**UNIVERSITY OF LJUBLJANA**
**FACULTY OF ECONOMICS**

**MASTERS THESIS**

# THEORY OF RATIONAL EXPECTATIONS AND THE CHOICE OF THE MONETARY POLICY IN A SMALL OPEN ECONOMY

**LJUBLJANA, JUNE 2007** **NEVEN VIDAKOVIC**

**STATEMENT**

Student Neven Vidakovic hereby state that I am the author of this masters thesis, which I wrote while mentored by prof. dr. Ivan Ribnikar, in accordance with paragraph 1, article 21 of the Intellectual property act I am allowing this thesis to be published by the faculty of Economics.

In Ljubljana, _____

Signed _____

Izjava

Študent Neven Vidaković izjavljam, da sem avtor tega magistrskega dela, ki sem ga napisao pod montorstvom prof. dr. Ivan Ribnikarja, in skladno s 1. odstavkom 21. člena Zakona o avtorskih in sorodnih pravicah dovolim objavo magistrskega dala na fakultetnih spletnih straneh.

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# 1. INTRODUCTION

## 1.1 Some Preliminaries

What does monetary policy do? There is a whole research field and segment of the economics called "monetary economics" whose sole purpose is to produce papers explaining what monetary policy does and how to do it better.

But let us now ask the same question but with a little twist to it: what is the importance of the choice of the monetary policy for the economy? Just to make the point clear, we are not talking about the conduct of the monetary policy, once the monetary policy has been chosen; we are talking about the ***implications of the choice*** of monetary policy as such.

The question can be expanded: What effect does a choice of a particular monetary policy has on the economy as a whole? Before the goal of the central bank is set the central bank has to determine how it is going to reach that goal. So the central bank has to choose the monetary policy to be conducted. The choice is important in the ways how to reach the goal, but at the same time the economy is not just a single cell organism. Does choice have an impact on other economic participants as well? Under alternate monetary policies will economic participants (households and firms) behave differently? Will the choice of the monetary policy affect the ways firm conduct business or will the choice of the monetary policy affect the consumption habits of the households?

But let us not get ahead of ourselves. In economics it is generally accepted the main purpose of the central bank is: maintain price stability while maintaining the sustainable growth of the economy.

However the above statement does not answer the question of the implications of the choice of the monetary policy. No matter what the choice of the monetary policy is, every monetary policy will try to achieve “control inflation stability while maintaining the sustainable growth of the economy”.

So the question remains: does the choice of monetary policy determine the path of the economy? Does the choice of monetary policy have any effect on the economy since all monetary policies have the same goal?

The main focus of this paper is to investigate the impact of the choice of the monetary policy on the economy.

In USA this question has been raised many times and currently a large debate is under way should USA move to inflation targeting from the interest rate targeting, (Bernanke and Woodford 2005).

This kind of monetary policy transformation from one monetary policy to the other has been termed a "regime switch". In a series of papers (Sims 1998) and (Sims and Zha 1994,2006), (Sims, Zha Leeper 1996) discuss this problem and perform several interesting experiments. They divide time history of monetary policy into several regimes and then they test the behaviour of each regime throughout the time series. Also they try to interpret the changes in monetary policy and the effect of those changes on the economy. In alternate scenarios the models are oriented towards understanding the way monetary policy would have been conducted under alternate monetary regimes and what would have been effects of this alternate monetary policy on the economy.

What has caused the Fed to move from one regime to the other and what effect did this "switch" in monetary policy had on the economy? What have been the implications of such behaviour? These questions are investigated in (Sims and Zha 2006), (Mankiew and Reise 2002) and (Blinder and Reise 2005).

## 1.2 Modelling Challenges

The impact of the monetary policy on the economy has been questioned by (Lucas 1972) with the assumption of neutrality. Lucas in his paper "Expectations and the neutrality of money" sets up a model where the participants do not react to known changes in the monetary policy and the only way participants would react to change in the monetary policy could be if they were uninformed; or if monetary policy was not know in advance.

Recently Lucas reiterated the same argument in a tour de force paper, (Lucas 2003) states that the short term monetary policy stabilizations exhibit almost non existing gains for the economy and the policy makers should focus on the long run stability of the economy. Similar conclusions about the lack of effect of the monetary policy on the long run stability or possible change in the path of the economy comes from (Sims, Leeper and Zha 1996) where the authors state the monetary policy ***does not*** cause recessions in the economy. Thus a switch from expansion to contraction in the monetary policy is not an event by itself, but a natural occurrence of the business cycles. Meaning the shift in the economy changes monetary policy, not the other way around.

One natural question comes to mind: what would be the net effect if the monetary policy was not changed from controlling monetary aggregates to controlling interest rates in 1980s in

USA? Would there have been any effect on the American economy? Would the USA economy still experience the boom of the 1990s under the control of the monetary aggregates rather then interest rates? As aforementioned some of that test have already been run in computer simulations and there are papers with this topic, but let us look deeper into the argument and the set up of the problem we are going to investigate.

Argument of testing a monetary policy in an alternate time with the alternate data can easily lead us to a new argument about the purpose of the central bank as a monetary institution.
The questions here are not just one of the monetary parameters like inflation, interest rates? Questions are something along the lines: if the monetary policy performs well under monetary rules (best example Taylor rules or inflation targeting) and central bank has very good models predicting the need for money in the economy (cash changes and monetary needs independent of monetary policy) do we even need a central banker?

Maybe it would be better to have a computer run the monetary policy. This is not a stretch of an argument. There are many comparative analyses of the alternative monetary policies like (Sims and Zha 1994,2006), (Bernanke and Woodford 2005), (Mankiew 2002).

The answer to the above question does the economy need a central bank in my opinion is unequivocally: YES. Beyond any reasonable and unreasonable doubt we would still need a central banker, and the main reason why we would still need a central banker is the fact the economy needs someone to determine and choose the monetary policy to be conducted[1].

Again we are not talking about the conduct of the actual monetary policy, but the actual choice of the monetary policy to be conducted.

Just like the Fed under Paul Walker controlled monetary aggregates and under Alain Greenspan controlled interest rates, the economy needs the central banker who will be able to choose appropriate monetary policy at certain times or to perform a switch from one monetary policy to another (Mankiew 2002)

Let us go a little further and expand the argument with already mentioned questions: what is the importance of monetary policy choice for the whole economy? What impact does a monetary policy have on the economy?

But before we come to an attempt to answer that question let us look at the history and development of monetary policy and economics as a science.

When it comes to the conduct of the monetary policy there have been many papers written about that topic. One of the foremost books on the topic of monetary policy history is

[1] Maybe after the choice has been made a computer can run the monetary policy.

"Monetary History of United States 1880—1960" (Friedman and Schartz 1971). An intricate look into the way monetary policy is conducted and the way alternate monetary policy have been chosen in the USA economy over time.

This magnificent economic work follows the monetary policy and the development of monetary policy for almost 80 years in USA.

In the "Monetary History" we have a whole chapter about the Great Depression, except Friedman calls it the Great Contraction. In his view the whole situation with the great Depression occurred simply because of the fact the Fed has completely misjudged the economy and choose a completely wrong monetary policy at the time. The monetary policy to be chosen was one of liquidity and not the one of the low inflation, hence the terminology the great contraction (monetary contraction that is).

As Friedman and Schwartz elaborate the choice of the non expansionary monetary policy instead of the expansionary monetary policy led the economy to implode. The liquidity dried up and the financial system started to crumble under the lack of liquidity and too much debt. The debtors did not have liquidity to repay their debt, this caused the banks to lose liquidity and the banks could not pay out savings deposits, so even more people could not repay their debt, the cycle was imploding and extremely vicious. The economy has entered the spiral of devaluation and a liquidity trap.

For Friedman the solution was simple. Print more money and remove the liquidity constraint from the economy, thus revitalizing the system.

Prime example of another mistake made by the central bank is the "great stagflation" in the 1970s.

The usual conception is to "blame" the period of great inflation and great unemployment on the fact there was a supply side shock that altered the supply of goods in the economy and has thus caused inflation. The prices of oil went up (due to the lack of oil supply, not increase in demand) and the economy simply could not handle such stress. The increase in the price of oil, led to increase in the prices of other goods and this domino effect propagated. The domino effect caused economy to spin out of control; the rise in prices led to rise in the instability of the economy and thus produced a rise in the unemployment (Barsky and Killian 2001).

This is the usual "text book" explanation of the great stagflation in 1970s in the USA. However the interpretation by (Barsky and Killian 2001) is completely different. The main reason for the great stagflation was the wrong conduct of monetary policy and possible a wrong choice of the monetary policy. The Fed believed in the stabile Philips curve and the purpose of the monetary policy was to control the economy’s movement along the Philips curve. So the policy increased inflation in order to decrease the unemployment; however this

policy tool did not work, due to the change in the expectations of the economic agents the economy spun out of control resulting in high unemployment and high inflation.

Both of these examples show how the conduct of monetary policy was not optimal. In the case if the Great Depression (Great Contraction) the Fed should have put more money in the economy and stimulate liquidity of the system. In case of Great Stagflation Fed should have focused on the control of inflation, not on the control of unemployment.

As illustrative these examples are about the conduct of the monetary policy they do not say anything about the choice of monetary policy. What would have been the impact if the monetary regime was different at the time?

Let us assume Great Contraction and Great Depression have occurred only due to the wrong conduct of the monetary policy. In that case the destabilization of the economy was the effect of the inappropriate monetary policy. The question: Was the inappropriate monetary policy that has led to the recessions or the wrong choice of the monetary policy regime?; still remains to be answered.

Another argument is the fact that hindsight is always 20/20. Some of the monetary policy tools and models Alain Greenspan had at his disposal during his term as the Fed's governor, for his predecessor in 1920s could only be described in wildest monetary science fiction papers. The computing power and the information flow simply did not exist in 1920s as they do today. It is much easier to say the monetary policy was wrong looking from today's perspective then it was to actually do something back then.

So the following question is more of a scientific nature, rather then applied one: what would have happened if the Fed had conducted different monetary regime? Would great depression occur if there was inflation targeting back in 1929? Would stagflation occur if the Fed controlled interest rates instead of trying to serve as a tool for full employment in 1974? I believe these are the real interesting questions.

Alas there are no simple answers to these questions. The economy changes almost yearly, let alone in the time span of several decades. We could try to make some parallels between the occurrences in history and in recent times and use those as some ponders of economic behaviour of the economic participants. One could argue the economic set up in the late 1990s has been similar to the one in 1929. It is true a lot of similar things have happened: low unemployment, high stock market, prosperity. Then stock market crash, one happened in 1929, the other happened in 2000, with an interesting twist. The stock market after the 1929 crash bounced back up and broke new highs in matter of 2 years; however with the 2000 crash the NASDAQ is still only one half of its maximum value and Dow Jones is only now reaching its all time high levels (end of 2006).

There are strong differences in the way of life in 1929 and 2000, there are some economic similarities and the truth remains that the conduct of monetary policy in those two periods has been completely opposite.

Once the stock market collapsed in 1929 the Fed saw this as a natural progress of the economy, since the 1920s had large inflation, a period of deflation was welcomed by the Fed, but once the banks started to go bankrupt it was obvious the economy was in deeper problems. However once the Fed reacted in 1932 it was already too late.

The Fed under Greenspan's tried to curbed the stock market explosion with higher cost of borrowing. The strong growth of technologies stocks, doubling its value in 1997 and 1998 did not seem sustainable in the long run, nor have such high growth rates of the stock market been followed by the actual fundamental changes.

In 2000 the behaviour of the Fed was completely opposite of the one in 1929. Once the stock market crashed the Fed perceived this as a systemic problem for the economy. In order to provide the economy with enough liquidity the Fed lowered interest rates and tried to provide liquidity for the economy through large open market operations and inputting new money in the economy.

One can make similar parallels between 1974 and today. Between 1973 and 1975 the price of oil quadrupled, the Fed was faced with a massive supply shock. Same thing has happened between 2004 and 2006, the price of oil has quadrupled, but this is where the similarity between the time periods stops.

There are no gas lines in the USA today, there is no parallel movement of prices and unemployment, and we are not seeing any sings of stagflation. But what is even more important the monetary policy was completely reversed. While in 1974 the Fed was oriented towards increasing employment in the economy, in the first decade of 21$^{st}$ century the Fed was oriented towards keeping inflation low and providing interest rate simulative environment in period 2000-2004.

In order to better understand the behaviour of the central bank in certain economic situations and to understand the drive behind the choice of the monetary policy it is necessary to understand the history of monetary economics.

Once we understand the history it would be much easier to explain the choice of the monetary policy regime and understand the consequences of the choice of the monetary policy regime in a small open economy.

## 1.3 The power of rational expectations

This section offers a brief history of the development of economic thought and the development of the solutions for dynamic problems in economic/econometric models.

The problem of dynamic behaviour of economic agents is one of the oldest and most interesting problems in economics. One of the first people to write about this topic is Alfred Marshall in his Principles of Economics (Marshal 1890).

Marshal tried to formalize the problems, but the discussion of the dynamic behaviours of economic problems can be found even earlier. One of the first dynamic problems was the interaction between the issuance of bonds and the behaviour of the government finances, these concepts can be found in the works of David Ricardo's "On the Principles of Political Economy and Taxation" (Ricardo 1817). In his book Ricardo discusses the problem of funding a war through two principal means: taxes and/or debt.

The popular concept of Ricardian equivalence is nothing more but a dynamic optimization given the current expectations of future variables, namely the current expectations of future government funding. The concept was described and in a paper by (Barro 1974)

Another even earlier concept of economic dynamics can be found in Hume's (Hume 1752) essay about money where Hume hypothesizes about the possible neutrality of money concluding the money alone can not have a prolonged real effect on economy. A concept mathematically developed and defined as neutrality of money in (Lucas 1972).

Even though in those early days of economics the economists did not posses the mathematical tools to answer complex optimization questions which perplexed them they have openly discussed them and tried to answer them through verbal analysis.

The verbal analysis has stuck with economists for generations and today the results of that verbal discussion can be found today in complex mathematical models in economic papers.

The model to be developed in this paper is principally a macroeconomic model; due to that fact further discussion in this section will be regarding the macroeconomic developments of dynamic tools.

Macroeconomics as a science came out of the tour-de-force known was the "General Theory of Money Interest and Unemployment" (Keynes 1964). Even 70 years after it was written it is still one of the most widely cited economic books. In the period from 1966 to 1986 "General theory" was 14$^{th}$ most widely cited book and Keynes died in 1946 (Garfiled 1990).

As a book "General Theory" is a work is full of questions about the influence of behaviour of one agent (mostly government) and the reactions of the other economic agents (mostly households). Thorough the book the questions about how do the actions of one economic agent influence the behaviour of another economic agent are asked.

This interaction between agents and how the effects of certain policies are being propagated thought the economy latter gave birth to one of the founding pillars of Keynesian economics: the economic multiplier. Under this assumption the effects of certain policies like fiscal spending do not have a liner influence on the economy, but a non linear effect, yet to be determined as positive (greater than 1) or negative (smaller than 1), (Barsky, Makiew, Zeldes 1986).

The question of how to solve the recursive problems in economics and the influence of one economic agent on the other was not answered in the "General Theory". But the intellectual foundation of the analysis of the recursive processes was laid down.

The impact of the "General Theory" in economics was felt very soon. As the direct result of the Keynes' work IS-LM model was born. The first and the oldest macroeconomic model was the work of the young (33 years old) John Hicks in his 1937 paper "Mr. Keynes and the Classicists: a Suggested Interpretation", (Hicks 1937).

Trying to reconcile the stands of the classical economists who believed in the self correcting mechanism of general equilibrium models and Keynes' view about the inherent instability of the economy, Hicks tried to interpret the main point of the "General Theory" as an interaction between two curves the IS and the LM.

The IS-LM model was a simple graph that presented the interaction of the goods market and the money market. However the model, even when it was latter much more sophisticated, had several inherent problems that latter manifested themselves in the actual conduct of monetary policy.

One of the main problems of the model was the fact it was very general and almost too macro. It was hard to anticipate the behaviour of the economic agents; the expectations of economic agents were not included. The second big problem of the model was the fact the model did not care about the simple household. The microeconomic aspect of the economy was not included in the analysis and it was assumed the economy functions as aggregate.

