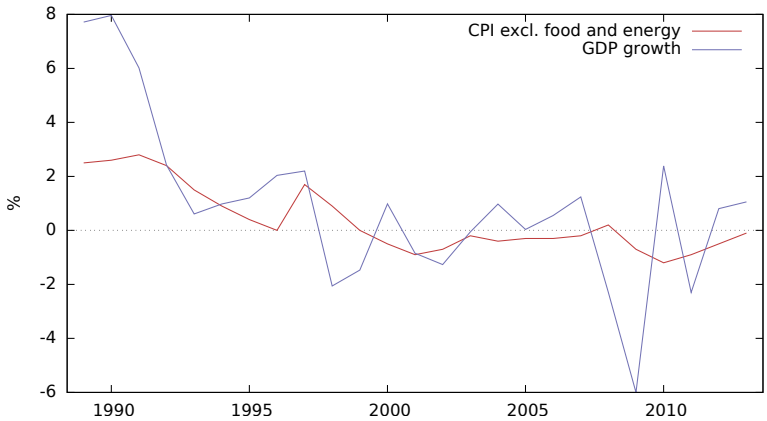
4.2.3 QE in Japan

This part analyses quantitative and qualitative easing (QQE) applied in Japan. Empirical analysis of past and possible future impact on inflation (as measured by CPI and GDP deflator) and GDP gap is carried out in the Chapter 5.

Historical conditions and development of macroeconomic indicators

Until 1989 the Japanese economy was growing at very good pace. As Figure 4.2 shows, GDP growth in 1990 reached almost 8%. Unfortunately, Japanese performance went through a major change in 1990, and an era of long lasting recession began with average GDP growth between 1994 to 2014 at only 0.91%, and inflation (excluding energy and food prices which highly reflect oil price changes) ranging from as low as −1.2% in 2009 to 1.9% in 2014, but mostly fluctuating around 0.1%.

Figure 4.2: Evolution of GDP and inflation (Japan)



No single economic factor can be considered as the catalyst for initiation of this era per se. There were many indicators which all in combination led to the length and severity of Japanese recession. According to the research of McKibbin (1996), a lot of attributes of Japanese economy since 1990 can be explained by trend changes in productivity and population growth, and set macroeconomic policies. Japanese population has been declining due to low birth rates, and accompanied by population ageing, this trend has caused decrease in labor force. Moreover, labor market conditions in Japan are very rigid. Many people have contracts for life-time, and it is very costly for employers to fire someone. Thus, instead of unemployment rate increase during recession, labor force productivity decreases.

Another troublesome issue has been a very high level of Japanese government debt. As the spending for social security and health care systems need to be increased, the government debt to GDP ratio has been growing gradually from approximately 0.75 in 1990 to 2.3 in 2015[4].Nevertheless, the main event which is considered to have started the period of stagnation is a burst of an asset bubble which was inflating to massive volumes during 1980s. The bubble arose from excessive loan growth quotas that commercial banks had to comply with due to the Bank of Japan's policy decisions. As the banks were lending large amounts without deeper regards to the quality of borrowers, they accumulated a pile of bad debts. After the bubble burst, these banks turned into "zombie banks" through postponing the recognition of losses, and injecting additional funds in long lost firms. Thus Japan ended up in a harsh time which has lasted for more than two decades, and is often referred to as "Two Lost Decades."

Summary of policy application in the 1990s

There was no clear strong policy implemented to deal with this downfall in the 1990s. Due to a tight bound and business culture between the government and industrial groups with banks in Japan, the bureaucrats were too conservative and protective to let the banks fall. Banks which got into serious problems were often

[4]data source: Trading Economics, retrieved 2016-4-22, accessible at: http://www.tradingeconomics.com/japan/government-debt-to-gdp

quietly bailed out on temporary basis with loans and investments from other fellow members of the corporate group.[5] Therefore, the banking sector with many banks on the verge of bankruptcy was not capable of helping the economy to recover, as further lending was completely off the table. As a result, financial intermediation by banks stopped working as it normally should.

Concerning fiscal policies, during the 1990s, Japanese government provided ten fiscal stimulus packages summing up to more than 100 trillion yen. None of them was successful to cure the recession.[6] In 1997, VAT was increased from 3% to 5%. This tax increase, intended to decrease the government debt, rather increased it as a result of significantly suppressed consumer spending which contributed to GDP drop by 2.06% in 1998.

As for monetary policies, despite the fact that the Bank of Japan attempted to boost recovery by inflating monetary base, broader monetary aggregates and bank credit failed to increase. As Table 2.1 shows, despite the increase of monetary base by one quarter between 1994 and 1997, money was rather hoarded by banks than further provided to households and firms in form of loans. Bank credit raised only by 0.9%. Consequently, decrease in consumption and investment occurred, and GDP further contracted.

The interest-rate targeting also failed to enhance the economy which was already captured in a liquidity trap with short-term interest rates close to zero. At this stage, traditional monetary policies become inefficient, because open-market operations have little or no effect on interest rates; hence attempts to boost aggregate demand fail. Figure 4.3 captures short term interest rates (BoJ), and 9-year Japanese government bond yields (JGB9y). As it can be seen, since 1996 interest rate as a policy tool has been almost depleted, as they approached zero.

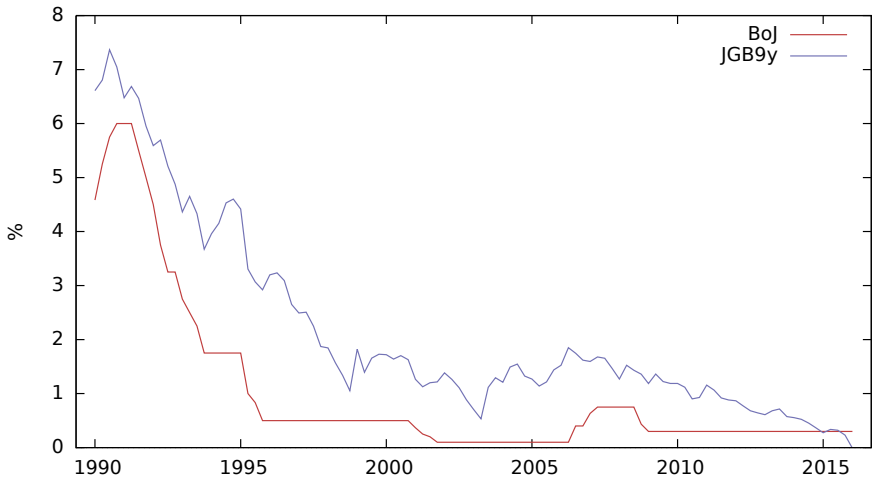
Bank of Japan QQE 2001-2006

In 2001, the Bank of Japan announced the start of quantitative easing policy. As the first of central banks in the world, it switched monetary policy from interest-

[5] Lohr (2008)

[6] Powell (2002)

Figure 4.3: Short term interest rates and JGB yields (Japan)



rate targeting to current account balance targeting (target on excess reserves of commercial banks). However, steps taken by BOJ were not trustworthy enough. The public was not fully convinced that BoJ will follow its promise to project it into expectations, and hence the real inflation. As Figure 4.2 indicates, CPI was still declining. During this period, monetary base increased by almost 60%. Rises in M2 and M3 did not by far correspond to the volume of monetary base change, but there was a visible growth in lending to households which immediately dropped to negative numbers along with contraction of monetary base as presented in Table 4.3.

Table 4.3: Evolution of monetary indicators and consumer credit during QQE1 in Japan

Year	**MB** ($\Delta\%$)	**M2** ($\Delta\%$)	**M3** ($\Delta\%$)	**CC** ($\Delta\%$)
2001	7.58	2.20	1.00	5.96
2002	25.70	3.50	1.00	5.96
2003	16.44	1.90	1.00	9.05
2004	7.12	1.60	0.80	3.42
2005	1.97	1.90	0.90	6.27
2006	-13.27	1.80	0.20	-0.54

source: BoJ Time Series Data Search

Concerning the BOJ balance sheet composition, worth noting is that only government Treasury bills and bonds, and stocks held at trust property (in very small amounts though) were added to portfolio. No corporate bonds or commercial papers were the acquisition target. However, most significant is the fact that as soon as interest call rates turned positive (in half of the year 2006), Bank of Japan reversed its previous actions, contracted monetary base by 13% and sold almost one fifth of the government securities despite the non-improving inflation, and inconvenient GDP growth.