So what is today the foundation of the economic analysis, the household, was ignored in the early Keynesian models. The model assumed there is an aggregate and the economy behaved as the leading agent (government) said it should behave. The focus was on the fiscal power of the government, which was able through discretionary spending to facilitate the

countercyclical behaviour the economy needed. Monetary policy was slightly pushed aside and it was assumed it served the current fiscal policy, a point stated by Friedman (Friedman 1956, 1969).

One has to be fair in analysis and say that with all of the flaws from today's perspective the IS-LM model was pure and simple revolution

With the creation of macroeconomics as a science, Keynes has initially bypassed the recursive nature of economics as a science. After the "General Theory" and Hicks' "Suggested Interpretation" a new model was formed. The first macroeconomic model was the first tool the economists had when making decisions. The model was a static one, but it was able to answer crucial economic questions about policy effects. However the main problem of the Keynesian models was the fact they were ex ante models. Their basic function can be summed up like this: if there some shock or a policy change in the economy induced by the fiscal or monetary policy, how will the economy react? The early Keynesian models did not have households or any other microeconomic participants, as mentioned, just aggregate economy.

The faultiness of those models was raised by the second Chicago School which was led by Milton Friedman and Edmund Phelps (Friedman 1969) in which they are asking following questions:

How do households influence the economy? What would be the path of the economy if the participants are prepared for economic shocks? What influence do microeconomic structures have on the aggregate economy?

Today these questions are standard modelling questions, but at the time, considering the prevailing economic academic opinion these questions were sacrilege.

This last questions caused biggest chink is the Keynesian armour. The works of Friedman, Phelps and Anna Schwartz have noticed some major flows in the Keynesian reasoning were discovered[2], (Friedman 1969)

The main premise of the Friedman – Phelps work is the household's expectations of the future. Once this variable is included in economic models the economic analysis is radically altered.

The assumptions about expectations are highly intuitive for an economist. Households receive information about the status of economic variables in the economic system which surrounds them, once they have information about the state of the economy the households create

[2] Here two works come in: Theory of Consumption Function (1957) and Monetary History of United States (1963)

expectations about the future events; they try to adjust their economic behaviour to those expectations and prepare for economic shocks

As described in Friedman's Nobel lecture (Friedman 1977), the expectations are created on the basis of household's adaptive behaviour to the new information; hence the expectations process is named adaptive expectations. This hypothesis is based on the theory the participants adjust their expectations by the difference in their previous expectations and the actual outcome, so in essence the expectations serve as an adjustment variable to the model.

Taking into account economic participants receive information from the economy that surrounds them, they process information and based on that information prepare for the future. The problem of household's expectation formulation Friedman used in two separate direction of his research.

The first was microeconomic and it was described in "Theory of Consumption Function" (Friedman 1957). In this monumental work Friedman has defined the household consumption over time. The work also determines the reactions of households towards fiscal and monetary changes. The main foundations of Friedman's research can be summed up as follows:

a) People plan their expenditures over long horizons of time
b) Economic participants (households) try to "smooth out" their consumption over time, although their real income will vary thought their lives.
c) In order to have a major shift in household consumption households have to believe the shock is permanent, not just temporary.

The permanent income hypothesise had profound impact on the perception of economic behaviour of households. The main controversy was regarding the tax policies of the Kennedy administration. The temporary tax cut was not a positive economic decision. According to the permanent income hypothesis due to the fact tax cut was only temporary the impact of it could not have a very strong impact on consumption if viewed form a long time period perspective.

The second direction in Friedman's research was macroeconomic. Here Friedman (in cooperation with Edmund Phelps) went against Philips curve hypothesis which was the main policy tool of the prevailing Keynesian doctrine of that time (Friedman 1969).

At the time the Philips curve was thought to be the ultimate policy tool. The economists believed there is a stabile inflation – output tradeoffs. In this economic frame, policy maker once faced with recession just had to increase inflation (through fiscal or monetary policy) and the level of unemployment would go down. In case of the explosive economic boom the policy maker would make the reverse policy and put the economy back on the sustainable growth path (Sargent Lucas 1981).

In this segment of his research Friedman stated there is no permanent or long run employment/output – inflation trade-off. The economic participants can not be fooled every single time and eventually this surprise effect will wear off and the policy will not have any effects (Friedman 1977).

At the ends of the Philips curve the temporary inflation – employment trade off will break down and lead economy into hyper inflation or into another great deflation, the policy undertaken by the fiscal or monetary authority leads to one of the extremes at the limit ends of the inflation unemployment relationship towards an unstable equilibrium outside of the relationship.

This economy prophecy came to life in the 1970s, when it was called stagflation. The recent research by (Barsky and Killian 2001) show the great stagflation was in essence a wrong monetary policy conduct, not some major supply side (oil shock).

Although Friedman's work was ingenious and presents the foundations of modern macro economics the question of economic dynamics and recursive relationships in the economy was still not resolved. The main problem of how to shape and econometrically solve expectations was still open. Although the theory was intuitive it needed a strong econometric foundation behind it.

From today's perspective the theory of adaptive expectations has several problems; the first one was the theoretical: how the expectations are formed? Friedman stated adaptively, the past variables are weighted unequally and the expectations are created, so this can be mathematically presented as:

$$y_{t+1}^{e} = \alpha y_t + \alpha(1-\alpha) y_{t-1} + \alpha(1-\alpha)^2 y_{t-2} + \alpha(1-\alpha)^3 y_{t-3} + .... + \alpha(1-\alpha)^n y_{t-n}$$

What is extremely relevant about this mathematical formation of the expectations is that there are no major shocks, there simply can not be any, and due to the fact the past variables also have effects on the creation of expectations. Friedman explained that all shocks are propagate thought the economy in from of a lag, (Friedman 1961), so it takes time for the shock to take full effect.

The model has an important implication for the choice of monetary policy is a small open economy: if there is a major shift in the exchange rate the expectations variables like inflation, unemployment and future exchange rates will not drastically alter because of the weights the expectations have on the past variables.

This model prevents research in direction of sudden stops and major policy changes and that is precisely what this paper is trying to investigate. So we and the economy needed a better model.

As we can see the adaptive hypothesis did not solve the problem of large shocks.

The second problem of the adaptive hypothesis was how to incorporate adaptive expectations models into the econometric setting and estimate the value of the weights to be attributed to each past observation. The expectations as a parameter in the economic models were not enough. The incorporation of expectations in economic models had to satisfy the econometric conditions as well as overall mathematical solvability of the models. This problem will be solved by the Chicago's third school of economic thought.

When discussing the recursive relationships in the economy we have to pay attention to the two separate problems. The first one is the mathematical formation of expectations and the solution to the workable econometric setting with expectations. The second problem is mathematical formation of the dynamic behaviour of the economic participants. If we assume the economic participants are rational and act once the new information is received we have to have mathematical tools that can react instantaneously to the new inflation and the change in the behaviour of economic participants.

The mathematical tool of dynamic economic behaviour is the technique of dynamic programming with its main tool the bellman equation, named after the father of dynamic programming Richard Bellman.[3], (Bellman 1957) Over time the bellman equation became the workhorse of recursive macroeconomics.

The dynamic programming has the main assumption of optimality, meaning the economic participant behaves optimally considering the information available, (Cooper and Adda 2003, page 14)**.**

One of the early examples of combination of the dynamic setting can be found in (Muth 1961) and (Lucas 1972) who states the whole premise of the optimizing agents with forward looking expectations is based on the principle of optimality, the fundamental principle of dynamic programming.

In early 1960s John F. Muth was working to the solution to the movement of prices of futures contracts and the way traders come up with futures prices. The main problem Muth faced was

[3] The story about how the dynamic programming was crated is an interesting anecdote. In mid 1950s student Richard Bellman entered the classroom several minutes' latte. He saw a problem on the board and wrote it down, thinking it as homework, but in reality it was the introduction to the lecture and the professor was stating the problem could not be solved. Not knowing the problem can not be solved; Bellman went home and solved the problem. The theory of dynamic programming was born. Both professor and Bellman was surprised at the discovery.

how to model economic behaviour in an information rich setting, where the moods of economic participants are fast changing and the flow of new information is almost constant. Trying to solve the problem Muth came up the theory of rational expectations.

Although in some ways similar to the theory of adaptive expectations, the theory of rational expectations had many novelties. The theory can be summed up as follows:

1. Economic participants have expectations about future events.
2. The expectations are made based on information available, but the information does not have to be perfect information.
3. Expectations are made on all available information.
4. Economic participants will act upon their expectations.
5. There is a representative agent in the economy and all economic participants have the same expectations since all of the participants have the same information (this assumption came from later works and is not directly stated in the Muth's early paper).
6. If the expected event occurs there shall be no reaction to the event, since all the agents have already prepared for the event.

The last two assumptions are crucial for the theory of rational expectations. The first assumption is of the representative agent and it implies that one agent covers all of the economy and that this participant and the econometrician have the same model (Sargent and Lucas 1981).

This makes economic modelling a lot easier, the economy of many participants can be explained through just one participant presenting all others. The model assumption of rational representative agent has an important policy implications as well and we shall see this in the model latter developed in this paper.

If the econometrician (policy maker) has the same model as the economic participant in that case the policy outcome will be exactly as predicted, and this leads into the second assumption the assumption of neutrality.

The combination of representative agent and neutrality is what gives power to the rational expectations models. In the model created in this paper the representative agent is used extensively and the neutrality is the main assumption when the economic policies are made.

These two assumptions are the foundations of the third Chicago school led by Robert Lucas, Robert Barro, Thomas Sargent, Edward Prescott in (Sargent and Lucas ed. 1981). Modern macroeconomics is built on rational expectations, optimal control, dynamic programming and neutrality of expected policies.

We should also make a note about the mathematical tools used in this paper, which are based on the tools of optimal control. In physics the problems are solved using the mathematical tool called optimal control. The process and the set up of the optimal control problem can be described like this:

a) The person conducting the experiment has to have a function how the variable will behave through the time length of the experiment. In economics this is the time series. The name of this variable is the state variable.
b) The person conducting the experiment also needs the variable that he is going to control thought the length of the period. This is the control variable.
c) Once the state and the control variable are found the value function is set up.

This is the main set up of the dynamic programming value function. In economy a state variable can be income and the control variable can be consumption. So we are trying to maximize the consumption considering the stream of income through time.

As presented in the above example the economy does resemble a complex system that could be solved using optimal control. In economics we have time variables that can serve as a state variable and the control variable is easier to set up. This argument may look sound; however that is not the case in economics. There are two main reasons why the usual tools of physics can not be so easily applied to the economics.

The first reason is the fact human beings will not respond to the same occurrence in the same way every single time. While under same conditions the water will always boil at the same temperature this is not the case with the economic participants. Again we can use the oil for an example. In the 1970s the price of oil went sharply up and stagflation ensued. In early 21$^{st}$ century the same thing occurred but there was no stagflation. So for the same "stimulus", we have a different response. But it is also obvious that today we have a very different economy and knowledge of economics then we had in 1970s.

The second reason is that the rules of the system are frequently changed and with them the expectations of the economic participants change as well. In physics it is easy to repeat the same experiment multiple times; however that is not the case in real life economies. The same policies can be repeated under similar economic data[4], but the experiment can never be exactly replicated.

This problem of the theoretical and practical disproportion of the assumption of the representative agent was almost immediately recognized and the solution to that problem is at the forefront of the modern economic research (Sargent and Hansen 2001).

[4] One of the policies that can be used repeatedly are the Tylor rules.

Robert Lucas (Lucas 1975) has defined the problem of alternate settings in the model and called it model misspecification. Further research of this topic was made by (Sargent and Hansen 2005) in papers “Certainty Equivalence” and “Model Uncertainty”. The aforementioned papers are trying to set up complex economies that have still a representative agent, but with a multiple choice of models and the uncertainty regarding what model to choose. We shall obey the Lucas critique and we shall set up two models, one for each monetary regime.

We use basic properties of the rational expectations and we shall use the main tool of rational expectations and incorporate it into the optimal control mathematics used in the model.

This tool is called cross equation restriction, but first we shall set us an optimal control problem.

Let us look at a representative household. The household has expectations about economy. The economic decisions are made without the influence of the household and under current set of economic rules. The rules are provided and determined by the policy maker and the household has to optimize its behaviour with respect to the current regime of rules. The determination of the policy rules and the effect of those rules is the main focus of this paper.

We shall look at a state vector y. The vector has information set from the beginning of the economic regime that started at time s, the subscript t denoted the history from s to t. In this system we have a transition movement:

$$y = \begin{bmatrix} x_t \\ z_t \end{bmatrix}$$

And the law of transition of the exogenous component z is is

$$z_{t+1} = f(z_t, \varepsilon_{t+1})$$

Where ε is a set of shocks with an undetermined distribution. Component z is the part of the economy not under the influence of the economic agent, but the rational agent is trying to make a probability distribution of the component z and create rational expectations based on such distribution. The decision of the rational agent are influencing x and now we have the transition law of x as:

$$x_{t+1} = g(x_t, z_t, u_t)$$

The movement of economic decisions thought time can be denoted with the following decision rule function:

$$u_t = h(x_t, z_t)$$

From the above equations we have the behaviour of economic agents, determined by the economic processes around them and under the rules of the economic institutions that determine the economic system. The above problem can be solved using a feedback-feed forward solution for the set up of the Stackelberg problem. Using a min-max Bellman equation, but we shall leave this for the chapter on the behaviour of the central bank.

As the problem notes we have economic environment with shocks and an economic participant trying to optimize its behaviour with respect to the shocks he does now know, but he can expect.

The main point of the description of this problem is not finding the solution to the problem, but setting up the economic groundwork for the cross equation restriction. Let us now see how the cross equation restriction works in practice.

**Lemma 1: The representative agent creates rational expectations of the economic conditions.**

Proof:
This lemma is the fundamental property of the rational expectations models and it is called the cross equation restriction. We shall use a proof by example in this case.
Under rational expectations the expectations of the representative agent are always correct, using this we can set up the following condition:

$$p_t \equiv p_t^e \equiv p_t^*$$

The expectations of the economic agent are always correct, from this we can obtain proof by example. Let us solve the following difference equation:

$$p_t = \alpha + \beta p_{t+1}^e + \varepsilon$$

Where p is some variable, $p_{t+1}^e$ is the current expectation of future value of that variable, α and β and constants and ε is error with property N(0,σ)
The only way to solve this equation is to use the condition stated adobe. If we take expectations of the above equation and use the condition stated we get:

$$p_t^* = \alpha + \beta p_{t+1}^*$$

Solving for p* forward we get the rational expectations equilibrium

$$p^* = \frac{\alpha}{1 - \beta}$$

QED.

The above equation gives us the practical tool how to solve models containing the expectations. For more solutions to rational expectations models the reader is referred to (Sargent and Lucas ed. 1981a)
This rational has made the rational expectations models so appealing and practical. Models having expectations of future variables can easily be solved using the cross equation restriction.

## 1.4 Comparing economies

The determination of proper economic policies is the hardest thing for an economist. At the beginning of this paper we had discussion regarding two fundamental problems for economist: it is hard to conduct and to repeat economic experiments is the first problem, the second problem is the fact the structure of the economy changes over time.

Both of these problems present a real life problem for the policy maker since they are interrelated. As the economy grows and develops over time the behaviour of the economic participants change and the environment of the economic participants changes. 50 years ago monetary policy was conducted thought the actual increase (printing) and decrease (destruction) of money in the economy. Today we are moving towards the cash-less economy where money is replaced with computer signals. So the monetary policy tools used fifty years ago might not be applicable, on the other hand the essence of the economic problem has remind the same: how to avoid or at least dampen the business cycles volatility.

Following this logic it is hard to create a stabile economic policy rules that would fit the ever changing landscape of our lives. It is also just as difficult to create economic predictions about how the economies of past would react to the current economic policies or how the today's economy would react to the current economic policies and today's economic set up.
Given this one can only make comparisons.

For example one can create comparison about the economy of USA in 2006 and the economy of 1929 or 1974. Given the vastly different structures of those economics and the overall economic and social developments we might even say the only similarities that these three

economies have is that they are geographically in the same place and the currency is still called Dollar, although the look of the notes has changed as well[5]. Everything else is different, money, communications between policy makers and the economic participants, flow of information, technologies and the propagation of economic shocks, the impact of global politics and the globalization are just few variables we can distinguish that create such massive differences between the USA economies of 1929, 1974 and 2006. So we can make just parallels, but not adequate comparisons and definitely not the policy comparisons[6].