Soon after, the 2008 recession hit the Japanese economy strongly, and after the Great Recession even more disastrous event occurred in the form of 2011 earthquake seriously harming the economy in the "usual way", and unfortunately also damaging the Japanese nuclear power plants, notably in Fukushima. Moreover, another Value Added Tax Increases was approved by the Diet of Japan in 2012. The first being from 5% to 8% in 2014 and the second from 8% to 10% scheduled for 2015. While the first increase was actually performed, the second has been postponed in order not to suppress the consumer spending any more.

Abenomics and the new wave of QQE

Prime Minister Shinzo Abe took the office in December 2012. He promised to apply major changes in three fields, the so-called three arrows: monetary easing, fiscal stimulus and structural reforms; and came with an orthodox plan to set inflation target strictly to 2%, even if the independence of the central bank from political sphere should be abused.[7] The fiscal arrow is based on a massive stimulating package of investments into Japan's infrastructure. At an expense of increasing government debt, about 20.2, 5.5, and 3.5 trillion yen were successively invested, mainly into the infrastructure such as tunnels, earthquake-proof roads, bridges etc., and partly into private sector as well. The structural arrow consists mainly of agriculture liberalization, overview of sectors of healthcare, energy and environment, corporate tax cuts, changes in the pension funds system, and tax cuts based incentives for women. The main objective of the structural reforms is a fight against aging of the

[7] Kihara, 2012

Japanese population.

For the scope of this text the most important arrow is the monetary one, based on a new round of massive quantitative easing with the main target of achieving the 2% inflation target. 65 and 80 trillion yen worth bonds purchases were announced in April 2013 and October 2014 respectively. About 60% increase in the monetary base should have resulted in significantly weaker yen (25 to 30% decrease), and therefore larger exports and economic boost overall.

So far, better results compared to the first QQE attempt can be observed. Broader monetary aggregates have been performing slightly better as shown in Table 4.4. Asset composition of the BOJ balance sheet has been changed significantly. Besides increasing JGB volume more than three times the following riskier securities were added to portfolio: commercial papers, corporate bonds, stock, index-linked exchange-traded trusts, and Japan real estate investment trusts held as a trust property. The overall success of this round of QQE is yet unclear. Andolfatto (2014) shows that the last wave of QE (starting in April 2014) brought about an increase in inflationary expectations quite high compared to the previous attempts. However, this year, average CPI (January to September, OECD) excluding energy and food prices is 1.15%, still well below the target. Also, despite the fiscal stimulus, Japan fell back into recession in 2014, and the bank intermediation, though improved, was still not so well-performing, not to speak about the enormous government debt.

Table 4.4: Evolution of monetary indicators and consumer credit during QQE2 in Japan

Year	**MB** ($\Delta\%$)	**M2** ($\Delta\%$)	**M3** ($\Delta\%$)	**CC** ($\Delta\%$)
2012	7.15	3.00	2.60	3.25
2013	33.95	2.70	2.30	2.95
2014	44.12	4.30	3.50	2.49
2015	34.80	3.40	2.80	2.23

source: BoJ Time Series Data Search

In the empirical Section 5, an assessment of possible development and relations of MB with M2, GDP and is provided.

Chapter 5

Empirical analysis of QE

This part analyses Japanese and American data using vector autoregression. First the sample selection is described, description of the model and its assumptions follows, and finally selected results are presented and discussed.

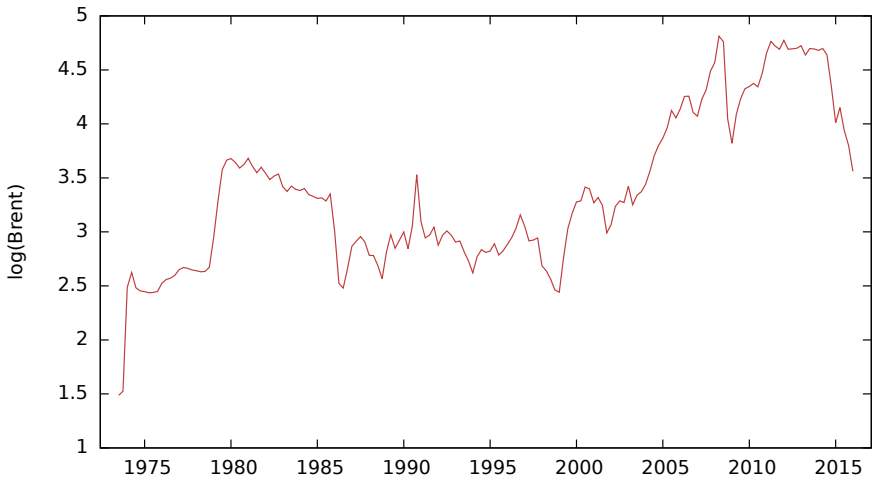
5.1 Data description

With regards to the fact that all variables included in the model are going to be macroeconomic and financial indicators, and examination of monetary policy, whose impacts are usually observed on quarterly basis, is within our interest, quarterly periodicity is selected for the time series collection. Variables that will be analysed are:

1. monetary base as the main indicator representing volume of quantitave easing,
2. policy nominal interest rates as a traditional MP tool,
3. broader monetary aggregate M2,
4. long-term government bond yields,
5. consumer price index as an inflation indicator,
6. and seasonally adjusted GDP as an indicator of economic activity which also reflects increased spending by both government and households.

All volume based data will be first transformed to their logarithmic forms to better depict percentage changes. As an exogeneous variable and a proxy of global price shocks influencing prices and inflation worldwide, price of futures on Brent crude oil is selected (Figure 5.1 presents logarithmized average quarterly values). Monthly data were retrieved from Thomson Reuters Datastream and adjusted to quarterly averages.

Figure 5.1: Brent crude oil price



Moreover, taking into account the significant changes in monetary policy systems that came along with the abolition of the Bretton Woods system in 1973, the data will be analysed from 3Q 1973 to the last available data on 1Q 2016 for the US, and from 4Q 1974 for Japan, since it was the first period when 9-year JGB were issued. The sample size will thus be 171 observations for the US and 166 observaitons for Japan.

5.1.1 American data

Monetary base (MB), M2, FED funds rate (FED), 10-year US Government Bond yields (GB10y), and GDP were retrieved from Economic research of Federal Reserve bank of St. Louis.[1] CPI was obtained from OECD Statistics.[2] The notation stated

[1] Accessed on 2016-04-26 at https://research.stlouisfed.org/

[2] Accessed on 2016-04-26 at http://stats.oecd.org/

in brackets is used in regressions. Logarithmised volume-based MB, M2, GDP and CPI are plotted in figure 5.2, and variables expressed in percentage volumes are presented in figure 5.3.

Figure 5.2: MB, M2, GDP and CPI (USA)

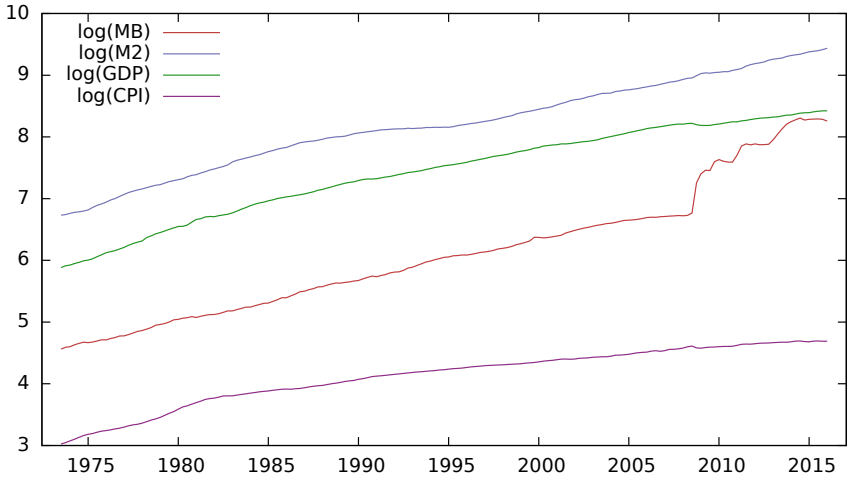
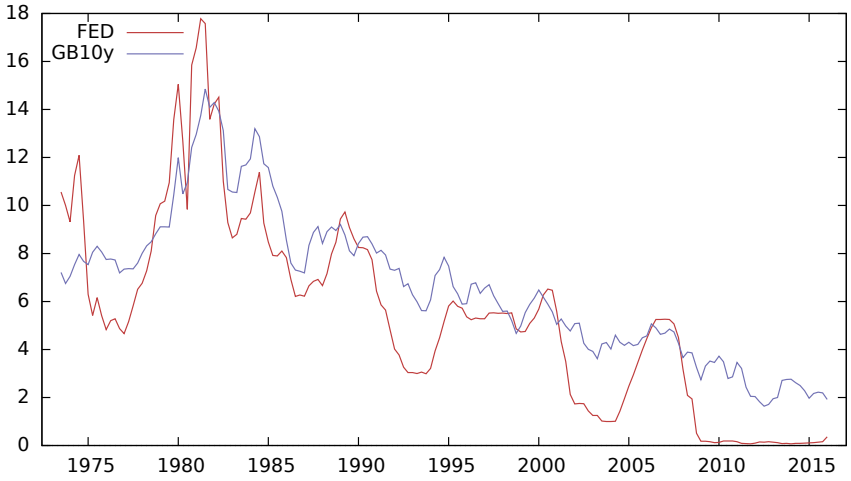


Figure 5.3: FED funds rate and 10-year GB yields (USA)



From the plotted series 5.1, 5.2, and 5.3 it is visible that the volume-based variables have a time trending tendency. The interest rates show a declining trend from early 1980's.

5.1.2 Japanese data

For the Japanese case, 9-year JGB yields were selected instead of 10-year, since 10-year JGB were historically first issued in October 1986 which would restrict the sample size. For the same reason, monetary aggregate M2 was selected instead of M3 series. Although M3 as a broader aggregate than M2 would reflect multiplicative effect better than M2, M3 is only available from the 90s when it was introduced as a new measure.

MB, M2, and BoJ's basic rates (BoJ) were retrieved from Bank of Japan Time Series Data Search.[3] The 9year JGB (JGB9y) yields were downloaded from the Ministry of Finance Japan website,[4] and CPI and GDP from OECD Statistics.[5] The time series are plotted in 5.4 and 5.5.

The growth of MB outpaced the GDP growth significantly after third QE was initiated in 2013 under Abe's lead pointing to high determinacy to convey the message that the scale of MP could be almost unlimitedly high, if necessary. Last wave of QE in Japan has been more aggresive than any of the US applied programmes. Further worth noting is the performance of CPI. Inflation was very mild during the whole observed period with the highest q-o-q change reaching only 4.3%, compared to 14.5% at the beginning of the 80s in the US case. As far as nominal policy rates are concerned, BoJ depleted its traditional MP power already in mid 90s. Prima facie GDP and CPI do not seem to be trending, and the remaining variables show the same patterns as the American.

[3] Accessed on 2016-04-26 at http://www.stat-search.boj.or.jp/index˙en.html

[4] Accessed on 2016-04-26 at http://www.mof.go.jp/english/jgbs/reference/interest˙rate/index.htm

[5] Accessed on 2016-04-26 at http://stats.oecd.org/

Figure 5.4: MB, M2, GDP and CPI (Japan)

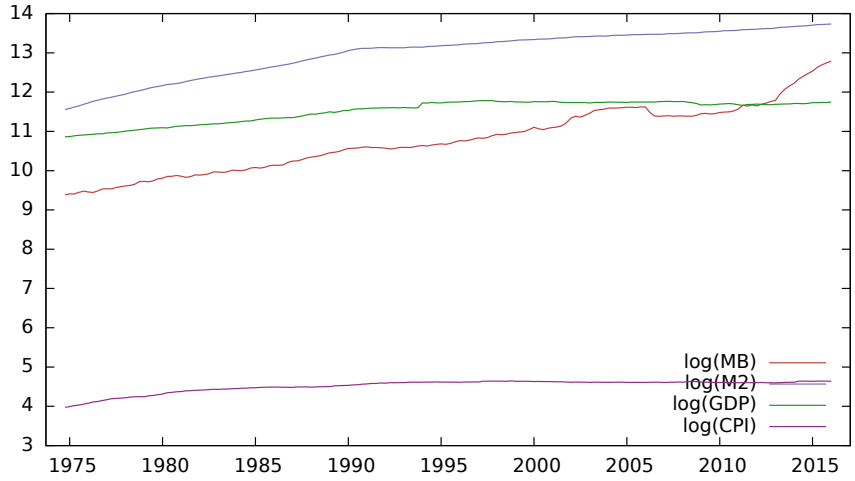
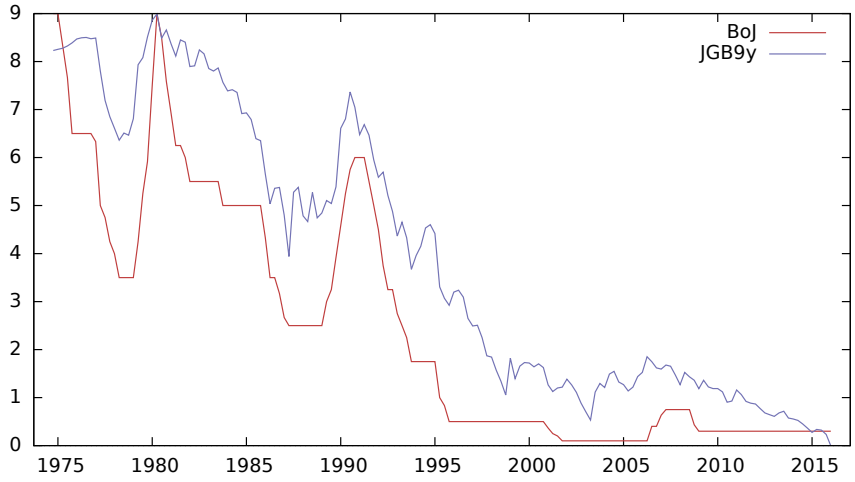


Figure 5.5: BoJ policy rate and 9-year JGB yields (Japan)



5.2 Model setting and description

Since macroeconomic indicators are very interdependent, sensitive to changes of each other, and also show autoregressive nature, applying basic OLS regression does not lead to results convenient for statistical inference, since assumptions necessary for consistency of the estimators are violated. The variables cannot be considered strictly exogeneous, sometimes not even contemporaneously exogeneous, which would cause OLS estimators not only to be biased, but also inconsistent. Therefore, an alternative linear model, vector autoregression (VAR) will be applied instead of basic OLS. Gretl software is used for the analysis, and 5% significance level is set

for hypothesis testing.

5.2.1 Vector autoregression in brief

VAR is a linear model of $n \in N$ variables in which every variable is explained by its owned lagged values upto a selected number $p \in N$ of lags, and by lagged values (upto the same selected number lags) of all other $n-1$ variables in case of reduced form of VAR, or by both current and lagged values of other variables in case of recursive VAR. The model considers every included variable endogeneous, thus solving the problem of most macroeconomic series not being strictly exogeneous. However, it also allows for adding exogeneous variables to control for exogeneous shocks, and enables modelling of impulse response functions which reflect how variables interact between each other within selected timespan. Furthermore, based on the past data, expected future evolution within selected confidence interval can be projected. More details on VAR theory is presented in Appendix C 6.2.

5.2.2 Stationarity control and differencing

For each variable from both datasets Augmented Dickey-Fuller (ADF) test will be conducted including constant, and a time trend for variables that a priori seem to be trending, to test for the integration of the process, and also to find a pattern of how much the past values of each variable influence the current ones. If unit roots are present in some series, differencing needs to be done in order not to violate stationarity which is one of the main model assumptions.