Bringing the argument closer to home; how can we compare the closed economy of Slovenia in SFRJ in 1967 and the economy of a small open economy with membership in the EU like Slovenia is today. There are not just social differences between the two economies (Slovenia in SFRJ in 1967 and Slovenia in 2006), but there is an important economic difference as well. In 1967 Slovenia was a member of a closed economy, while today it is an open economy and a member of a large monetary union. The geographical comparison is there, but there is hardly any economic comparison.

But the question regarding the success of the Slovenian economic policies remains. Would Slovenia been better off if it had followed Croatian monetary policies and vice versa?

We have already noted that it is impossible to re-run the economic history; Slovenia can not perform Croatian economic policies in a repeated experiment in a closed environment. Alternative question can also be asked: how would Croatian economy look like today if the Slovenian policies have been used? Again it does not make much sense to repeat Slovenian economic policies in Croatia since we can not get a controlled economic environment. So what are we left with?

We are left with two similar economies that have undertaken two alternate policies. We can not repeat experiment, but that does not mean we can not compare two similar participants under different conditions.

Another question that remains to be investigated and is the focus of this paper from the introducing argument is the monetary regime in open economy. How can we compare the monetary regimes in a small open economy? As noted we can not just perform a monetary switch and then see how the economies will react, no we have to do something easier.

In order to perform analysis of alternate monetary policies we have to solve two problems:

[5] The greenback as also a little of yellow and rose it himself these days.
[6] Although it might not be the best thing to create policy comparison that does not mean the economic models can not use the data from alternate time periods, for an excellent comparison of the same model is different time periods see Reise (2004).

1. Find two compatible countries. Similar past, completely different present (due to the different monetary regimes as hypothesized), similar economy structure (same labour education, same GDP, same size). This has already been done, we are going to use Slovenia and Croatia.
2. Determine what a monetary regime is in a small open economy and then model the regime or regimes.

The first problem is not hard to solve. Most of the ex socialist European countries share lot of economic qualities and have similar economic past. All have experienced transition from planned socialist/communist economy to a capitalist free market economy. Along that transition they faced similar problems and tried to maximize the effect of their policies. Fifteen years after the end of socialist system we have the ability to look the economic status of each ex socialist country and determine how successful they have been in their policies and the choices they have made.

The second problem might be slightly harder. When discussing big closed economies we have mentioned three monetary regimes: control interest rates, control monetary aggregates, control inflation. For a big economy that is self sufficient these are the three generally accepted monetary regimes. The Fed's control of monetary aggregates, as practiced by Paul Volcker the control of interest rates, as practiced by Alan Greenspan and today the control of the rate of inflation, as practiced by the EMU.

When it comes to a small open economy the problem of the choice of one of these regime might me more difficult. The way a small open economy functions is vastly different then the closed economy. So monetary regimes might not be appropriate as already noted.

A small open economy, by definition is a small economy that is largely dependent on exports and imports as part of the GDP. Monetary policy in a small open economy is also very tied to the flow of capital. New investments and the inflow of capital could alter the employment structure in terms of percentages. But the point I would like to stress is the fact that capital flows will cause exogenous changes in the target variables under the monetary regime. So just from this simple example we can see that in small open economies the three targeting variables (monetary aggregates, interest rates, inflation) might not be appropriate tool for the central bank to control, so we have to turn to another variable and that is the exchange rate.

If we do opt for the exchange rate as the appropriate monetary policy for a small open economy we automatically have the answer to the question what monetary regimes a small open economy can choose from: fixed exchange rate and the flexible exchange rate.

For our purposes we shall define fixed exchange rate regime as any monetary policy where the exchange rate is held completely fixed or in a small band. The Croatian National Bank

states "we intervene in order to decrease the volatility of the exchange rate", CNB's (web site www.hnb.hr).

We shall define flexible exchange rate as the exchange rate monetary regime where the central bank directly intervenes in order to manipulate the exchange rate with some purpose and move it in certain direction. In this paper we shall assume the direction of the central bank's actions is always towards depreciation.

## 1.5 Set up of the paper

Now that we have defined what is the monetary regime in a small open economy we can ask the main question of this paper: Does the choice of monetary regime in a small open economy have impact on the economic parameters? Does the choice of the monetary policy create a system that defines the behaviour of economic participants? By economic parameters I mean macroeconomic variables like: real GDP, employment, inflation, real exchange rate. Keep in mind the author here is talking about the whole set of economic variables, not just one variable. I am not trying to solve the problem like: is inflation greater under fixed or under flexible exchange rate regime? I am talking about the economy as a whole. Does the choice of the monetary policy determine the future path of the whole economy? In this paper I will argue that it does.

The main thesis of this paper is that the choice of monetary policy for a small open economy determines the path of the whole economy and every participant in it. Since the determinant of the monetary policy is the central bank I shall argue the choice the central bank makes (between the fixed and flexible exchange rate regime) is the most important choice a small open economy has to make, because it determines the future path of the whole economy.

The choice of the monetary policy has a recursive effect on the economy. Once the monetary policy is chosen the economic participants note the choice and start behaving accordingly. The behaviour of economic participants influences the economic data. The data generated from economic participants further enforces their behaviour and this recursive effect propagates through the economy[7].

As the economy by the system is defined by the choice of the monetary policy so is the economic data. The economic data is the direct product of the economic participants so if the thesis is correct we should see different data values for same economic variables.

[7] This tautology is the direct effect of the cross equation restriction and the forward solution of the model.

I present a rational expectation model augmented for open economy. Due to the Lucas critique I present two versions of the model, one for fixed exchange rate regime and one for flexible exchange rate regime I then analyse the behaviour of the economic agents with rational expectations model, under different regimes. Special attention is paid to the implications of monetary policy on inflation and inflation on the real exchange rate.

This paper is organized as follows. Part two develops a model using tools from rational expectations and optimal control. The special emphasis is not the two regimes and how each monetary regime needs its own model. Part three looks at implications of the model. The focus in this part is on the effect of the real exchange rate on the behaviour of consumers and producers. Part four looks at the economic data and how economic data relates to the model. This part tries to connect the main thesis of the model with the real economic data. Part five concludes.

# 2. THE MODEL

In this section we are going to develop the model to be used in this paper. The model used is going to be an rational expectations model with strong emphasis on the tools used in dynamic programming and optimal control literature.

The emphasis will be on how the participants behave when faced with choice and what the governing force behind their behaviour is. Special attention will be paid to the creation of alternative models for each monetary policy regime.

## 2.1 The implications of the Lucas Critique

Lucas in his seminal paper about the use of econometric in economics argued the econometric models are not equipped with adequate ability to recognize abrupt changes in economic behaviour of economic participants and to simulate those changes (Lucas 1975). By abrupt changes in economic behaviour Lucas meant changes in economic policies or economic regimes.

The econometric models are based on the past data, when there was some stable relationship between the variables, but there is no guarantee the relationship of the two economic variables will not change in the future.

This is an extremely important point for the development of the model in this paper. If the economic participants behave the same way under any monetary regime we would only need one model. The data generated under alternative monetary regimes would have to have similar properties. However if the choice of the monetary policy changes the behaviour of the economic participants the parameters of the model have to change as well (in essence we need one model for one system) and the data generated under one regime will be different from any other regime. This demand posed on the economist modelling the economic process will be reiterated several times in this paper and demonstrated in several examples as well.

The main point of Lucas Critique is that under different monetary (or fiscal) regimes the parameters of the model will change as the regime changes. The change will be instantaneous and abrupt, not slow and gradual over time like adaptive expectations hypothesis suggests. Recently in a series of articles (Sargent and Hansen 2001, 2003, 2005a) have addressed the problem of regime changes and the impact the regime change has on economic participants.

Although this point on surface seems trivial it has several implications that have to be addressed.

If we have a data set under one monetary regime, then the model we are going to create based on the past data is valid only for that regime. The parameters of the model we have obtained are determined by the past data and the past data is determined by the economic regime under which the data has been generated. In this case the model can be used only for one regime and for the alternate policies that do not alter the regime. To test any kind of regime change is not valid.

So the model under one regime can be tested for the behaviour of economic variables and economic participants under that regime. The model can also be used for forecasting, but the model's validity comes into question if we try to test a regime change.

If we assume the regime changes, then there is no reason to believe the parameters of the model will remain the same. So for a test of implications of a change in regime we have to do one of the two things, either change the model or change the parameters of the existing model by obtaining alternative data set.

This interaction of the parameters of the model and the relations of variables in the model will be demonstrated in section 2.6 where we look at the regression of the exchange rate on exports in Slovenia and in Croatia and then analyse the parameters of the model.

As we have noted any kind of modelling has to take into account a possible regime change. (Reise 2006, 2006a) bases the whole validity of his model if the model satisfies the Lucas critique.

As presented there are two ways to obey the Lucas critique, one is to have alternate parameters is the model for each of the regimes studied or to have multiple models. In this paper there will be special focus on the Lucas critique and in order to "obey" the Lucas critique two models will be created, one for each regime (fixed and variable)

### 2.1.2 What is a "regime change"?

What is a change in regime? In economic terms a change in regime is any kind of structural change in the economy that changes the behaviour of economic participants and/or the structural changes to the relationship between economic variables.

The prime example of a radical economic regime change is a move from hyper inflation into low and stabile inflationary environment.

There has been several occurrences when inflation just had a sudden stop, an example is in (Sargent 1986 p 40-110) where four large inflations came to an abrupt stop in matter of days. One of the best recent examples of this is Croatia in 1994, (Rohatinski et al. 1994)

What is interesting to note in Sargent's paper is the reflection on the fact that the behaviour of the government has not changed, but the beliefs of the economic participants have. (Sargent 1986 p. 85) writes:

"...documents a pattern that we have seen in the three other hyper inflations: the substantial growth of the central bank note and demand deposit liabilities in the month after the currency was stabilized. As in the other cases that we have studied...."

What we are seeing here is an abrupt stop in a regime and a creation of a new one. The economy moves from hyper inflationary regime to low inflationary regime in matter of days, but there was no actual change in the behaviour of the government. This kind of sudden change can not be observed in models that have adaptive expectations, because the expectations are based on the previous data and the change in participant's behaviour is slow and gradual over time. However such sudden change is possible in the rational expectations models.

In the hyper inflationary regime growth of money was synonymous with inflation; however with a change in the regime the growth rate of money did not pay any significant role in the creation of the inflationary expectations as we can see from the quote above even though the behaviour of the government did not change.

Almost exactly the same thing occurred in Croatian in 1993 where the inflation stopped literary over night, as described in (Rohatinski et all 1994 p 31). Immediately after its foundation Croatia was faced with a war, the fiscal and monetary policy of the new nation needed to be rebuilt. Over time in the period 1992-1994 inflation was slowly rising, reaching its peak at the monthly rate of 24%. Then in 1994 a stabilization program was executed and the inflation stopped and it has remained at low levels until today.

These and other examples present a radical change in the monetary regime, however there are other examples. Like a change in USA monetary regime where the USA monetary policy moved from monetary aggregates targeting to interest rates targeting. This process was described in detail is a series of papers by (Sims and Zha 2006, 2006b) and (Sims, Leeper, Zha 1996). The overall conclusion of these papers is that there were no substantial monetary regime changes in the US and that the monetary policy does not have a significant effect on

economy. The conclusion of the papers is the monetary policy did not change the course of the economy, but the other way around.

### 2.1.3 Why different parameters?

The interesting question now to ask would be: what causes the change in the parameters of the model? Here we can look at two alternate hypotheses:

a) Change in the expectations. Under one regime two variables might not be interrelated, but under different regime two variables might be related. As demonstrated in (Sargent 1986) we had an abrupt stop in inflation, but the quantity of money still continued to rise. In this case the change of parameters in the model has occurred due to the radical change in the expectations of the economic participants.

b) Change in the structure of the system. An example here is a dollarization of a country. In the case of Croatia the authors in (Rohatinski et 1994) all have strong emphasis on the fact the Croatian government has created several pillars of stability of the system before it moved towards the anti-inflationary program. Like the promise to keep the deficit in check and agreement with IMF. According to the authors these system changes created a perception of stability and seriousness to fight inflation.

Determinants of what changes the system from the above argument are crucial in creation of the model. It is fundamental for model development to determine: What is the cause of the change of the monetary regime? In the model developed in this paper we shall focus on the case under a) scenario and that is the change in expectations.

From the model developed it will be seen the parameters of the model are driven by expectations also the behaviour of the economic participants is determined by the expectations of the relationship between the variables in the model, not necessarily the fundamental changes in the underlying variables.

## 2.2 Households - introduction

Both models shall have some common overlaps. Both shall have representative economic participants. The first economic participant we shall look at is the household. The household

lives infinitely and provides one unit of labour in every time period. The main problem the household has is the utility maximization which we shall formulate:

1. $\max E\left[\sum_{0}^{\infty} \beta^t u(c)dt\right]$

The household tries to maximize the expected utility over time. U(c) is a continuous, twice differentiable function, β is a discount factor.
However the household has some budget constraint. The budget constraint is derived from income. The expenditures in time period t we shall define in the following way:

2. $\mathrm{E} = c + s + \kappa * \Phi$

Parallel to the expenditures we can derive the income in time period t

3. $I = w + \tau * S + \phi$

The household expenditures (E) can be divided into consumption c, savings s and the portion of the existing debt paid off in that time period. The portion of debt paid off is marked with κ and it has the value $0<\kappa<1$. Income of the household I, comes come wage w, new debt Φ and the portion of savings that gets liquidated τ; τ has the same properties as the κ. S is the total savings the household has accumulated up to time period t and s is the new savings in time period t

If we look at the savings and debt we have to note savings and debt accumulate over time and the accumulation can be expressed with the two following equations:

4. $\Phi_t = \sum_{0}^{t-1} \phi_{t-1}(1 + r_i^*)^{t-1-i}$

5. $S_t = \sum_{0}^{t-1} s_{t-1}(1 + r_i)^{t-1-i}$

The debt is increasing and accumulating at the rate r*, this it is the rate the bank is offering to the household. We shall assume the rate is the same for each household, exogenous and perfectly inelastic for any level of demand[8]. The household gets savings rate of r.

In equilibrium the usual E=I holds, when we solve the equations for the c we get the equation:

6. $c = w + \tau * S + \Phi - s - \kappa\phi$

[8] As we shall latter in the model see the level of credit in the economy is not determined by the supply, but by the demand coming from household̲s.

Which represents the flow of consumption in every time period.
The household utility function is homogenous, twice differentiable and it has the following form:

7. $$u(c) = \left( \frac{c}{1-\gamma} \right)^{1-\gamma}$$

Before we move to the formulation of the bellman equation we have to analyse the state function.
We can now get the difference equation for income in each time period t+n:

8. $$I_{t+n} = \alpha_0 + \alpha_1 * w_{t+n-1} + \alpha_2 * \omega_{t+n-1} + \alpha_3 * \Phi_{t+n-1} + \varepsilon_t$$

Where ε is error term with distribution N(0,σ) and it is valid for all three variables and $\omega = \tau * S$, E is the expectations operator for each variable condition on the past information.
Equation 8 in the expected income the household is going to receive in some future period which is n period from period t. However the equation 8 is expected income only for period t+n, what we are looking for is the solution to the above equation and also for the present value of all future income.

We can solve equation 8 using the (Muth's 1961) method of undetermined coefficients which gives us following solutions satisfying both criteria we mentioned:

9. $$W = \overline{W} + \sum_{t=0}^{\infty} {}_i \varepsilon_{t-1}$$

Parameter W is the present value of all future income the household is going to obtain.
Now we can use the utility function as the control function and consumption function as the state function and we can set up the Bellman equation, the value function. And the value function takes the following form:

10. $$V(c) = \max_{W' \in [0,W]} u(W - W') + \beta V(W')$$

Where W' is the next period total income left to the household. This is general formulation of the bellman equation. Another thing has to be noted the equation 10 is not a stochastic bellman equation. The lack of the stochastic element will have a major impact on the development of the model as we shall see latter.

## 2.3 Household in a Small Open Economy

The problem a household in a small open economy faces is a little more complex due to the ability to choose the source of the goods it is consuming. By the source here I mean whether the goods are imported or domestically manufactured. We shall now reformulate the consumption function, based on the source of goods. Now we have the consumption function as:

11. $c = \lambda c + (1-\lambda)c$

The consumption of a household is split between two segments, domestic and foreign. The parameter λ has property $0 \leq \lambda \leq 1$ and presents what fraction of the goods the household consumes is manufactured domestically and what fraction is imported.