Maximum lags to be included in the ADF is eight. The typical policy application transmission lag is considered four to six quarters, hence 8 lags should be sufficient. Schwarz-Bayesian criterion and Akaike criterion of lag selection results are compared for each of the variables.[6] In Appendix D 6.2 Figures 6.1, 6.2 present results for US monetary base in its log form and a discussion of data adjustments implied by the results follows in this section as an example. The same process was conducted for each variable, but presentation of the outputs is not necessary.

[6]See Appendix C 6.2 for more details on lag criterion selection

Using BIC yields (6.2) the result including only one lag, while AIC (6.1) included five. In both cases, asymptotic p-values above 0.85 in both cases are very high, meaning that the null hypothesis of unit root presence cannot be rejected. The variable will have to be differenced. The expected time trending nature of the series was not confirmed, since in both cases, estimated coefficient is not significant neither statistically (insignificant at even 10% level), nor economically (values of coefficients are negligible). Hence, we can conclude that the growing tendency of the variable over time is caused by autoregressive nature of the variable, not by a time trend.

ADF is retaken for a differenced variable as a control that the variable is now weakly dependent. As Figure 6.3 shows, we can reject the null hypothesis of unit root presence at 5% significance level.

Based on ADF evaluation all variables including Brent price are integrated of order one in the US case, hence will be used in differenced versions. Japanese MB and BoJ basic rate are integrated of order zero according to ADF at 5% significance leve, thus remain in an unchanged form. M2, GDP, JGBs and CPI are random walking, thus need differencing.

5.2.3 Ordering and lag selection

Since the order of model input variables plays role in computation of the output estimates, we need to pay attention to ordering. Using Cholesky decomposition, the expectedly most exegeneous variables should be placed at the start, and the most endogeneous, and fastest reacting ones at the end. Therefore, with regards to macroeconomic convention, and ADF testing conducted previously a selected order is:

a) for US: MB, M2, GB10y, FED, GDP, and CPI,

b) for Japan: MB, M2, JGB9y, BoJ, GDP, and CPI

as respective endogeneous variables, and Brent is added as an exogeneous variable to both models. The regression is first run including a time trend too. Then Wald test is executed to either reject or not reject the null hypothesis of no trend.

Further, selection of appropriate number of lags has to be done. We will test for 8 lags at maximum. Preferably, lower number of lags would be included in order to keep maximum possible degrees of freedom, hence making the estimated parameters as precise as possible. Otherwise, it is also possible to adjust the model by omitting some of the endogeneous variables which is not desirable for depiction of relationships between the variables.

Figure 5.6: Lag selection test (US)

VAR system, maximum lag order 8

The asterisks below indicate the best (that is, minimized) values
of the respective information criteria, AIC = Akaike criterion,
BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

lags	loglik	p(LR)	AIC	BIC	HQC
1	1849.90723		-22.171694	-21.142495*	-21.753824*
2	1903.16976	0.00000	-22.384812	-20.669481	-21.688361
3	1948.84390	0.00000	-22.504246	-20.102782	-21.529215
4	1977.21406	0.01524	-22.410050	-19.322454	-21.156439
5	2021.92598	0.00000	-22.517605	-18.743876	-20.985413
6	2059.77282	0.00012	-22.540405	-18.080544	-20.729634
7	2101.47489	0.00001	-22.610801*	-17.464807	-20.521449
8	2132.14296	0.00530	-22.544975	-16.712848	-20.177043

Figure 5.7: Lag selection test (Japan)

VAR system, maximum lag order 8

The asterisks below indicate the best (that is, minimized) values
of the respective information criteria, AIC = Akaike criterion,
BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

lags	loglik	p(LR)	AIC	BIC	HQC
1	1896.39948		-23.470057	-22.418864*	-23.043131
2	1970.45985	0.00000	-23.954902	-22.202914	-23.243359*
3	2009.18015	0.00007	-23.989556	-21.536773	-22.993395
4	2063.42507	0.00000	-24.221975	-21.068397	-22.941197
5	2105.74557	0.00001	-24.302491*	-20.448118	-22.737095
6	2129.15189	0.10710	-24.142062	-19.586893	-22.292049
7	2150.43871	0.20910	-23.954633	-18.698669	-21.820002
8	2180.70424	0.00642	-23.881583	-17.924823	-21.462334

The lag selection test for US data is presented in Figure 5.6 above. Both Hannan-Quinn, and Schwarz-Bayesian criteria suggest inclusion of only the first lag, while Akaike criterion suggests inclusion of 7 lags. Test for Japanese data in figure 5.7 yields different recommendation by each of the criteria from one lag selected by BIC to 5 lags suggested by AIC. The models will be executed in upto seven and five lag versions respectively for US and Japan. The most suitable ones in terms of

compliance with assumptions and intuitive results will be presented.

5.2.4 A posteriori tests

Once VAR is conducted, there are several other control mechanisms to recognise whether applied model is feasible or needs restructuring. First, companion matrix can be constructed and its eigenvalues found to check whether the process really satisfies the stability condition,[7] or needs certain adjustment. Moreover, residual plot and correlation matrix should be controlled whether white noise assumptions are satisfied.

5.3 Results

5.3.1 USA

When VAR(1) was executed according to HQC selection, correlation of residual matrix with its past values occured, hence violating assumptions of the model. Therefore, VAR(7) was then run, yielding convenient results. Time trend was included in the regeression, as the Wald test confirmed that the null hypotesis of no trend could be rejected in favour of its presence at 5% significance level. A likelihood ratio test confirmed that the system with 7 lags computes parameters more precisely than a test with only 6 lags.

The companion matrix and its eigenvalues were computed then and confirmed the stability of VAR process, as the modulus of eigenvalues is lower than one in all cases. Also the zero mean condition can be considered satisfied, as the matrix of residuals is very close to zero in all value. Positive eigenvalues of matrix $E(\mathbf{u_t u_t^T})$ confirm it is a positive definite matrix, hence contemporaneous correlation of the noise is positive. However, a problem occurs with correlation of past values of residuals. Finally, Ljung-Box tests (for upto 8 lags) presented in Figure 5.8 proves that the null hypotheses of no serial correlation cannot be rejected, so the assumption $E(\mathbf{u_t u_{t-s}^T}) = \mathbf{0}$ also holds.

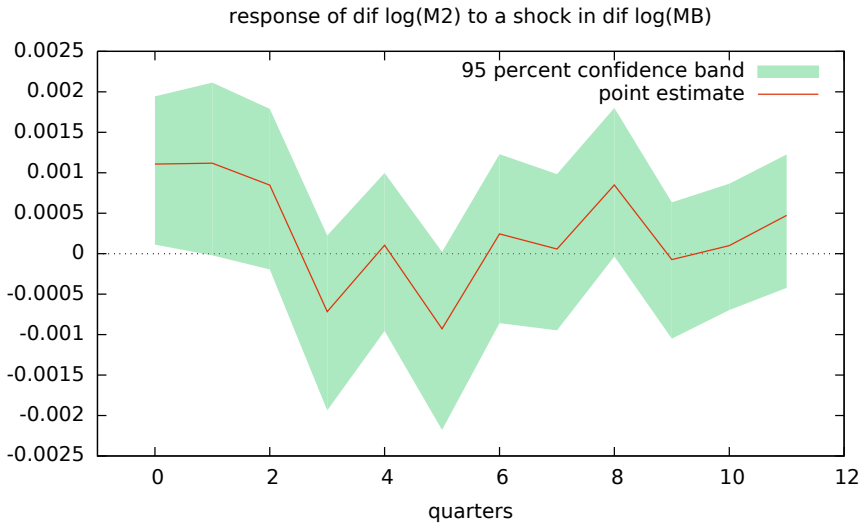
[7] See Appendix C 6.2 for more details

Figure 5.8: Ljung-Box test for residual serial autocorrelation

```
Equation 1:
Ljung-Box Q' = 1.95089 with p-value = P(Chi-square(8) > 1.95089) = 0.982

Equation 2:
Ljung-Box Q' = 2.4646 with p-value = P(Chi-square(8) > 2.4646) = 0.963

Equation 3:
Ljung-Box Q' = 1.94078 with p-value = P(Chi-square(8) > 1.94078) = 0.983

Equation 4:
Ljung-Box Q' = 6.44108 with p-value = P(Chi-square(8) > 6.44108) = 0.598

Equation 5:
Ljung-Box Q' = 7.77559 with p-value = P(Chi-square(8) > 7.77559) = 0.456

Equation 6:
Ljung-Box Q' = 2.90779 with p-value = P(Chi-square(8) > 2.90779) = 0.94
```

Below are presented impulse-response function for 12 quarters for selected variables that should ideally be affected by MB increase.