So in a small open economy the goods can be from domestic source $\lambda c = c_d$ or from $(1-\lambda)c = c_f$ a foreign source. Now the utility function in its parameter form looks like this

12. $u(c) = \left( \frac{c_f + c_d}{1-\gamma} \right)^{1-\gamma}$

Again trying so set up a dynamic formulation of the problem the household is trying to solve is

$\max E\left[ \int_0^{\infty} \beta^t \left( \frac{c_f + c_d}{1-\gamma} \right)^{1-\gamma} dt \right]$, subject to I (where I is again income)

Let us take a representative good x, in the case of determining the price of goods x we have the two different possibilities of price

13. $p_{f,x} = p_x * e$
$p_{d,x} = p_{d,x}$

The price of the domestic goods x expressed in domestic currency $p_{d,x}$, on the other hand the price of the foreign good is the price of the foreign good x, $p_{d,x}$, expressed in foreign currency times the real exchange rate noted as e. This is price valid for any time period or monetary regime.

The reason why we use the real exchange rate is the fact that we have a rational expectations model, so the nominal disturbances are of no importance to the household. Under fixed exchange rate regime there is never a change in the nominal price of the exchange rate. Under variable exchange rate we have constant changes in the nominal rate so only the real disturbances will have an effect on the economic participants. With further development of the model we shall demonstrate the importance of the real exchange rate for both producers and consumers.

Since the household is trying to maximize the utility and utility comes from consumption the household is trying to consume as much as it can. We shall assume the household is indifferent between consuming domestic and foreign goods[9].

We now have tree basic cases of how the household shall choose between the goods:

$p_{d,x} = p_x * e$ the household is indifferent between which good to consume

$p_{d,x} < p_x * e$ the price of the domestic good is less, the household will choose the domestic good

$p_{d,x} > p_x * e$ the price of domestic good is greater the household will choose the foreign good.

Looking at the set up of consumption from the above three consumption we see that it is much easier to control the preferences of the households in the economy where the monetary policy can control the real exchange rate.

As long as the real exchange rate of domestic currency is depreciated from the macroeconomic level thought macroeconomic policies the individual household's consumption can be controlled and stirred towards the consumption of domestic goods.

The household's consumption is determined by the real price of goods. However the price of imports is determined through the real exchange rate. If the policy maker has an object to maximize the domestic production and facilitate exports, the choice of monetary regime as to be a regime under which the real exchange rate is going to depreciate, thus depressing the consumption of foreign goods and increasing the consumption of domestic goods.

In essence the whole path of consumption for a household is determined by the choice of the monetary regime. This premise shall be very carefully analysed and explained in details in the sections 3 and 4 of this paper.

[9] The author is aware of the fact the this assumption might not absolutely hold in real life, due to the patriotic and brand preferences, but as the model shall show this assumption will hold due to law of large numbers and in the long run.

## 2.4 The firm

Again we have a representative agent, in this section that is going to be a representative firm. The firm is trying to produce some good x, sold at the price p. For the production function we shall use the common production Cobb-Douglas function:

14. $y = AK^{\alpha}L^{1-\alpha}$

The cost of production is the cost of labour and the cost of capital. Under capital I assume all of the materials used for the production of good x. Now we can formulate the profit function:

15. $\pi_t = y * p - nw - k$

Where y is the total of the goods produced; the goods are sold at price p minus the expenses. The firm pays n wages at the cost of labour w, and has some cost of capital k.
The segment k can be separated further into:

16. $k = p_d m_d + p_f e m_f$

Total cost of material is the cost of the domestic material times the price of domestic material, plus cost of foreign material expressed at the foreign price times the real exchange rate times the amount of the foreign material. Again as we can see the main variable here is the real exchange rate.

So the basic problem the firm is trying to solve is

17. max $E\left[\int_0^{\infty} \beta^{t} \pi \, dt\right]$ subject to y

We could use the equations 14-17 and set us a bellman equation for the producers using the same methods and process as in section 2.2. However latter in the paper we shall demonstrate we are not interested in the behaviour of the firms, but with the choices the new firms are faced in the small open economy. Further model development will go into the behaviour of entrepreneurs and new entrepreneurs and how their choices are determined by the real exchange rate.

## 2.5 Lucas Critique and the Central Bank

The central bank has the principal problem of the **choice of the monetary regime**. Once the monetary regime has been chosen the central bank has to monitor and maintain the regime. As explained in the introduction there are two main choices the central bank has in a small open economy and in this model.

The first choice is the fixed exchange regime. This is the regime of simplicity of the monetary policy conduct. The central bank sets up a band and keeps the currency inside the band through monetary interventions. Under absolutely fixed exchange rate the central bank holds the monopoly on the currency market. In the case of the exact fixed exchange rate the central bank sets the rate, creates the law by which there are no other currency transactions, except through the central bank and the monetary policy conduct[10] is solved.

This is the case in Croatia the exchange rate is kept in a narrow band. The HRK exchange rate is not fixed with Euro and the central bank also points the price of HRK is freely formed by the market. The really of the situation is slightly different, the exchange rate is freely formed by the market, but the central bank keeps the currency is a very narrow band. Thus creating an exchange rate system that is not an absolute fixed exchange rate system, but it has all of the properties of the fixed exchange rate system as we shall demonstrate on the data in the section 4 of this paper.

The alternative to the fixed exchange rate system[11] is the floating exchange rate as the choice of monetary policy. This is a regime in which the central bank depreciates the exchange rate over time. In our model we shall assume we are always dealing with the depreciation of the exchange rate and never with the appreciation over time.

A small note here is in order. As we have mentioned in section 1 of this paper the conduct of a fixed exchange rate monetary policy is pretty straightforward. Keeping the currency in a narrow band is also somewhat easy. Intervene whenever the exchange rate approaches the upper or the lower band. The actual conduct of the flexible (continuously depreciating exchange rate) and the determination of the optimal depreciation can present a strong challenge to any central banker.

There is an overall impact of the depreciation on the way the economy functions. Very fast depreciation might cause problems for the accounting of firms or it can cause large menu costs for the firm. At the same time depreciation can be slow over time so the economic participants might not notice it. They can choose to be inattentive to depreciation as we shall

[10] Please note the choice of wording. Conduct of monetary policy, not monetary policy or choice of monetary policy.
[11] Or a band, dirty peg system as we have in Croatia.

see in the section 2.8 (page 42). Finding the optimal depreciation rate can be extremely challenging for the central banker.

Now we shall look at the implications of the Lucas Critique. Under the rational expectations the agent is a representative agent and it has the same model as the central banker. This assumption is the direct result of the neutrality we find in the rational expectations models (Lucas 1972) and in econometric modelling it is demonstrated by the cross equation restriction. Also the expectations are not just an input variable of the model, they are the output variable of the model as well.

Expectations as part of the model have important implications. Under true rational expectations, since the agent and the creator of the monetary policy have the same model there is no way the creator (the central bank) of the policy would ever want to “cheat” or fool the agent, nor is that possible.

Following this line of reasoning the credibility of the central bank in this model is absolute and perfect. The monetary regime is defined by the central bank and the central bank has no reason to perform an unannounced regime switch. Under these assumptions the model created under one regime and tested under that regime's data holds and the Lucas Critique is obeyed.

If the central bank is undergoing a policy of a fixed exchange rate regime it is using a model appropriate for the fixed exchange rate regime. This model works under the fixed exchange rate regime and it is useless to test the alternative policy of the flexible exchange rate. Using the model's parameters to test for the alternative monetary regime is pointless, because the structure of the economy will change as noted in (Lucas 1975). This can cause problems with modelling and it can lead to the wrong conclusions about the alternate monetary/policy regimes, as exemplified by (Cota et all 2005). This misconception and proper form of modelling the behaviour shall be demonstrated in the next section.

## 2.6 Modelling the behaviour of the banking sector

### 2.6.1 Banking Sector

The banks in this model serve two purposes. The first one is to collect savings from household and firms and to give loans to both firms and households. The firms collect deposits and give a different rate to households and companies a passive rate r, at the same time the banks give loans at the rate r*. The rate r* is the adjusted for any regulation the central bank might impose.

We shall assume the banks are not subject to liquidity constraint and in case they are not able to fund themselves through the domestic savings sources they can obtain funding from abroad.

In case the central bank constraints the funding sources through reserve requirement, the bank will have to obtain more funding from abroad. We shall assume the extra regulation from the central bank only increases the foreign debt.

We shall see in the model the foreign debt is the not caused by the foreign banks; it is a product of the monetary system the central bank chooses.
The banks are profit maximizing firms whose object is to

$$\max f(\pi) = NNI - wn$$

Where π here stands for profit subject to the constraint X>0.

$$NII(t) = X*(r*-r)$$

Where NII is net interest income, the X is the total amount of loans outstanding and the (r*-r) is the net interest differential, w is wage, n is the number of employees.

## 2.6.2 Central Bank

The central bank, no matter, what the regime is has a common goal and that is to minimize the inflation and to maximize growth of the whole economy. The problem can be described as the usual Phelps problem of minimizing the variances of the inflation and output.

18. $$\min \sum_{0}^{t} (\pi_i - \pi^*)^2 (y_i - y^*)^2$$

Where π is the current inflation rate π* is the optimal or some target inflation rate, y is the real GDP growth rate in the current time period and y* is the natural rate of growth.

However this general formulation has to be developed further. Because of this we shall set up an optimal control problem in order to represent the behaviour of central bank.

The central bank model here is the modification of the models presented in Sargent and (Hansen 2005) and (Vidakovic 2006). The model presented here is the model based on the optimization of the real exchange rate or the nominal exchange rate.

In case of the fixed exchange rate regime the central bank is controlling the nominal exchange rate, in case of the variable exchange rate the central bank is trying to optimise the real exchange rate.
In case the central bank decides to fix the exchange rate the actions it conducts will be govern by the prime directive of the exchange rate stability or the fixation of the nominal exchange rate.

In case the central bank decides to have a variable exchange rate policy the central bank is essentially trying to optimize the real exchange rate of the country. The purpose of this analysis is to obtain the decision function in general form to be used under any monetary regime.

We shall note the nominal exchange rate or the real exchange rate with e[12]. The exchange rate will have two components the endogenous one x and the exogenous one z. The endogenous one is the component that is under director control of the central bank, while the exogenous one is a component that is not under direct control of the central bank and it represent the exogenous changes in the controlled variable. Using the vector notation these two components can be presented like:

19. $e_t = \begin{bmatrix} x_t \\ z_t \end{bmatrix}$

The exogenous part of the exchange rate vector shall have the transition law,

20. $z_{t+1} = f(z_t, \varepsilon_{t+1})$

Where ε is identical and independently distributed shock with a distribution Φ.
Now we can formulate e in the next period and we get:

21. $e_{t+1} = g(e_t, z_z, s_t)$

We are not dealing with the stochastic process the central bank is trying to optimize, we can formulate the optimization as:

[12] Since the model can be used as real and as nominal exchange rate control from now on the variables will be lumped up together and just referred as the exchange rate.

22. $E\left[\sum_{t=0}^{\infty}\beta^t r(e_t, s_t)|\mathbf{y}^0\right]$

Where $\beta$ is the discount factor with values $0<\beta<1$. E(.)|**y** is the mathematical expectations operator conditional on $\mathbf{y} \equiv (\mathbf{x}^t, \mathbf{z}^t)$, and s is the optimal control function dictating the central bank's behaviour per observed e. So the central bank is making decisions in order to maximize s with respect to the previous three equations.

We have defined the problem, now we can use "feedback-feed forward" solution and we get the policy function in the function form and the solution to the optimal control problem as:

23. $s_t = h(x_t, z_z)$

This is the optimal decision function with respect to the monetary policy chosen by the central bank. The modelling process here is relatively simple. First we have determined what we want to control, variable e in our case, then we have set up the optimal control problem and we have defined a decision function the central bank has to obey in order to be in "compliance" with its policy.

What has to be noted here is that there are other mathematical ways to set up the solution to the problem of how to control the exchange rate. One such technique can be just a simple regression, but such techniques have to have a bayesian component in them like structural VAR. The modelling has to be done using technique that allows for the change in the parameters of the regression. This will be demonstrated in the section 2.6.2.

Having the whole process defined, control, state and policy function we can set up the bellman equation for the whole process. The bellman equation shall be expressed through Riccati equation.

24. $V(e_0) = -y'_0 P y_0 - p$

Where p is the implied volatility and P and the matrix of variables we are analysing. The model can also be solved using the Stackelberg solution to the problem, but with a special addition to the model and that is the model error.

The error in the model or as (Sargent and Hansen 2004) call it the model uncertainty comes from the exogenous component z. Since we are dealing with the Stackelberg solution to the problem we have a participant player, who is a follower and policy maker, the leader of the game. Since we have an exogenous component z, we have to supplement the transition law with w, thus having

25. $z_{t+1} = f(z_t, \varepsilon_{t+1} + w_t)$

Now we can set up the solution to the Stackelberg problem in the form of the min-max bellman equation:

26. $\min_{w_1} \max_{s_0} E\left[\sum_{t=0}^{\infty} \beta^t \{r(y_t, s_t) + \theta\beta w'_{t+1} w_{t+1}\}\right] y_0$

Where β is the discount factor and θ is the robustness parameter. Using a computer simulation we can get a perfect Markov equilibrium as the solution, obtaining the probability density function of all the simulation from the model we can get the distribution of the solution and then measure the actual error of the model.

It should be noted the model here is a rational expectations model, but it leaves some room for extensions. The robustness parameter θ in pure rational expectations models does not exist. It would be a violation of the cross equation restriction. But as we shall see the strict rational expectations assumptions are going to be relaxed in order to get a model real life feel in the model.

The policy maker can also measure entropy or the error of his model by using the following equation:

27. $E[m \log m]$

Where m is the variable of solution. The similar procedure can be found in (Lunquist and Sargent 2004), (Sargent and Hansen 2006) and (Sims 1998).

The model can now be used under any monetary regime and it can also be used for the policy testing for the alternative regimes.

## 2.6.3 Why optimal control: an example

Here we shall analyse the importance of the Lucas critique for the determination of the monetary policy. In standard econ papers (Cota et all 2005) and (Stučka 2003) there is a common mistake to use the data under one monetary regime and then try to construct alternative policy, since these statistical methods are based on the statistical data under one monetary regime they can not be used for the policy testing. This is the crucial point of the

Lucas critique and in effect such analysis comes into question as valid since it violates the Lucas critique. We shall look at a simple example and demonstrate the importance of having two models one for each regime.

Let us look at a standard linear regression:

$$e_t = \alpha + \beta_1 c + \beta_2 d + \beta_3 f + ..... + \beta_n g + \eta$$

In this formulation β is a static factor determined from the past data. The relationship in β variable is static and does not change under the change of the monetary regimes; it is robust to the changes in the participant's expectations or any external shocks generated by the new system.
We shall, demonstrate this by using a very simple test. Using the data and results from Vidakovic (2006) we shall regress exports on nominal exchange rate using the data from Croatia and Slovenia.

Now if we follow standard logic the relationship of two variables should be the same for both variables under both monetary regimes, if they are not then we have some unexplained relationship between the variables and we need a more complex model.

There is also one more point: if the relationship of the two variables under two different regimes is not the same, then we can not use data from one regime to test for the alternative regime because the regression is telling us the parameters change with the regimes.
For Croatia the regression is (t statistic below the number)

$$EX = \underset{37}{7} + \underset{1,54}{6,58}E$$

Identical regression for Slovenia is:

$$EX = \underset{16,687}{94} + \underset{19,89}{0,03}E$$

E is the nominal exchange rate, a EX is exports.

What did we get? In one country the relationship is statistically significant in the other one it is not. How is this possible? What has caused two variables to have different relationships in two different countries? Following from the results of the regression we have to conclude that under alternative monetary regimes the relationship between the variables is not the same and there is no point in making policy changes comparisons using the data for Croatia or Slovenia. This result is not surprising, considering the fact (Sargent 1986 p. 85) made the same observation in the paragraph we have already cited. Under the change of system or in

alternate monetary regimes the relationship between the variables does not have to remain the same.

We can not use the data from the variable exchange rate regime and say this would be the relationship between the variables if the monetary regime changes, just like we can not take data for the fixed exchange rate in Croatia and use the data to test what would happen if Croatia moved to the flexible exchange rate.

With the change of the monetary regime there was a change of the parameters and relationship between the variables. This is the point of the Lucas critique and the reason for the creation of the optimal control model that is robust to the Lucas critique and does not have fixed relationship between the variables, but the parameters as susceptible to change.

## 2.7 Some Explanations of π*

We shall now look again at the equation 18:

$$\min \sum_{0}^{t} (\pi - \pi^*)^2 (y - y^*)^2$$

In this equation we have noted the y* and π* to be the optimal levels of GDP growth and inflation respectively.

When a monetary policy regime is chosen in a small open economy there is usually one strong argument in favour of fixed exchange rate: price stability. The purpose of this section is to reiterate the argument and the purpose of the next two sections is to show that the argument does not hold.

When a small open economy chooses the monetary policy it is usually under the imperative of price stability. For the purpose of this paper the price stability shall be defined as variance of the price level. So the central bank is trying to minimize the variance of the inflation rate over time. We are assuming the inflation rate is impossible to avoid.

The main argument why a country should have a fixed exchange rate monetary regime is the implication that the fixed exchange rate implies the inflation of the small open economy shall be the same as in the rest of the world. In this case the country with whose currency the peg is established.

Alternate argument in case of the fixed exchange rate regime is: why would a central bank want to depreciate the exchange rate, since it is going to completely transfer into inflation? So the depreciation of the exchange rate does not have any purpose since it transfers into inflation and does not affect the nominal price of exports[13].

The implications of this are far reaching. With a fixed exchange rate regime the central bank in essence is moving the monetary policy in the hands of another central banks. The variable $\pi^*$ is transferred under the control of another central bank. So under the fixed exchange rate, $\pi^*$ is the inflation rate in the country with which the central bank has decided to tie the national currency to. For the countries we are looking at (Croatia and Slovenia) the $\pi^*$ is the inflation in the EMU.

When discussing the fixed exchange rate regime most of the economists are obsessed with the exchange rate pass-through. For just some examples see (Jazbec, Corricelli, Mastens 2006) and (Burstein, Eichenbaum, Rebelo 2005, 2006). These papers show that there is an exchange rate pass-thought, or in simple language any depreciation transfers itself in the inflation rate. The transfer is immediate or over time.

If we assume a flexible exchange rate we have to discuss the definition of flexibility. The rate by which the central bank is depreciating the currency can be two fold. It can be fixed each period or it can have alternate magnitudes in alternate periods. In case the depreciation is fixed each period we have a variation of the Friedman's k rule (Friedman 1969 p 31). Or the rate of depreciation can be a stochastic rate. In that case each time the exchange rate depreciates it is at an unknown rate and at the unknown period.

As we shall latter see for producers and for consumers both ways of depreciating an exchange rate are the same.

Even if the nominal exchange rate is stochastic I shall demonstrate that in the long run the depreciation still transfers into inflation one for one, however the exchange rate depreciation one for one in my model is actual a positive and a preferred monetary policy. The announced rate of depreciation with known time period and known magnitude actually has a stabilizing effect on the economy.

The assumption of the exchange rate pass through and its translation to inflation of one for one is consistent with the neutrality principle and the standard rational expectations assumptions, as a matter of fact is has been one of the assumptions of this paper as well.

[13] The rise in prices is equal to the depreciation of the currency so the two offset each other; thus keeping the price of goods constant over time in the eyes of foreigners.

## 2.8 Depreciation

In his seminal work about rational inattention (Sims 1998) creates a revolutionary concept. The economic agents have rational expectations, but they have the problem of processing information fast enough. So the information gets processed at some later time and we have nominal rigidities in the data. The whole concept has been extended to producers and consumers in the papers by (Reise 2006, 2006b). In equation 26 that was the robustness parameter θ we have mentioned. The technical aspect of those papers is far more complex then this paper, so we shall content ourselves with a simpler approach in order to prove the point.

As we have seen in the flexible exchange rate model under the rational expectations the inflation is always equal to the expected depreciation of the exchange rate. This result is the direct effect of the cross equation condition imposed on the rational expectations models.

The cross equation restriction puts a lot of rigidity in the model and does not account for some real life problems we are facing, as will be described by an example of a coffee shop owner who is trying to price a cup of coffee.

In this section we are going to relax the strict rational expectations framework and introduce inattentiveness, a property of economic participants who are not able to process information at perfect speed. So their behaviour is inattentive.

There is a question of what goes on in the real life? In real life and we shall see in the data the condition $p_{t+1} = p_{t+1}^{e}$ does not hold and we have a discrepancy in the data. There has been an alternative theory proposed why there are rigidities in the data proposed by the New Keynesian Economics and it centres on price stickiness. According to this theory the prices are "sticky" they change, but they change at uneven intervals and after some threshold has been breached (Mankiew, Romer, Ball 1988)

The price stickiness and the New Keynesian models have been recently pushed back by alternative theory of rational inattention as proposed by (Mankiew and Rise 2002) and in several papers (Sims 1998, 2003). The crux of this theory can be summed up as follows: the economic agents are rational, their model is a model of rational expectations, but sometimes they choose to be inattentive to the problems and the changes in the economy around them.

The prime example of this can be the menu costs. If the inflation rate in the economy is 3% and a cup of coffee is 1 €, there is no point is changing the prices to 1,03€, if not for the menu costs, then for the simple fact the innkeeper would have to have a lot of 1 ¢ coins and rest of the coins in small denominations to give change. So since the owner is not updating the price

every time he learns of a relevant piece of information[14]. The coffee shop owner in essence is choosing to be inattentive to this new information. Although under the strict behaviour of the rational expectations model he would have to update his price.

Following the model presented in (Reise and Makiew 2002) we shall set up a model with rational agent, but that have some processing issues ie. they are inattentive.

The optimal price the firm desires at which it maximizes profits is:

28. $p^*_t = p_t + \alpha y_t$

Where p is the overall price level and the y is the firms output. The firm updates its price every period and the expectations of the optimal price evolve according to

29. $x_t^j = E_{t-j} p^*_t$

The aggregate price level has the following equation:

30. $p_t = \lambda \sum_{j=0}^{\infty} (1-\lambda)^j x_t^j$

In a case of coffee shop owner he has a desired price as presented in equation 28, has some update as presented in equation 29 and is aware of the overall price level as presented in 30.
The same rational is with the flexible exchange rate regime. The producer is using some imports for production, is aware of the overall exchange rate and has some update time for the changes in the exchange rate. Once the prices of inputs change, so does the price, but not instantaneously, that is why the producer is inattentive. But the question is: when do the prices move?

Here we shall introduce the threshold of attention, as used in (Rise 2006).

31. $\alpha = \frac{\sigma + \psi}{1 + \theta\psi}$

Where θ is price elasticity, ψ is the labour supply elasticity, σ variance. Ball and Romer (1990) call this parameter α parameter of real rigidities in the economy or it can also be interpreted as the threshold of attention for a producer.

[14] Like the changes in inflation in the last quarter.

Following this set up, let us create the state variable for the price changes in economy with variable exchange rate regime. We know the price shocks are caused by the changes in the exchange rate, in that case we can set up a process for the changes of those shocks and we can define the total level of shocks from period 0 to period j. The total shock are:

32. $S_t = \sum_{0}^{N(j)} x_i$

The shocks x are generated based on some process, let us now set up that process.

Let N(j) be a homogenous Poisson's Process with intensity, $\lambda>0$ and u the number of shocks do to point t, x is the amount of the shock and S is a compound Poisson's process. We shall assume x is iid across the economy. So each economic participant has his level of inattention. Also N(t) is independent of all x. From this we can derive the expected value of S:

33. $E[S_t] = \lambda * \mu * t$ with $\mu = E[x_i]$

34. $p \in [p_0, p_1]$

35. $p \leq p_1$

**Proposition 1**: in the long run the absorption of shock is one for one.

Proof: the proof is trivial. If we take the limit as t approaches infinity we get:

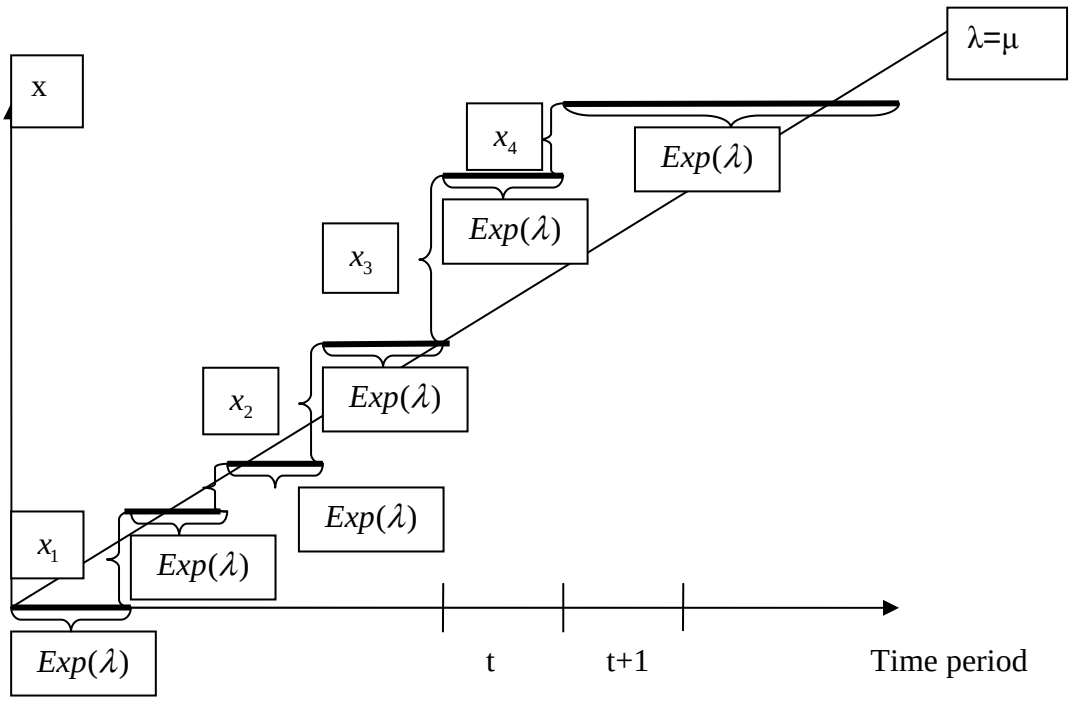
36. $\lim_{t \to \infty} = \frac{absorbed}{total\ \lambda \mu t} = 1$

This implies in the long run all of the shocks get absorbed or as the usual economic jargon states the shocks have a pass through from depreciation into inflation. There have been many studies studying the absorption of exchange rate into the price level. Studies like (Jazbec, Corriceli 2006), show what is the time period it takes for the exchange rate shock to get absorbed after devaluation, whoever that is not the point. What I am trying to show here is the policy implications of two different monetary policies. The graphical presentation of the described process is in Graph 1.

Under fixed exchange rate there is only supply shock to be absorbed. The supply shock can come internally or externally. The internal shock is the internal rise of producer's price. A typical example of this is the rise in utility costs, an external price shock is related to the rise of prices of imported goods. All these shocks trickle down into the price level over time. This in essence shows that monetary policy is not able to control the stability of inflation in a fixed

exchange rate setting. The proof of this can easily be seen in the Croatian inflation data. The volatility of Croatian inflation data is large, although the exchange rate is fixed. This is shown in table 3 (page 63).

**Graph 1:The policy shocks in each time period and the update.**




X is the magnitude of shock, t time period

On the other hand under the variable exchange rate can be effectively used as an ultimate policy tool in inflation control.

What the central bank in real life and in this model is looking for is price stability. However this has nothing to do with the actual rate of inflation. The price stability is in effect the control of the variance of the inflation rate.

As we saw in the model and in the data under the fixed exchange rate central bank does not have control over inflation rate and subsequently the volatility of the inflation rate. However under the variable exchange rate the central bank does have that ability.

**Proposition 2**: under the fixed exchange rate the volatility of inflation rate can be 0, if the rate of depreciation is announced.

Proof:

The proof comes from the two aspects. The first aspect is the cross equation restriction. If we have that $p_{t+1} = p^e_{t+1}$, and we assume perfect absorption we have that the rate of depreciation is effect is $p^e_{t+1}$. So the expectations of economic participants are fixed. This is the fundamental proposition of the rational expectations theory as stated in (Lucas 1972). The second segment of the proof comes from the proof of proposition 1. If in the long run the level of absorption is 1, then if the shock in every period is known the price changes over aggregate economy will equal to the level of depreciations. QED.

As we can see if the depreciation rate is fixed, it can be an effective policy tool for the inflation rate stabilization.

## 2.9 Inflation Under Monetary Policy

Up to now we have talked about the inflation and have proven that the inflation rate under both monetary regimes is

37. $\pi = \pi^* + z$

Where π* under flexible exchange rate regime is the rate of depreciation. In essence we have decomposed the inflation into endogenous and exogenous part, along the lines of the vector in section 2.6.1 equations 19.

As shown in the previous part, the depreciation transfers into inflation in the long run. However the transfer of depreciation into inflation is not 1 for 1 in the time period after depreciation due to the inattentiveness. Under the fixed exchange rate is the inflation in the rest of the world. The detail analysis of inflation will be in parts 3 and 4 of this paper.

This concludes the model and now we can move to the implications of the model.

# 3. THE IMPLICATIONS OF THE MODEL

The introduction into this paper argued the importance of the choice of the monetary regime. The importance of monetary policy was not just the control of inflation, but the impact the choice of monetary policy has on the whole economy. In part two we have created a model that has three economic participants trying to optimize their behaviour under the rules set by the central bank[15]. The model was latter relaxed from strict rational expectations model restrictions to include inattentiveness and provide a more real-life like feel for the model and more natural behaviour of the economic participants: firms and households.

Since we have two participants in the economy, governed by the rules set by the central bank, now we are going to investigate their behaviour under alternate monetary regimes. In this section we are going to look and what changes have to be made to the initial set up in order to obtain a model functioning under each of the monetary regimes we are analysing.

Since we are dealing with two monetary regimes even before we look at the model some initial observations are in order.

We are dealing with a profit maximizing firm and with a utility (consumption) maximizing household. In this case the goods used or consumed are going to be the ones that have the lowest price[16]. Although this point might seem trivial once we look at the impact of the real exchange rate on the behaviour of firms and households this point shall gain some weight.

We are in a small open economy. The goods used for consumption or used for production come from two sources, a domestic source or they are imported.

In combination with the real exchange rate we shall see the behaviour of households and producers is driven by the choice of monetary policy.

## 3.1 Real Exchange Rate Index

As presented in the development of the model real exchange rate plays an important part for both the consumers and the producers.

[15] The central bank follows its own choice of monetary policy.
[16] We are constantly assuming the goods used in production or for consumption are perfect substitutes and the only force determining the choice of the good is the real price.

Real exchange rate for producers is manifested in several areas:

1. Cost of production. What is the cost of the imported goods used in production?
2. Pricing of products/competitiveness. In a small open economy a producer has to compete with the goods that are imported. In case of a producer exporter, real exchange rate determines the price of his goods that are competing in a foreign country.

Similar argument can be presented for a consumer. A consumer tries to maximize utility, through consumption. If domestic good and a foreign good, are perfect substitutes the consumer will opt for the cheaper good, thus maximizing his utility[17]. But before we look at the impact of real exchange rate on consumers and producers we have to have some measure of the real exchange rate.

In this paper we shall develop a very simple real exchange rate index as used in (Vidakovic 2006). The index can be presented as follows:

Index of the real exchange in the model is going to be:

38. $$\Phi_t = \Lambda \prod_0^t \frac{1}{\left(e_t^{ex} - e_t^{im}\right) + 1}$$

$\Lambda$ – Constant, the beginning value of index. In the discussion we shall use 1994 = 100.

$e^{ex}$ - price change in Croatia or Slovenia (percentage change or inflation) *plus exchange rate appreciation minus the exchange rate depreciation in the period in percentages*.

$e^{im}$ - world inflation, in this case inflation in EU*, in percentages*.

The index created here is very simple, yet it has powerful implications for the behaviour of economic participants as we shall see.

If the index is going down, means the prices in domestic country are going up at higher rate then the prices in the rest of the world[18]. Meaning the real exchange rate is appreciating. The domestic goods are more expensive, foreign goods are cheaper. Under the assumption of perfect substitutability between domestic and foreign goods in this case the domestic consumers will substitute domestic more expensive goods for cheaper foreign goods.