Figure 5.9: Impulse response function of M2



According to IRF plot 5.9, M2 aggregate reacts positively within the first 2 quarters after MB boost, but then the effect becomes negative. This result partially reflects the past evolution between 1973 and 2005 when changes in MB and M2 were not evolving in similar directions, nor magnitudes as visible in Figure 5.10. Even after application of QE1 and the other two waves presented in Figure 5.11, the peaks in M2 do not have any stable pattern in relation to MB despite several improvements following MB increases. Hence, it cannot be concluded that improvements in M2

levels would be a result of QE.

Figure 5.10: MB and M2 q-o-q changes (US)

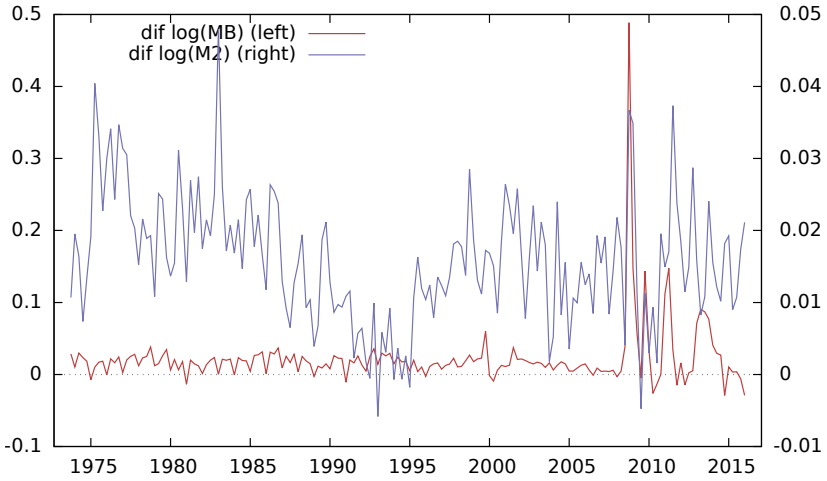


Figure 5.11: MB and M2 q-o-q changes with QE depicted(US)

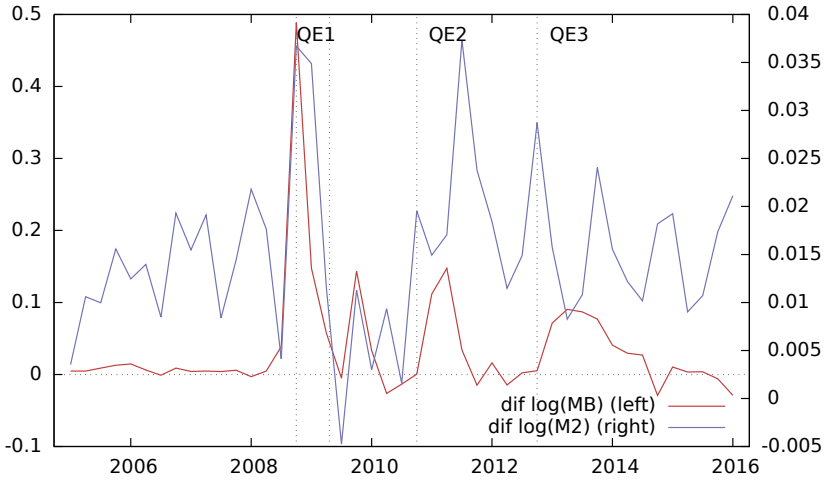


Figure 5.12: Impulse response function of GDP (US)

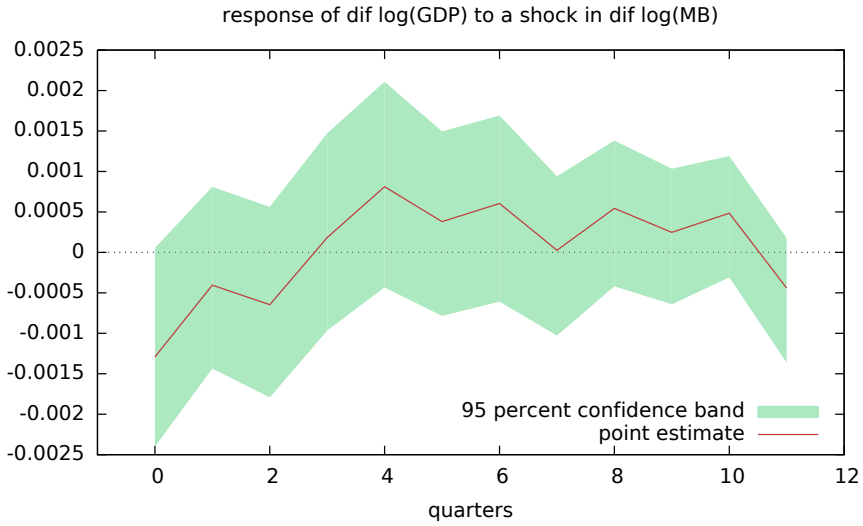
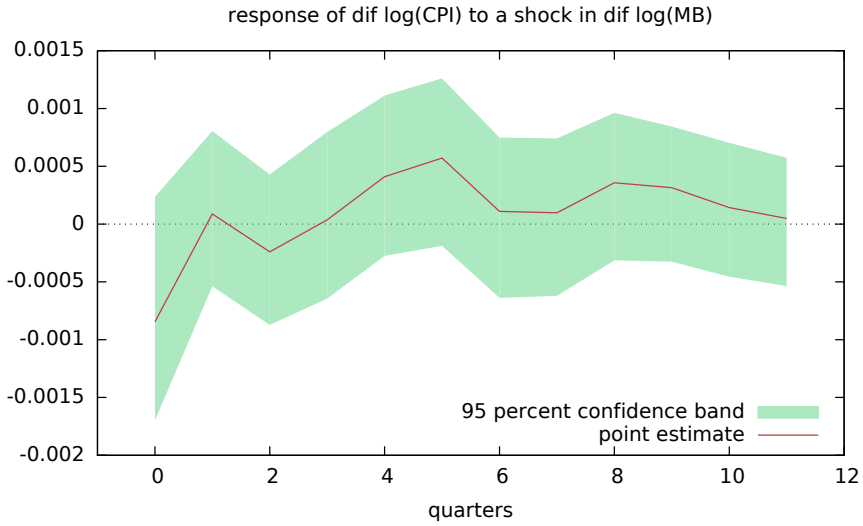


Figure 5.13: Impulse response function of CPI (US)



Both GDP and CPI first show declining tendency that diminishes within three to four quarters when the impact of increased MB volume becomes positive. This lag in reactions quite well illustrates that it takes time for the MP to go through all transmission channels. The effects remain neutral to positive for quite a long period; until approximately 11^{th} quarter. However, the conclusion should not be overly optimistic, since confidence intervals cover even areas below zero, so especially after 7Q, the chance that the indicators start declining is not negligible.

In the CPI estimated equation significant parameters are those at lagged CPI

($1^{st} - 3^{rd}$, 5^{th}, and 6^{th}), third lag of monetary base, and Brent prices. Both MB and Brent have expectedly positive sign, while influence of CPI's own lags have changing signs with positive ones dominating the negative in volume. This corresponds to a macroeconomic theory that inflation expectations, which determine real inflation, are backward looking.

Worth noting is also the fact that in the predicted equation for FED funds rate, the largest impact in magnitude and also in statistical significance is attributed to first two lags of GDP in an intuitive positive direction, but CPI parameters are insignificant, hence seemingly FED pays more attention to economy's output than overall inflation when determining nominal interest rates, or reacts rather to core inflation than the overall.