[17] Again emphasis is on the assumption the domestic and foreign goods are perfect substitution. So the customer buys cheaper good in order to consume more for the same amount of money.
[18] Naturally there is a reverse interpretation in the case of deflation. The domestic prices are falling at a slower rate then the prices in the rest of the world.

On the other hand if the index is going up, the prices in the rest of the world are increasing faster then the prices in domestic country and the real exchange rate is depreciating, the households will start to substitute foreign goods for the domestic goods.

According to the basic theory fall in this index should be negative for the exports in small open economy. Alternatively a rise in index and real depreciation of domestic goods should create a rise in exports and decrease in imports.

But in order to analyse the behaviour of economic participants under alternative monetary regime we have to determine for a fact that Croatia and Slovenia had opposite monetary regimes in the period studied.

## 3.2 Real Exchange Rate

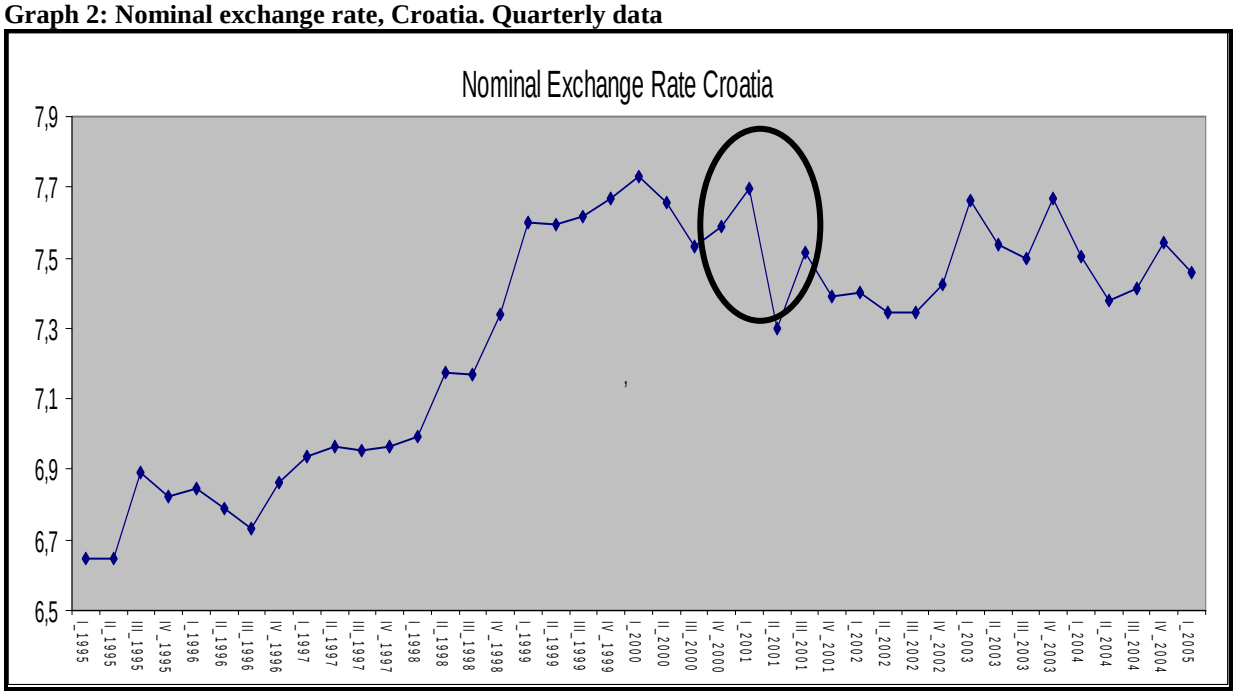
In this section we are going to look at the technical and basis statistical analysis of the movement in prices of HRK and Slovenian Tollar over the period studied. The purpose of this brief analysis is not to set up a complex model, but rather to provide a basic difference between the way exchange rates of HRK and Tollar have moved over time.

Slovenia had a flexible exchange rate regime with constant depreciation of the nominal exchange rate. In the same time period Croatia had two monetary regimes, a flexible exchange rate regime that lasted from 1994 after the end of hyperinflation up to 2000. After this period there was a period of a fixed exchange rate regime. The indication of a change in the monetary regime in Croatia can be seen from the graph 2 (circled page 50). The time period for both series is between the 01/95-01/05.

As it can be seen from the picture it is clear the Kuna exchange rate has been in a very narrow range from the period of mid 1998 until today. The mean of the whole period is 7,28, with the standard deviation of 0,33. Minimum of the series is 6,61 and the maximum is 7,73. The lower band is 0,67 Kuna away from the mean of about 9%. The upper bound is 0,45 Kuna away from the mean or 6%, essentially indicating an upward resistance.

The important point in the monetary policy of Croatia comes in 1999, in that year the depreciation of the exchange rate has stopped and Kuna remained somewhat flat between 7,5 and 7,7. We see a switch in the monetary regime. The switch occurred in 2000 when the new CNB governor came to power. We see a sudden sharp move in the graph where the exchange rate was moved from 7,6 to 7,4 as circled in the graph. Since then the exchange rate has been between 7,3 and 7,5 without any clear trend.

**Graph 2: Nominal exchange rate, Croatia. Quarterly data**




Source: CNB average month exchange rate

The graph shows that since the beginning of 2001, after the initial appreciation from 7.7 to 7.3 Kuna was heavily controlled. The exchange rate was not fixed, but it was been kept in a very narrow band.

The regime switch can be assumed based on the sudden change in the direction and volatility of the exchange rate. The impact of the fixed exchange rate regime should be translated in the real exchange rate data. We should see the impact in the change of the regime on the index of the real exchange rate once the equation 38 is simulated. If fixed exchange rate has caused real exchange rate to appreciate in that case Croatian exports should be stagnating and Croatian imports should be flourishing.

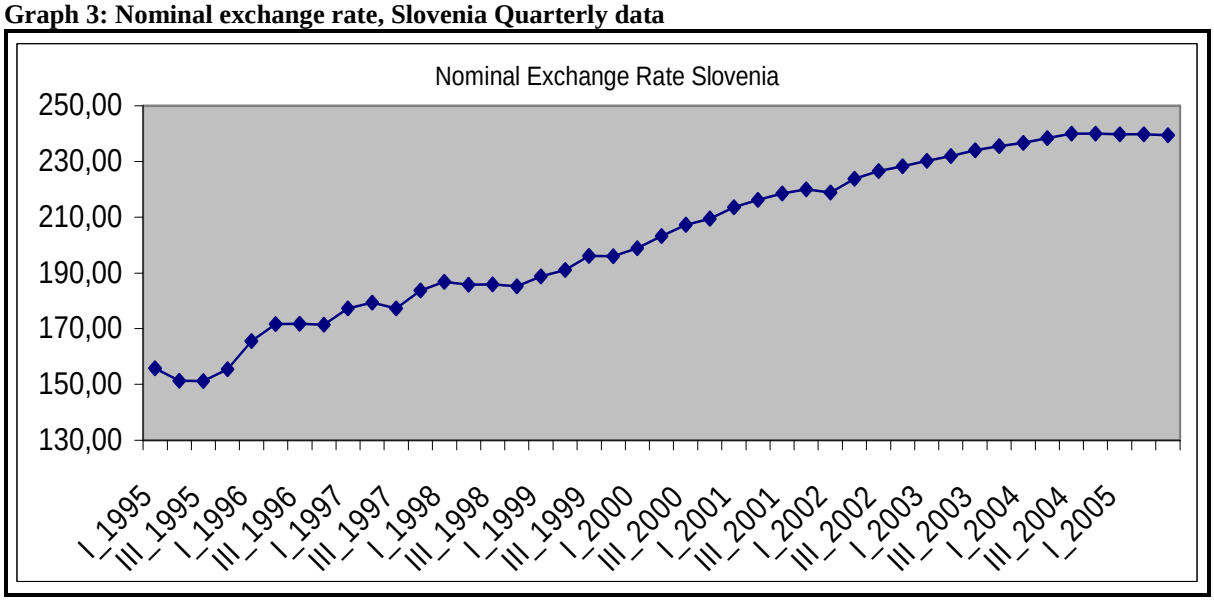
The same analysis can be done with the Slovenian Tollar, The graph is indicating a constant flexible exchange rate regime of depreciating currency. The mean of the series is 201,783. The highest point is 239, 99 and the minimum of the series is 150, 78. It should be noted that the minimum value occurs at the beginning of the series and the highest value occurs towards the end of the series.

The fact that Slovenian dollar has had a very clear direction indicates the monetary regime was oriented towards depreciation of currency.

When comparing the two graphs the first and the most important comparison should be made based on the shape of the exchange rate curves. The Kuna is a straight line in period 1999 until 2005, while Dollar is almost linear function with a steady slope. The slope ends and levels off once Slovenia got into EU and had to stabilize the exchange rate in order to prepare

for the EMU, again this kind of change in the monetary policy indicates a change in the monetary regime a move from a flexible exchange rate policy to a fixed exchange rate policy. The implications of this monetary policy should be reflected in the real exchange rate. If Slovenia has managed to create a real depreciation if its currency we should see in the data a strong rise in exports over time and decrease or small rise in imports over time. Also when calculating the equation 38 for Slovenia we should have considerable different results for Croatia.

**Graph 3: Nominal exchange rate, Slovenia Quarterly data**




Source: Bank of Slovenia average exchange rate in period

Flexible exchange rate brings also another variable that should be considered and that is the spill over effect of change in monetary policy into inflation. In section 2.8 we have created a theoretical proposition where we have proved flexible exchange rate monetary policy is superior monetary policy in both the short and long run.

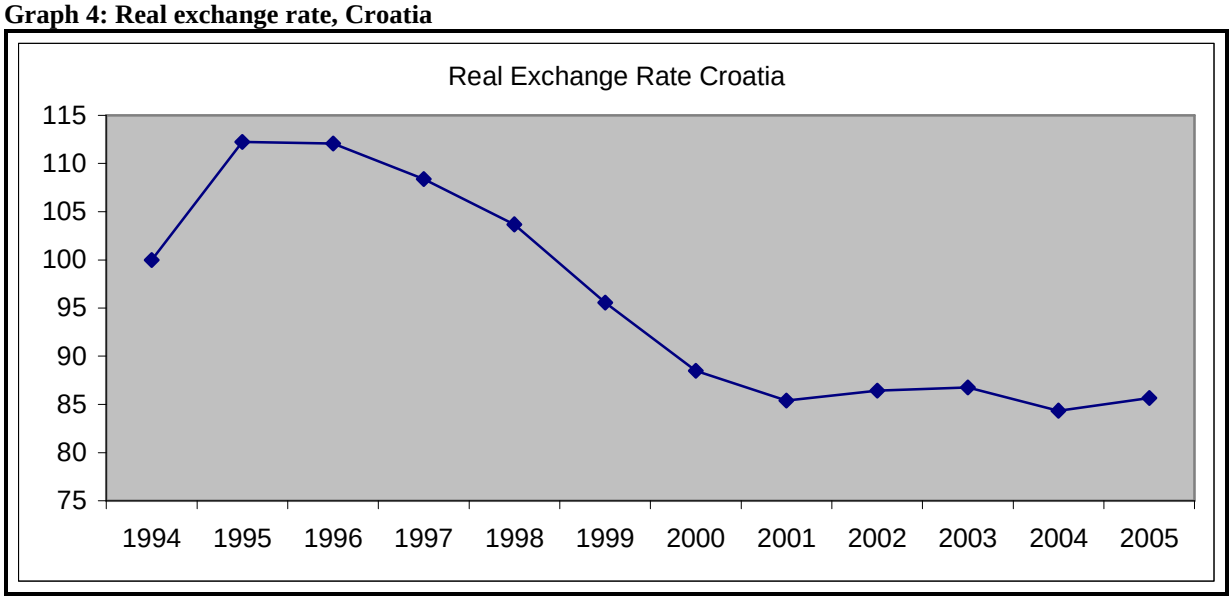
In the short run central bank can offset the changes in the real exchange rate thought depreciation in the long run the depreciation translated into inflation one for one. This effect of translation of the depreciation into inflation one for one keeps the $e^{ex}$ (equation 38, page 48) parameter in the real exchange rate index at 0 in the long run. This implies the real exchange rate will depreciate as long as the inflation in the rest of the world in greater then 0.

Here lies the superiority of flexible exchange rate policy, with $e^{ex}$=0 we have a constant increase in competitiveness of exports. This will set into motion the substitution effect from the households. Since the households will demand more domestic (cheaper goods) there is going to be incentive for marginal entrepreneurs to start domestic production of goods.

Before the look at the data we shall look at the calculation of index for Slovenia and Croatia. Using the above created index we can not calculate the index and analyze the behaviour the index over time.

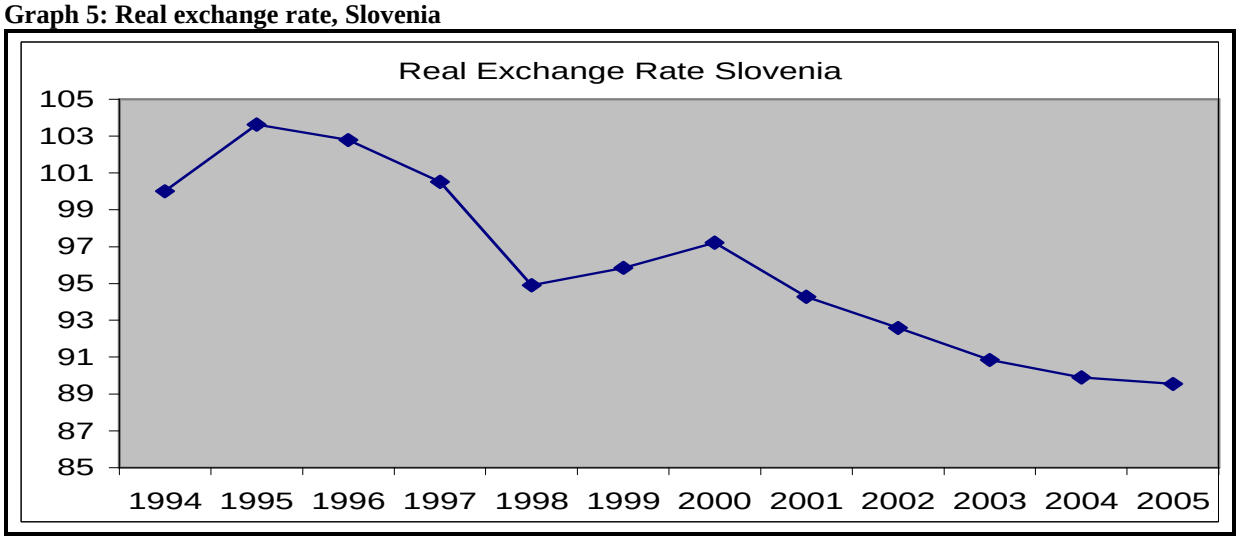
Let us now look at the real exchange index. Real exchange rate for Croatia and Slovenia:

**Graph 4: Real exchange rate, Croatia**




Source: Author's calculation

**Graph 5: Real exchange rate, Slovenia**




Source: Author's calculation

As the graphs show there has been a double appreciation. Over time both countries have experienced the downward movement in the real exchange rate. The results along the same line can be found in (Flere 2004) and (Coricelli and Jazbec 2004).

Here are the actual values for the index according to the author's calculation from the equation 17:

**Table 1: Real exchange rate index**

| year | Index Slovenia | Index Croatia |
|---|---|---|
| 1994 | 100 | 100 |
| 1995 | 103.61 | 112.24 |
| 1996 | 102.77 | 112.06 |
| 1997 | 100.51 | 108.37 |
| 1998 | 94.90 | 103.67 |
| 1999 | 95.84 | 95.55 |
| 2000 | 97.21 | 88.46 |
| 2001 | 94.28 | 85.39 |
| 2002 | 92.58 | 86.40 |
| 2003 | 90.85 | 86.74 |
| 2004 | 89.90 | 84.33 |

Source: Author's calculation

Slovenian real exchange rate fell by 14% from its peak while Croatian real exchange rate fell by 25% from their peaks in 1995.

As it can be seen when it comes to the control of the real exchange rate the flexible exchange rate is vastly superior to the fixed exchange rate.

What is a characteristic of Slovenian index is small volatility. The index in appreciating over time, but is should be noted rates of depreciation are very small. The difference from high to low are approximately 13 points.

Croatian index in is exhibiting a larger volatility and it has two periods. The first period is the period from 1994 to 1998. in this period the index has dropped, but then in 1999 and 2000 there are two substantial drops. Index moves from 103 in 1998 to 95 in 1999 and 88 in 2000, a 15 points drop in time span of two years. This is another indication of a change in the monetary regime in Croatia.

Using this data we can draw some initial observations:

1. Based on the real exchange rate index Croatia should have explosion in imports. In Slovenia imports should be up, but at a much smaller rate.
2. Exports in Croatia should be falling and in Slovenia rising or remaining flat in proportion to GDP.

3. We should see a large substitution effect in Croatia, a move from domestic to foreign goods and a small one in Slovenia and subsequently management of the economy.

The index tells us what has happened, now we shall look at the model and its behaviour under the two different real exchange rate behaviours and interpret possible findings in the data.

## 3.3 Consumers

In this model we are dealing with a rational, utility maximizing consumer. The consumer obtains utility through consumption.

The consumers can choose between the consumption of domestic and foreign goods. We assume the foreign and domestic goods and perfect substitutes. Under this assumption the only thing that differentiates products is their current price. In any time period the price shall be determined through real exchange rate. The total income spent on consumption in time period will be

39. $\varpi = c_f * p_f * e + c_d * p_d$

Where c is goods consumed, p is price of goods, e is the real exchange rate and subscripts f and d present foreign and domestic goods respectively.
Now we can rewrite the above equation as:

40. $\varpi_t = c_f * p_f * E\left[e|\Omega_{t-1}\right] + c_d * E\left[p_d|\Omega_{t-1}\right]$

The total income spent of consumption of goods in time period t+1 is now conditional of on the expectation of the real exchange rate in next time period.

But as presented in the 3.1 segment of this chapter under the fixed exchange rate regime the real exchange rate is conditional on the exogenous shocks z. We have seen that fixed exchange rate regime has no possibility in monitoring and offsetting the exogenous shocks.

So if the shocks are persistently negative we are going to have constant depreciation of the real exchange rate and because of that there will be constant substitution of domestic goods for foreign goods, leading to the constant widening of the trading gap due to the substitution effect.

Here we only see the substitution effect due to the exogenous elements that affect the behaviour of the household. Monetary policy and the real exchange rate are variables that are given for the household, they are imposed onto households, without the household's ability to control them. .The household can only behave given the information it possesses and optimize its consumption based on the information it holds. But now we can look at the behaviour the household can affect and that is the choice of level of debt the households are willing to hold.

Using the equation 6 for the consumption can now be augmented for expectations.

$$41.\ c_t = w_t + \tau \sum_{0}^{t-1} s_{t-1}(1 + r_i\ )^{t-1-i} + E\left[\Phi(t)\middle|\Omega_{t-1}\right] - s_t - \kappa E\left[\sum_{0}^{t-1} \phi_{t-1}(1 + r_i^*)^{t-1-i}\middle|\Omega_{t-1}\right]$$

Since all the banks are in foreign hands the debt of the households is in foreign currency, therefore the households has to bear in mind the currency exchange rate risk This has been noted by the expectation parameters of the new debt in current period and the repayment of debt in current period.

The exchange rate behaviour and the expectations of the value of the household debt are only relevant for the flexible exchange rate regimes. Under the fixed exchange rate regime we have that the nominal exchange rate in period t+1 is equal to the nominal exchange rate in period t. By introducing the variable exchange rate in the behaviour of the households we have in effect introduced uncertainty.

Here we find the very first implication of the monetary regime and the behaviour of the household. Under the fixed exchange rate regime the exchange rate does not play a role in the households' debt level in any period of time, however when we have introduced the element of uncertainty in the households through the exchange rate the behaviour of the household changes dramatically.

By introducing the uncertainty for the households the households are creating a risk aversion towards debt and the exchange rate serves as a deferent for the households when it comes to getting loans from the banks.

Using the same W from equation 9 we can also see that on the value function for the flexible monetary exchange rate regime, which now becomes:

$$42.\ V(c) = \max_{W' \in [0,W]} u(W - W') + \beta E[V(W')]$$

The equation 42 in fact is a stochastic bellman equation and the stochastic element is derived from the fact the consumer simply does not know what is his value of W in any given period under the flexible exchange rate. Where E denotes expectations.

The total value of W or the consumers net present value of all future income is dependent on the expenditure side through consumption, hence the W in the utility function. But under the flexible exchange rate the consumer does not know how much goods he can buy in the next period because the exchange rate is stochastic so in order to model the behaviour of the households under the flexible exchange rate we have to use the stochastic bellman equation.

## 3.4 Producers

In section 2.4 we have introduced the producers in the model. We have created the firm that tries to maximize profits and produces some good x. We have seen the good x is produced from domestic and foreign parts. The goods needed for production never change, but the level of usage of domestic and foreign component used in the production can change. The production industry is very open and we assume that no industry is absolutely self sufficient and there is an importing component in the production of goods.

In the consumer section we have analyzed the behaviour of the household when it is faced with the variable foreign exchange rate. We have presented how the behaviour of the consumers of determined by the exchange rate.

### 3.4.1 The Case of the Marginal Producer

In this section we are not going to analyse the behaviour of producers under the monetary regime and the choices the produces have to make under the alternative monetary regimes. Instead we are going to take a stop back and analyse the marginal entrepreneur. This marginal entrepreneur is a person that is deciding to start a business under the current monetary regime. We shall analyse the decision making process of this marginal entrepreneur and see how the choice of monetary policy impacts the behaviour of entrepreneurs.

Let us analyze the behaviour of a hypothetical man in our economy. We shall assume this representative person has obtained some inheritance, however the inheritance is conditional

on the fact the inheritance can not he used for consumption. It has to be used to start a new business[19].

There is no strict definition of what the business has to be, however it has to be a business. This would be a classical "marginal entrepreneur". One more business is going to get started in the economy.

We shall also assume our representative person creates expectations rationally under the rational expectations hypothesis. We shall also assume our entrepreneur he has lived under one of the monetary regime for all of his life. In essence he does not know any alternative monetary policy and he does not have any expectations the monetary regime is going to change.

Now we can present the basic problem this person in facing. In the model we have specified the foreign and domestic goods are perfect substitutes, so the only difference between then is the real price determined by the exchange rate.

It is generally accepted the firms get income from sale of the goods they produce and they have to pay the cost of the labour and capital. Here we are focused on the income the firm is going to obtain from the sale of goods and I will try to make the argument if the real exchange rate is against the entrepreneur in the long run he is going to bust.

It should be made clear the other two variables (the cost of labour and cost of capital) are not analysed here. The reason for that is following. If the marginal entrepreneur starts with a considerable cheaper cost of labour and capital but has exchange rate against him in the long run the exchange rate is going to offset the initial competitiveness of the cheap labour and capital.

In a small open economy a potential "marginal" entrepreneur is faced with two options:

1. Open a firm that is going to produce goods.
2. Open a firm that is going to import goods and then sell them.

Given the information available to our potential business man has to create a business model and then predict the success of each of the above options.

Once the model is created our agent assignees the probability of success to each of the possible business endeavours. So the probability for success of the importing business is p and the probability for success to the producing/exporting business is 1-p.

[19] We are dealing with a hard working uncle from Germany who did not have any kids of his own and now wants his nephew to gain everything through hard work.

We shall not deal with a whole business model, but with only one segment and that is the real exchange rate. Since the restrictions on the models are such that the firm is going to be a profit maximizing firm and in the long run real exchange rate can offset the initial competitiveness of labour and capital. .

The implications of the real exchange rate as following: no matter what the choice of business is the real exchange rate is going to play a crucial role in the success of our business man in the long run. Let us now assume the marginal entrepreneur starts an importing firm. If the real exchange rate is depreciating in the long run the goods that he is importing are going to lose competitiveness. Regardless of how competent he is in handling business affair or how much initially his imported good is cheaper then the domestic one. In the long run he is bust[20]. The opposite will happen in the case the real exchange rate is appreciating. In that case his goods are going to be cheaper over time and he is going to have major success.

Our agent is rational and has a perfect foresight so he can create the future expectation of the current price of some good. Using the rational expectation model now we can present the equation:

$$43.\ \Phi_t = \alpha + \beta E\left[\Phi_{t+1} \middle| \Omega_t\right] + \varepsilon_t$$

So the vector of the real exchange rate is a simple auto regression in a forward looking model. Where $\Phi$ is the index from equation 38 and $\varepsilon$ is the error $N(0,\sigma)$ The current value of the real exchange rate index is a OLS parameter $\alpha$ plus the expectations of the index in the next period.
Using the cross equation restriction the solution to the above equation and rational expectations equilibrium is:

$$44.\ \Phi_t = \frac{\alpha}{1-\beta}$$

We are dealing with the rational agent, operating under the assumption of rational expectations, so rational agent can use the above technique to predict the development of real exchange rate over time. Following the cross equation restriction he is always correct in his prediction. So the all our business man has to do is to create a forward projection of the equation 38 and he will have the answer to the future of the real exchange rate and what is his own future regarding the choice of business.

[20] However there is a caveat to this argument. In case he is importing something the economy can not produce this argument might not totally hold, but by law of large numbers analyzing the aggregate economy the argument is valid.

The monetary policy is determined by the central bank, and the central bank is under the commitment of monetary policy. Following the Lucas Critique the agent has no reason not to trust his model, since the model is trying to predict the changes in the real exchange rate under one monetary policy regime and the model does not try to test what will happen if the monetary policy changes. The entrepreneur lived under only one monetary regime and we assumed there is no reason for him to believe there is going to be a regime change.

The model is perfectly valid under the current monetary regime and it will remain valid until the regime changes, but the change in regime will present a whole new situation for our representative agent.

The implications of the solution are clear. If the marginal entrepreneur obtains a result of a permanent real exchange rate appreciation over time he will chose to enter into importing business immediately. Over time more and more new, "marginal" business created will be oriented towards the imports of goods and there will be an economic wide substitution from a producing economy to an importing economy.

The second solution to the equation is when the real exchange rate depreciates over time. In this case the new business will be immediately a producing one. The reason for that is the fact that importing goods over time will become increasingly less and less competitive and households will substitute them for domestically produced goods. From this perspective an importing business, due to the real exchange rate is destined to fail and the new business company will immediately be a producing/exporting one. Over time there is going to be an economy wide switch from importing to domestically produce goods and economy will be an export oriented economy.

If this theory is correct we should see this kind of development in the data. Using statistical data from Croatia and Slovenia (table 2 page 60) we can see that in 2005 there were 43 711 companies in Slovenia and 74 908 in Croatia. What is interesting is the number of companies that are classified as exporting companies. The number of exporting companies in Slovenia is 10 385 and the number in Croatia is 10 951. from this we see that 23,75% of companies in Slovenia are exporting. In Croatia only 14,61% of companies are exporting.

We can see the data completely validates the propositions made in this section and that theoretical example is not far from truth.

The implications of this are clear. The choice of monetary policy has had a significant impact on the development of Croatian and Slovenian economies. We have seen how the relation of the choice of monetary policy has led to the development in the real exchange rate. Now we have demonstrated both in theory and in example how a choice of the monetary policy has created a system and how the participants in that system behave.

In the following section we shall look even further into the economic data and see how other segments of economy have developed under alternate monetary regimes.

Looking as the data we can see the model is substantiated by the data:

**Table 2: Exporting companies Slovenia vs. Croatia**

| 2005 | Slovenia | Croatia |
|---|---|---|
| **Active companies** | **43 711** | **74 908** |
| | | |
| **Exporters** | **10 385** | **10 951** |
| **>99% exports** | **3 308** | **5809** |
| **80-99% exports** | **396** | **567** |
| **50-80% exports** | **62** | **69** |
| **<50% exports** | **6619** | **4506** |

Source: Croatian Chamber of Commerce and Croatian Business Daily

The data speaks for itself; 23,75% of the Slovenian companies are exporters, while only 14,61% of Croatian companies are exporters. Now there are some other facts that could have influenced the look of this table. There might have been some tax incentives the Slovenian companies have obtained, while the Croatian companies did not get the same incentives from the Croatian government, but the overall impression still remains. There are more exporters in Slovenia then in Croatia. Why?

Following the assumption of rationality and the ability to look forward and the model we have presented so far there is only one thing that ultimately determines why a company has turned towards imports or towards exports and that is the real exchange rate.

In the following section we are going to look even deeper in the data and try to determine what is the impact of the fixed vs. floating exchange rate on the economy.

# 4. MODEL vs. DATA

In this part of the paper we are going to look at the data and compare the assumptions and the results of the model with the real data from Croatia and Slovenia. We shall focus on four variables: inflation GDP growth, exports/imports and the creation of new capital in the economy.

We shall look how each of these variables should behave in the model and then contrast that with the economic data.

## 4.1 Inflation

Up to now we have analyzed possible scenarios is the model with little utilization of the real economic data. Now we are going to take a deep look at the implications of the model and the behaviour of the real life variables.

We have created two models that function under alternate monetary regimes and we have analysed the behaviour of producers and consumers under alternative monetary regimes. If the model is correct we should see a considerable difference in the economic data under alternate monetary regimes or the basic premise of the need for two models is incorrect.

This implies that the monetary regimes should have some effect on the economic data. Using the statistical terminology from this argument can derive H0 and H1 hypothesis. If the monetary regime does not have any impact on the economy we should see similar trends in economic data in both Croatia and Slovenia. In case the choice of monetary regime has impact on economic variables and economic data in that case we should see different trends in the economic data in Croatia and Slovenia.

In essence we are going to verify the hypothesis put at the beginning of this paper. Before going on with the data, let us summarize what we have been implying thus far.

The main premise of this paper has been that the monetary policy does not affect only inflation, but also a whole set of economic variables. The economic variables are generated by economic participants and the behaviour of economic participants is determined by the system they live in. The system is imposed on them by the central bank which has the power to choose monetary policy and by choosing the monetary policy a set of rules is determined. Alternative monetary policies bring alternative rules for the system.

In essence it has been argued that the choice of the monetary regime has an important implication for the whole economy and its future path. The model I have presented in this paper is a rational expectations model, although some relaxations of the rational expectations premises have been allowed.

In this model the agents have perfect foresight and have the same model as the policy maker. There is free flow and capital and the agents can obtain debt through banks, which are all foreign owned.

Both foreign and domestic goods in this model are consumed and are perfect substitutes for each other, the choice of consumption depends solely on the real price and the real price is determined through the real exchange rate.

The economy already exists in time period t, which is the beginning of time. There are some producers, some importers. The economy evolves over time. We have presented a profit maximizing producer and a "marginal entrepreneur" who is deciding to create a business and has to make a choice between the producing and importing of goods. We have also seen how there is a slow shift the structure of the firms in the economy which is determined by the development of the real exchange rate.

The central bank creates monetary policy. However before the actual conduct of monetary policy the central bank has to make a choice between the fixed and the flexible exchange rate. Once the system is set up the participants optimize their behaviour under the system.

We have already done the nominal exchange rate analysis in this paper; the analysis was presented in the section 3.1. From the data it was not hard to see Slovenia and Croatia had two different monetary regimes and that there was a monetary regime change in Croatia from 1994 to 1999 and then from 2000 until today.

In the section 2.9 I have presented the equation for inflation that I want to repeat it now:

45. $\pi = \pi^* + z$

The inflation equation states the inflation in the current period is the real exogenous shock to the economy and the $\pi^*$ variable. The $\pi^*$ variable is different under alternative monetary regimes. Under the fixed exchange rate regime it is the inflation in the rest of the world.

In the case of Croatia we have been observing the rate of HRK with Euro, so we are going to use $\pi^*$ as quarterly EMU inflation.

Under the flexible exchange rate regime $\pi^*$it is the depreciation of the currency in the pervious period in essence the exchange rate pass-through.

A note on methodology is in order. As a period I shall use a quarter. The equation 45 is not a differential equation; however for the purpose of the calculation of the z parameter I have assumed we are going to have a one period lag.