5.3.2 Japan

All tests VAR(1), VAR(2) and VAR(5) showed an issue with serial autocorrelation in noise. For VAR(5) the problem was rooted in equation for MB. Differencing also this variable improved the results, which points to caveat in precision of ADF assymptotic results, as the inference that MB is integrated of order 0 was false. However, even with differenced MB, serial correlation could be rejected testing only for upto 7 lags, but rejection of correlation with the 8^{th} lag was not possible. Testing for normality of residuals' distribution using Doornik-Hansen test confirms normal distirbution. Taking a closer view on residuals from the MB estimated equation in Figure 5.14, there is no apparent biannual pattern, hence conclusion that the correlation with 8^{th} lag residual is coincidental seems reasonable.

Wald test rejected the null hypothesis of no trend, hence the final model included the trend. Control of companion matrix eigenvalues, residual matrix elements, and eigenvalues of residual covariance matrix confirmed the remaining white noise assumptions and stability of the process. The selected IRFs for 12 quarters are presented below.

M2 responses to MB are positive with an exception of slight decline 3Qs after

Figure 5.14: Residuals from the MB estimated equation (Japan)

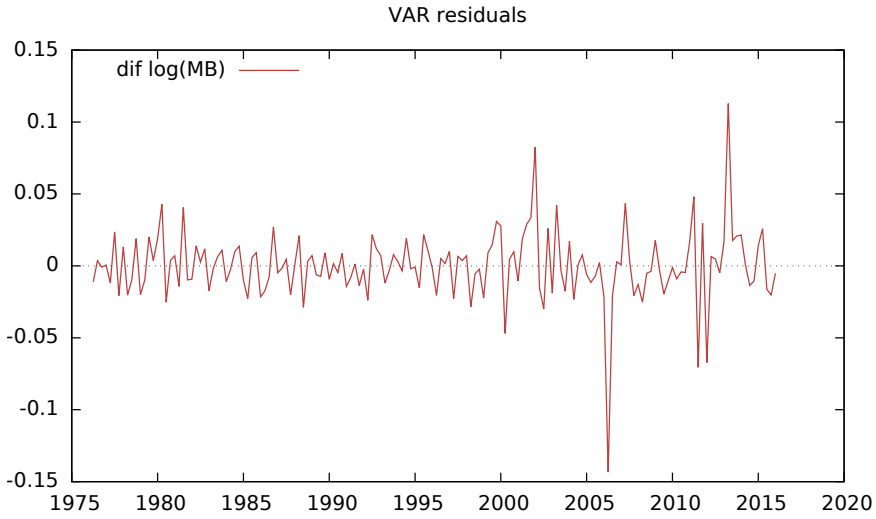
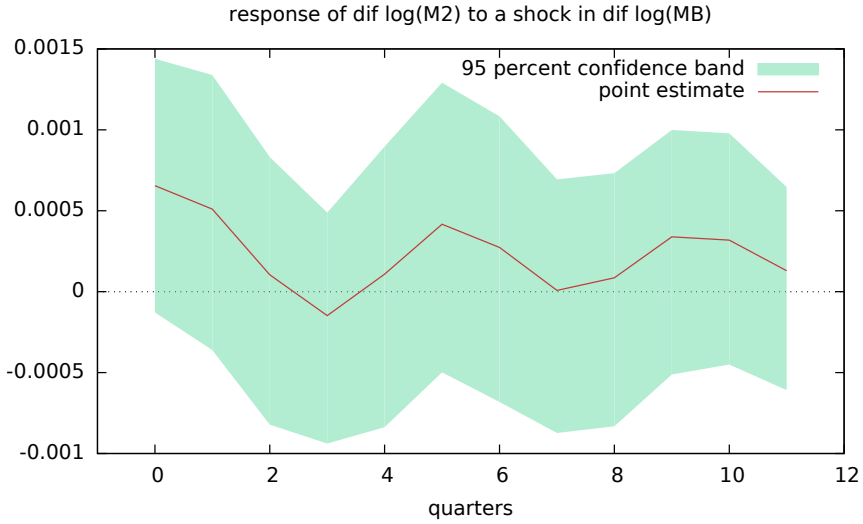
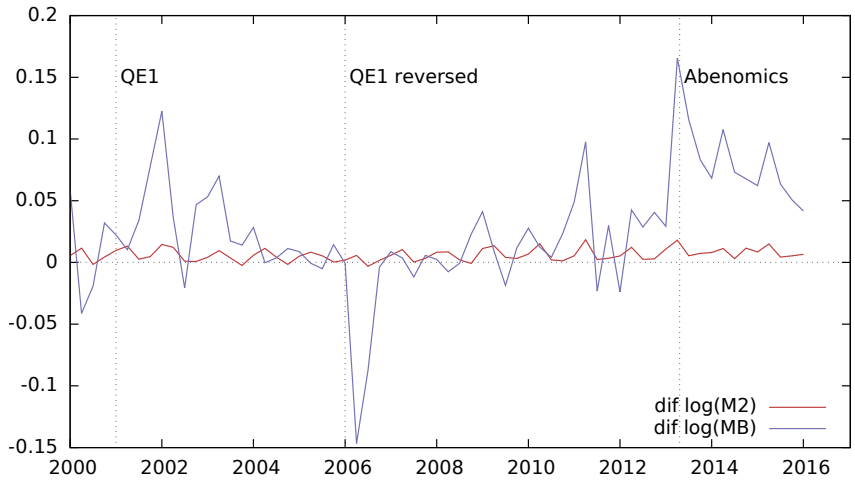


Figure 5.15: Impulse response function of M2 (Japan)



the easing. This result in comparison to the US possibly partially depicts the fact that the Japanese financial system is more bank than market based, and M2 is stimulated more by QQE than in the US. However, since M2 money stock measures vary in its definition in Japan and the States, direct comparison is not reasonable. Japanese M2 is a less broad indicator than the American, yet it changes less in magnitude. Additional interesting finding is that during the whole observed period, q-o-q change in Japanese M2 turned negative only upto negligible negative thousanths, even though the drop in MB following QE1 phase-out was very significant.

Figure 5.16: MB and M2 q-o-q changes with QE depicted (Japan)



Similar to the American case, GDP and CPI follow similar path in response to MB increase (see Figures 5.17, 5.18. For one quarter there is a slight declining tendency, but the positive effect occurs sooner than in the US case, and also has a bit stronger magnitude whih slowly fades out to close to zero positive effects for GDP, and possible worsening of CPI level after nine quarters for CPI which is reversed by 10^{th} quarter.

The estimated equation for CPI shows significance of 5^{th} lag of monetary base, 4^{th} and 5^{th} lag of BoJ policy rate, own 2^{nd} and 4^{th} lag, and Brent price. The sign at MB is surprisingly negative, but as the IRF shows, overall MB impact should be positive. BoJ signs, same as CPI are changing between positive and negative from quarter to quarter same as described at US CPI.

Figure 5.17: Impulse response function of GDP (Japan)

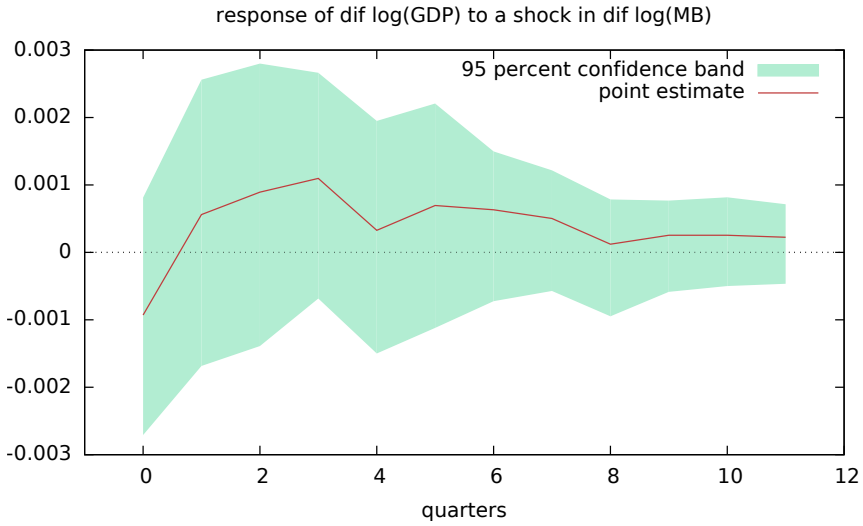
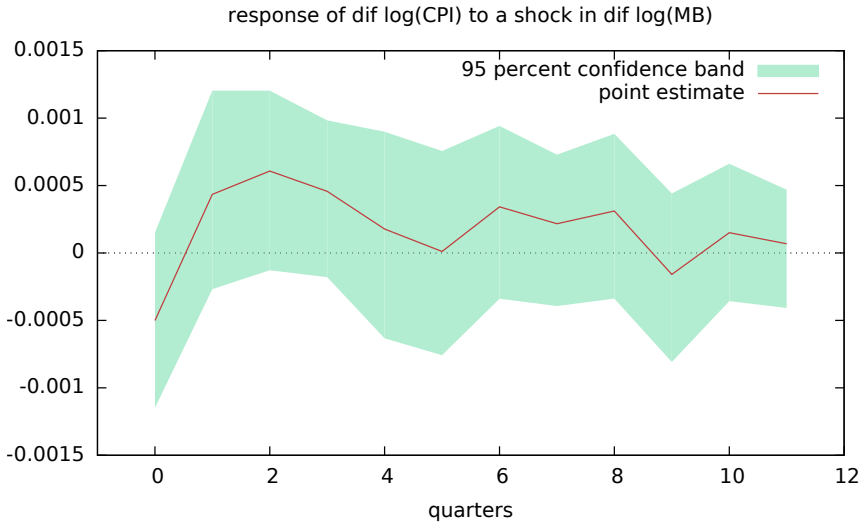


Figure 5.18: Impulse response function of CPI (Japan)



5.3.3 Summary

The empirical analysis proved presence of lags in policy application and its effects. Monetary base increases result in positive impulse responses of GDP and CPI after one to four quarters. CPI for both countries is estimated to depend most on its own values, thus reflecting the backward looking nature of inflation expectations. Money supply measure M2 is much less volatile in Japan than in the US which is also projected in its responses to MB boost. For Japan the impact on M2 is positive for almost the whole examined 12 quarter period, while for the US it balances on the

verge of negative and positive evolution. It has to be emphasised though that 95% confidence bands cover quite a wide range of possible reactions including both more optimistic and more pesimistic scenarios, hence sure conclusion cannot be drawn.

Chapter 6

Conclusion

6.1 Recommendation for future insight on monetary policy

Due to historical experience with crises in the 20^{th} century that were associated mostly with hyperinflations, price stability policy has been perceived as an anti-inflationary policy. Existing legal and institutional frameworks for monetary policies were thus set to address rather inflationary pressures than deflationary, but with regards to the current low inflation environment, new unconventional monetary tools should be incorporated in the legislation and central bank's competence in order to efficiently address deflationary pressures in the future. Direct distribution of cash to households is one option that would serve central banks as a potential tool to fight deflation, allowing monetary financing in special cases another. Hence creation of a feasible scheme for usage and implementation of these schemes might be reasonable. Specific circumstances allowing for the use of such unconventional tool should be carefully defined alongside.

6.2 Main findings in brief

The study in the theoretical part identified difference between liquidity trap and zero lower bound. Liquidity trap may occur with positive policy interest rate that the CB is unable to decrease, while the zero lower bound is constraint that nominal policy interest rate on deposits should not be negative due to the possibility to escape to non-interest bearing currency otherwise. Both conditions make traditional MP inefficient, and creates need for unconventional policies. These are based on inflationary expectations as the main channel of manipulation with other indicators. Key assumptions for CB's success in implementation of unconventional policies in a liquidity trap is clear communication of its targets towards public, and credibility that the committment to achieve these targets is in fact unlimited.

HDoM concept in theory rises inflationary expectations due to people's preferred amount of money balances in hands being dependent only on permanent income. A one time extra income received needs to be disposed through consumption. Consumption spending means additional income for a different person, hence the only possible new equilibrium is with increased prices as long as output remains stable. In real application, the concept would be functional under the assumption that the cash transfer transaction is permanent, and does not create any future liability. Assumptions of positive price of money and non-pecuniary benefits are nowadays automatically valid.

The institutional framework is not ready for distribution of the currency by the issuing authority, central bank, to households directly. Legal permission is missing, logistical network for electronic or physical distribution does not exist, and political willingness is also bounded. These constraints can be abolished, and HDoM can be indirectly executed by the government if monetary financing becomes legal, or directly if CB's mandate is extended for special circumstances.

Efficiency of cash distribution depends a lot on the target group and its propensity to consume. Since the poor are more sensitive to income changes, the HDoM effect can be the biggest if the lower-income groups are targeted. This also explains why cash distribution in third-world countries in various aid programmes is com-

mon, while Australia so far remains the only developed country which have handed cash to its citizens.

Analysis of monetary policies in Japan and USA with focus on QE revealed that effects of MB increases on broader aggregates were visible on raw numbers, but not corresponding in its extent to the volume of MB changes. Vector autoregression did not prove stable responses of M2 to MB shocks. Although for Japan, the predicted reactions were positive (while for US varying from positive to negative responses at different time lags), the 95% confidence interval ranges to negative numbers too. CPI and GDP development in reaction to MB boost was estimated as positive by VAR, but the estimate should also be treated carefully. Especially CPI shows very self-fulfilling character with more development being expressed by its own lags than any other variable. Therefore, monetary base increase can be considered a pro-inflationary policy, but on its own not a sufficient lever to prevent deflation. Inflation itself has to be influenced via inflationary expecatation channel, and a suitable combination of policies stimulating it.

Future research in this field should include possibilities to define legal framework for practical setting of a distribution scheme that would not cause disbalance to the system in terms of putting too much power to the hands of certain institution. Empirical analysis of QE effects might be broadened with the use of inflation-indexed bonds as a proxy for inflation expectations, and also extended by the data on QE applied by ECB, once it is terminated, and with a sufficient time lag to observe impacts.

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Appendix A

Quantity Theory of Money

In one of its forms, which will be the most useful for future explanatory purposes, the Quantity Theory of Money states that the quantity of money (M) in economy multiplied by the velocity of money (V) equals the economy's output times price level:

$$M \cdot V = P \cdot Y, \tag{6.1}$$

or in a rearranged form in terms of the real money balances:

$$\frac{M}{P} = k \cdot Y, \tag{6.2}$$

where $k = \frac{1}{V}$ represents the income velocity (how much money an agent wishes to hold for each unit of his income). Interpretation of the Quantity Equation depends on assumptions made about which variables are exogenous, and considered fixed, and which variables are endogenous, and non-constant. In the following parts of the thesis, this will be further discussed.

Fisher equation

The Fisher Equation states that the nominal interest rate (i) equals real interest rate (r) plus expected inflation rate (π^E):

$$r = i - \pi^E \tag{6.3}$$

Phillips curve

Phillips curve describes inflation as a variable dependent on the expected inflation, deviation of the unemployment rate (u) from its natural level (u_n), and exogenous supply shock (ϵ). It has the following form:

$$\pi = \pi^E - \beta(u - u_n) + \epsilon, \tag{6.4}$$

or due to the Okun's law which says that change in the output is linearly dependent on change in the unemployment, the deviation of the unemployment rate can be replaced by the deviation of output from its potential $\bar{Y}$:

$$\pi^E = \pi^E + \gamma(Y - \bar{Y}) + \epsilon. \tag{6.5}$$

Aggregate demand and aggregate supply

Economic textbooks explain the theory of aggregate supply and demand usually from Keynesian perspective with sticky prices in the short-run, and from classical perspective with flexible prices and monetary neutrality in the long-run. The figure below represents transition between short and long-run.

Taylor principle

Introduced by John Taylor in 1993 in his study Discretion Vs. Policy Rules in Practice, Taylor rule represents an approach towards policy setting of nominal interest rates. If inflation is above target (π^*) or when there is a positive output gap $(Y - \bar{Y}) \geq 0$, the nominal interest rate should be increased, and vice versa. The formula for computation of an "ideal" nominal interest rate is:

$$i = 2\% + \pi + 0.5(\pi - pi^*) + 0.5(Y - \bar{Y}), \tag{6.6}$$

where the inflation target is usually set at 2%, and using Fisher equation the following formula for real interest rate can be derived:

$$i = 2\% + \pi + 0.5(\pi - 2\%) + 0.5(Y - \bar{Y}) \tag{6.7}$$

$$r = 1\% + 0.5\pi + 0.5(Y - \bar{Y}) \tag{6.8}$$

Taylor rule recommends reaction of nominal interest rate to changes in inflation rate to be more than proportional, because if the reaction was one to one or less, real interest rate would not rise with an increase in inflation, causing output increases which consequently lead to further inflation.

> "If both the inflation rate and [output] are on target, then the [policy interest] rate would equal 4%, or 2% in real terms. (Using the inflation rate over the previous four quarters on the right-hand side of equation 6.8 indicates that the interest/rate policy rule is written in "real" terms with the lagged inflation rate serving as a proxy for expected inflation.)[1]

[1] Taylor (1993), p.202

Appendix B

Money stock measures by Federal Reserve System

Retrieved from Federal Reserve Statistical Release H.6 - October 17, 2013. [online]. Accessed on 2015-10-16 at http://www.federalreserve.gov/releases/h6/current/h6.htm

M1 consists of:

1. Currency outside the US Treasury, Federal Reserve Banks, and the vaults of depository institutions;

2. traveler's checks of nonbank issuers;

3. demand deposits at commercial banks (excluding those amounts held by depository institutions, the U.S. government, and foreign banks and official institutions) less cash items in the process of collection and Federal Reserve float;

4. other checkable deposits (OCDs), consisting of negotiable order of withdrawal and automatic transfer service accounts at depository institutions, credit union share draft accounts, and demand deposits at thrift institutions. Seasonally adjusted M1 is constructed by summing currency, traveler's checks, demand deposits, and OCDs, each seasonally adjusted separately.

M2 consists of

1. M1;
2. savings deposits (including money market deposit accounts);
3. small-denomination time deposits (time deposits in amounts of less than $100000), less individual retirement account and Keogh balances at depository institutions;
4. balances in retail money market mutual funds, less IRA and Keogh balances at money market mutual funds.

Money stock measures by the Bank of Japan

Retrieved from Bank of Japan. *Explanation of "Money Stock Statistics"*. [online]. Accessed on 16-10-2015 at http://www.boj.or.jp/en/statistics/outline/exp/exms.htm/

M1 consists of:

1. Currency in circulation;
2. deposit money: current deposits, ordinary deposits, saving deposits, deposits at notice, special deposits, deposits for tax payments minus checks and bills held by the financial institution.

M1 accounts for all depository institutions including credit federations.

M2 consists of:

1. Currency in circulation,
2. deposit at banks.

M2 only accounts for banks.

M3 consists of:

1. M1;

2. quasi-money: time deposits, fixed savings, installment savings, foreign currency deposits,

3. CDs

M3 accounts for all depository institutions including credit federations.

Appendix C

Vector autoregression

In the basic reduced form which is applied in the analysis, the model consists of a vector of n endogeneous variables $\mathbf{y_t} = (y_{1t}, ..., y_{nt})$. The following equation then defines the VAR(p) process (where $p \in N$ is the number of lags included):

$$\mathbf{y_t} = \mathbf{A_1 y_{t-1}} + .. + \mathbf{A_p y_{t-p}} + \mathbf{u_t}, \tag{6.9}$$

where $\mathbf{A_i} \in M(n \times n), i = 1, ..., p$, and the error vector $\mathbf{u_t}$ is an n dimensional process satisfying the following three conditions:

1) Zero mean: $E(\mathbf{u_t}) = \mathbf{0}$,

2) No correlation with past values: $E(\mathbf{u_t u_{t-s}^T}) = \mathbf{0}$,

3) Contemporaneous correlation is positive: $E(\mathbf{u_t u_t^T})$ is a positive definite matrix.

Each of the n equations is then estimated by classical OLS regression. The estimator of parameters is the same as generalized least squares, if there are no restrictions imposed on the parameters. Hence, inference using t-statistics and F-tests is valid, if the process is dynamically stable. Stability revision for VAR(1) can be conducted by computation of characteristic roots (eigenvalues) of the parameter matrix $\mathbf{A_1}$. If they are less than one in absolute terms, then VAR(1) process is stable. VAR(p) stability check requires construction of a companion matrix:

$$\mathbf{C} = \begin{pmatrix} \mathbf{A_1} & \mathbf{A_2} & \cdots & \mathbf{A_p} \\ \mathbf{I_n} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \ddots & \mathbf{0} & \vdots \\ \mathbf{0} & \mathbf{0} & \mathbf{I_n} & \mathbf{0} \end{pmatrix}$$

For its eigenvalues it then applies that their modulus must be less than one for stability to hold. Wider theoretical background of the model is explained for example by Watson (1994) or by Luetkepohl (2011).

An essential part of model setting is selection of a proper number of lags. There are three information criteria most commonly applied for this purpose, and provided in default statistical packages: Akaike (AIC), Schwarz-Bayesian (BIC) and Hannan-Quinn (HQC) criterion. According to Luetkepohl (2011), Hannan-Quinn criterion is the most suitable for quarterly data, since it is the middle path. AIC always recommends the highest number of lags, while BIC the smallest. In the analysis, we will stick HQC where possible.

Appendix D

Figure 6.1: Augmented Dickey-Fuller, AIC

```
  k =  8: AIC = -557.296
  k =  7: AIC = -559.166
  k =  6: AIC = -561.155
  k =  5: AIC = -562.271
  k =  4: AIC = -561.336
  k =  3: AIC = -556.720
  k =  2: AIC = -558.114
  k =  1: AIC = -559.584
  k =  0: AIC = -544.411

Augmented Dickey-Fuller test for l_MB
including 5 lags of (1-L)l_MB
(max was 8, criterion AIC)
sample size 165
unit-root null hypothesis: a = 1

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.017861
  test statistic: tau_ct(1) = -1.17981
  asymptotic p-value 0.9136
  1st-order autocorrelation coeff. for e: -0.010
  lagged differences: F(5, 157) = 5.893 [0.0001]

Augmented Dickey-Fuller regression
OLS, using observations 1975:1-2016:1 (T = 165)
Dependent variable: d_l_MB

             coefficient    std. error    t-ratio   p-value
  ------------------------------------------------------------
  const       0.0579108     0.0486528      1.190    0.2357
  l_MB_1     -0.0178610     0.0151388     -1.180    0.9136
  d_l_MB_1    0.373014      0.0790914      4.716    5.27e-06 ***
  d_l_MB_2   -0.0481245     0.0831192     -0.5790   0.5634
  d_l_MB_3   -0.129392      0.0820553     -1.577    0.1168
  d_l_MB_4    0.244438      0.0825352      2.962    0.0035   ***
  d_l_MB_5   -0.137906      0.0810883     -1.701    0.0910   *
  time        0.000456060   0.000309352    1.474    0.1424

  AIC: -575.847   BIC: -551   HQC: -565.761
```

Figure 6.2: Augmented Dickey-Fuller, BIC

```
Augmented Dickey-Fuller test for l_MB
including one lag of (1-L)l_MB
(max was 8, criterion BIC)
sample size 169
unit-root null hypothesis: a = 1

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.0195054
  test statistic: tau_ct(1) = -1.38989
  asymptotic p-value 0.8642
  1st-order autocorrelation coeff. for e: 0.018

Augmented Dickey-Fuller regression
OLS, using observations 1974:1-2016:1 (T = 169)
Dependent variable: d_l_MB
```

Figure 6.3: Augmented Dickey-Fuller 2, AIC

```
Augmented Dickey-Fuller test for d_l_MB
including 0 lags of (1-L)d_l_MB
(max was 8, criterion BIC)
sample size 169
unit-root null hypothesis: a = 1

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.69438
  test statistic: tau_ct(1) = -9.33907
  p-value 3.038e-013
  1st-order autocorrelation coeff. for e: 0.023

Dickey-Fuller regression
OLS, using observations 1974:1-2016:1 (T = 169)
Dependent variable: d_d_l_MB
```