46. $\pi = \pi^*_{t-1} + z$

Here is the table with some basic information about the rate of inflation in Croatia and Slovenia over the period 01/1995-06/2005:

**Table 3: Calculation of the equation 46 data: 01/1995-06/2005**

| | inflation SLO | inflation CRO | z SLO | z CRO |
|---|---|---|---|---|
| **ave** | 1,68% | 1,16% | 2,28% | 0,65% |
| **st. dev** | 1,00% | 1,30% | 1,76% | 1,39% |

Source: Authors calculation, data from BSI and CNB

What is interesting is the fact Slovenia has higher inflation, but it has smaller standard deviation of the inflation rate. On the other hand average rate of inflation in Croatia is much smaller, but has higher standard deviation.

This fact has some interesting implications for the u parameter z. As we can see from the table the z parameter is larger in Slovenia, but the standard deviation is approximately the same for both Slovenia and Croatia indicating the shocks are the same for both countries, but they have different magnitudes.

The implication of this is something along the lines of signal extraction as proposed in (Lucas 1972, 1975). In (Lucas 1972), Lucas presents an argument that the economic participants are not well enough informed and although they have a rational expectations and they form their expectations rationally they all have alternate sets of data and due to this fact react differently to the same information. The empirical validation of that can be found in (Lucas 1975).

What we are seeing in the inflation data in Slovenia is along the same lines as presented in the section 2.8 where we presented a model of jumping inflation.

What we have in Slovenia are economic participants that react to the changes in exchange rate through inflation, whoever these participants can not distinguish between the inflation caused by the exchange rate and the inflation caused by the real shocks in the economy.

On the other hand in a fixed exchange rate economy like Croatia in the time period after 2000 it is much easier to distinguish real shocks caused by the change in prices of particular imports.

The model presented in section 2.9 states that in the long run we expect all exchange rate depreciation to transfer into inflation. If that is the case the only inflation signal for the economic participants is the nominal depreciation of the currency. The real shocks no longer play any role in the creation of inflation.

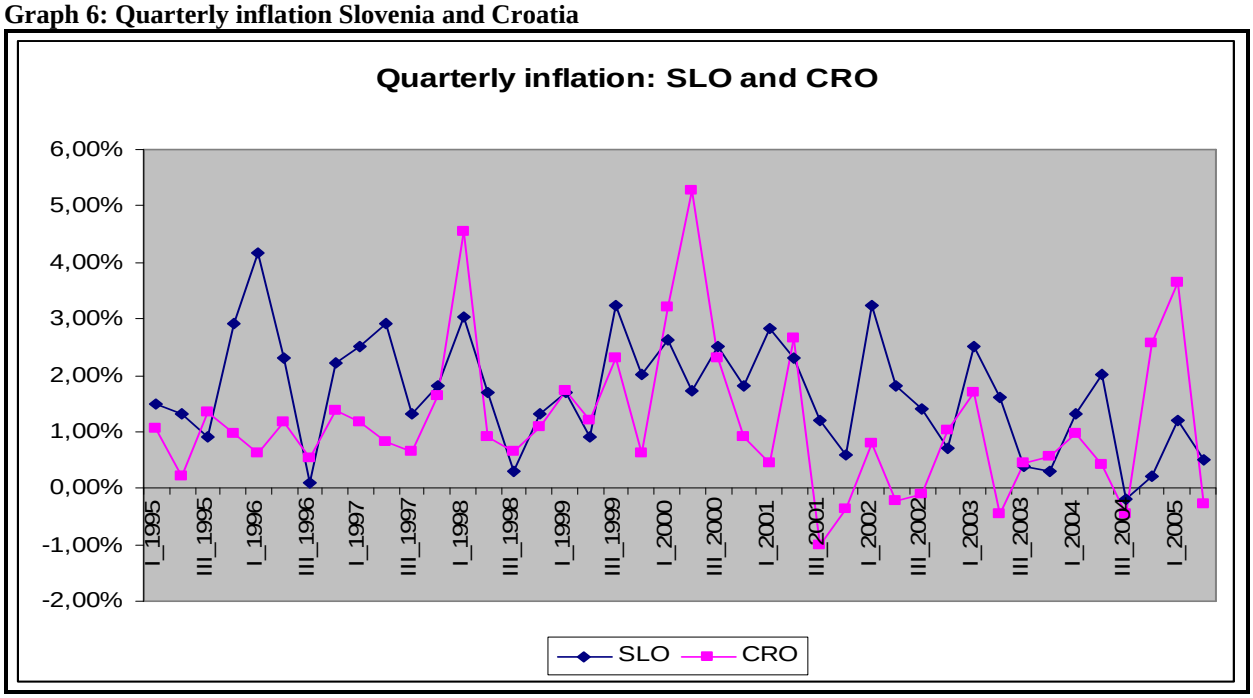
Under the fixed exchange rate the participants have no signal from the change in nominal exchange rate so all signals come from real shocks to the economy.

What is interesting in this graph is the fact the value of the z parameter in Slovenia is fairly stabile and as the Slovenia was approaching the EMU we can see the u parameter's values are going down implying the synchronisation of Slovenian inflation with the inflation in EMU.

Also some of the value of the z parameter for Slovenia might come form the lag effects of the nominal depreciation and the inflation pass through[21]. Perhaps the initial calculation of lagging just one period is not enough and more sophisticated econometric techniques should be used.

In Croatia we are seeing much larger magnitudes of oscillation in the z parameter. The z parameter is extremely inflationary in the third quarter of 1997 and deflationary in second quarter of 2001, when Croatia had the lowest inflation in last ten years.

**Graph 6: Quarterly inflation Slovenia and Croatia**



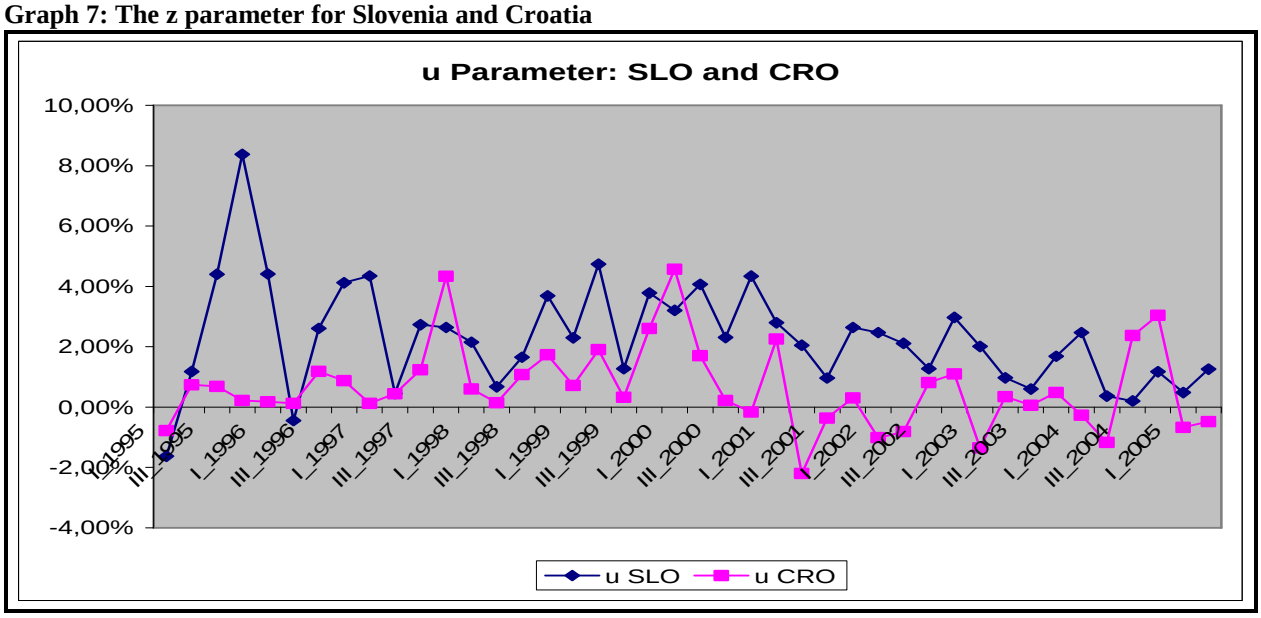

Source: CNB and Bank of Slovenia

[21] I am not concerning myself with the econometric challenges of the model, but rather the overall macroeconomic implications.

We are arguing Slovenia had one monetary regime and Croatia has two. If this is true the z parameter should have constant behaviour in Slovenia and two sets to patters in Croatian data. We are seeing this to be true. Except for one outlier in 1997 and 2000 the z parameter in Croatia is stabile and in range from 0 to 2% in the period from 1995 to 2005. After the regime switch the behaviour of the z component changes as well.

We see a radical change in the behaviour of parameter once Croatia moves to the fixed exchange rate system. The z parameter becomes much more volatile.

**Graph 7: The z parameter for Slovenia and Croatia**




Source: Author's calculation

## 4.2 GDP Growth rates

What policy making is all about is the economic growth so that economic participants can have better living conditions now, not in the long run on the average.

In this paper there has been no mention of economic growth or how the growth rate of the economy shall respond to the choice of the monetary policy. The main reason for this is the hardness to determine what is the source of economic growth and here it is not enough to day the source of economic growth is for example consumption. We would also have to determine what part of consumption, from which the increase in consumption is coming from (households or government) and how it is financed.

We can see the issue at hand is very complex, that is the reason why we shall just look at the data and not draw any conclusions about how that growth was generated and what are the implications with the respect of the choice of the monetary policy and economic growth.

What is the most interesting fact about this table is the fact that both Croatia and Slovenia, on average have the same growth rate. One could us this as an argument that the monetary policy regime does not influence the growth rate, again we come to the need to investigate what is the source of economic growth before we make any strong conclusions.
We shall not look at the overall GDP levels, but rather at the growth rates:

**Table 4: Real GDP growth rates Slovenia and Croatia**

| | **SLOVENIA** | **CROATIA** |
|---|---|---|
| | | |
| **1995** | 4,11% | |
| **1996** | 3,73% | 5,9% |
| **1997** | 4,84% | 6,8% |
| **1998** | 3,87% | 2,5% |
| **1999** | 5,42% | -0,9% |
| **2000** | 4,10% | 2,9% |
| **2001** | 2,66% | 4,4% |
| **2002** | 3,45% | 5,2% |
| **2003** | 2,65% | 4,3% |
| **2004** | 4,17% | 3,8% |
| **2005** | 3,81% | 3,6% |
| | | |
| **ave** | 3,89% | 3,85% |

Source: CNB and Slovenian Central Bank

The year 1995 is taken out of the consideration for Croatia due to the war. But the war plays a very important factor in this analysis. Usually after the war the growth rates of the economy are very large[22]. The reason for this is the fact the growth rates are percentage and after the war economy starts from a very low level and has large reparation investments.

Destruction of Croatia during the war was very large and spread thought-out its territory, it would make sense to see larger growth rates then we see in a country that did not have large war destructions like Slovenia. Even today, 10 years after the war Croatian government is using approximately 1,5 billion euros per year for reconstruction of the war torn areas.

But after the war in 1995 and after peaceful reintegration of eastern part of Croatia in 1998 we are not seeing staggering growth rates.

[22] We are talking about percentages here.

Using this, rather dangerous development of discussion was could make conclusion the growth in Croatia is actually financed though government spending or through rise in foreign debt as we shall see in section 4,5. We could also make an argument the reason for lack of growth is a bad privatisation in Croatia, but without any significant evidence to any of those claims would not have any significance.

It would be also wrong to try and make an argument the growth rates are low because of the bad choice of monetary policy. But the fact of the matter is the growth rates in Croatia are unnaturally low for a country just coming out of the war and even in comparison with the other post socialist countries.

## 4.3 New capital formation

In section 3.4 I have argued the fixed monetary policy can lead to the suffocation of the industrial production. Under the fixed exchange rate appreciation the products made in the economy will become increasingly uncompetitive and the economy would slowly restructure towards companies oriented towards imports.

As it was presented in the aforementioned section the main choice of the entrepreneur is the choice between the production and imports. If the real exchange rate is appreciating over time a new business would be started as an importer, not as a producing business. The choice of new business has large implications for the creation of new capital, since producing companies are more capital intensive then the importing companies.

One might argue this is the hardest test for the model and the argument made in this paper. The argument went that under the flexible monetary policy the economy does not experience the real exchange rate appreciation. The changes in the value of nominal exchange rate off set the rise in inflation. In the long run when all nominal changes in the exchange rate are absorbed into the inflation, the real exchange rate is determined through the rise of inflation of the rest of the world. Under fixed exchange rate we are dealing with real shocks to the economy and real appreciation of the currency.

Due to this behaviour of the real exchange rate the rational entrepreneurs would turn towards the production of goods under the flexible exchange rate (with assumption the real exchange rate is depreciating). Under the fixed exchange rate (under the assumption the real exchange rate is appreciating) rational entrepreneurs would turn towards imports of goods.

In order for an entrepreneur to produce he would need capital and since we are dealing with a marginal entrepreneur the creation of capital in the economy oriented towards production should be large.

What do we expect to see from the data? Croatia had war and then a monetary regime switch. We should see in the date strong capital formation after the war and a drop in the new capital formation after the regime change in 2000.

Slovenia, constantly under the variable exchange rate should have strong capital formation thought the period. The capital formation should also be increasing over time and then have an inflection point since the rate of new producers entering the economy should be increasing and then decreasing.

The data we are going to analyse is taken from EUROSTAT and it is in constant 1995 millions of US dollars.

**Table 5: New capital formation Slovenia and Croatia**

| | **SLOVENIA** | **CROATIA** |
|---|---|---|
| | | |
| **1995** | 3553,8 | 2532,5 |
| **1996** | 3738,2 | 3336,1 |
| **1997** | 4196 | 4475,3 |
| **1998** | 4615,6 | 4143,6 |
| **1999** | 5467 | 3814,5 |
| **2000** | 5589,5 | 3447,5 |
| **2001** | 5351 | 3392 |
| **2002** | 5567,3 | 2909,8 |
| **2003** | 6130,5 | 2269,3 |
| **2004** | 6696 | 2344,4 |
| **2005** | 6636,5 | 2406,5 |
| | | |
| **SUM** | 57541,4 | 35071,5 |
| | | |
| **ave** | 5231 | 3188 |

Source: eurostat

As we can see from the data the model is absolutely correct. If we look at the sum of the total new capital formation we can see Slovenia has created more new capital in 10 years then Croatia. The level of capital formation is also significant. Slovenia has created 1,6 times more capital then Croatia in time span of ten years. Keep in mind that Slovenia also has about half of the population of Croatia. So if we look at the new capital formation per capita we get

astounding figures. In Slovenia the new capital formation per capita is 28770 1995 dollars and in Croatia 8 768 1995 dollars per capital. The magnitude of difference is 3,3 times.

The data points towards the fact the Slovenian economy was oriented towards new business that needed more capital[23]. Remember Table 2 (page 60) and the data on the structure of companies in Slovenia and Croatia. Table 2 (page 60) clearly shows there are more exporters in Slovenia then there are exporters in Croatia.

Again the data for Croatia is inconsistent. For a country just out of the war new capital formation would be essential in the process of reconstruction, but we are not see that in the data when compared with Slovenia. We are not seeing a surge in capital formation in 1995 or in 1998. But one thing should be noted the new capital formation is increasing in the period from 1995 to 1998. It begins to fall and in the period from 1997 to 2003 the growth rate of new capital formation halves. This sudden change in the values of the data has again implication for the regime switch and it substantiates the model.

In the previous section I have argued the low level of GDP can not be "blamed" on the bad monetary policy, but in this part of the paper this is not the case. The only reason why we are seeing what we are seeing in the data is the choice of monetary policy. Once the monetary policy is chosen the economy restructures over time. We see that in the Croatian data and in Slovenian data.

It would be interesting to analyse this data in five years time to see the impact the entrance into EMU will have on Slovenian economy and capital formation.

## 4.4 Imports and Exports

In this section we shall look at the imports and exports in Croatian and Slovenia. As noted in previous sections we are looking at the impact of choice of monetary policy on the economy. The data for exports and imports used in this section includes both goods and services.

If we see the real exchange rate appreciation, we should see a drop in the companies which are oriented towards production and exports. The opposite argument ensues in the case of the real exchange rate depreciation.

[23] Who has obtain the new capital, was it new companies or old companies expanding is not relevant for this argument. The main point is that there was need for new capital.

In section 4.3 we have seen how the Croatian economy has restructured towards the economy of importing companies. We have seen that in the data showing the new capital formation. In this section we shall focus on the actual export data.

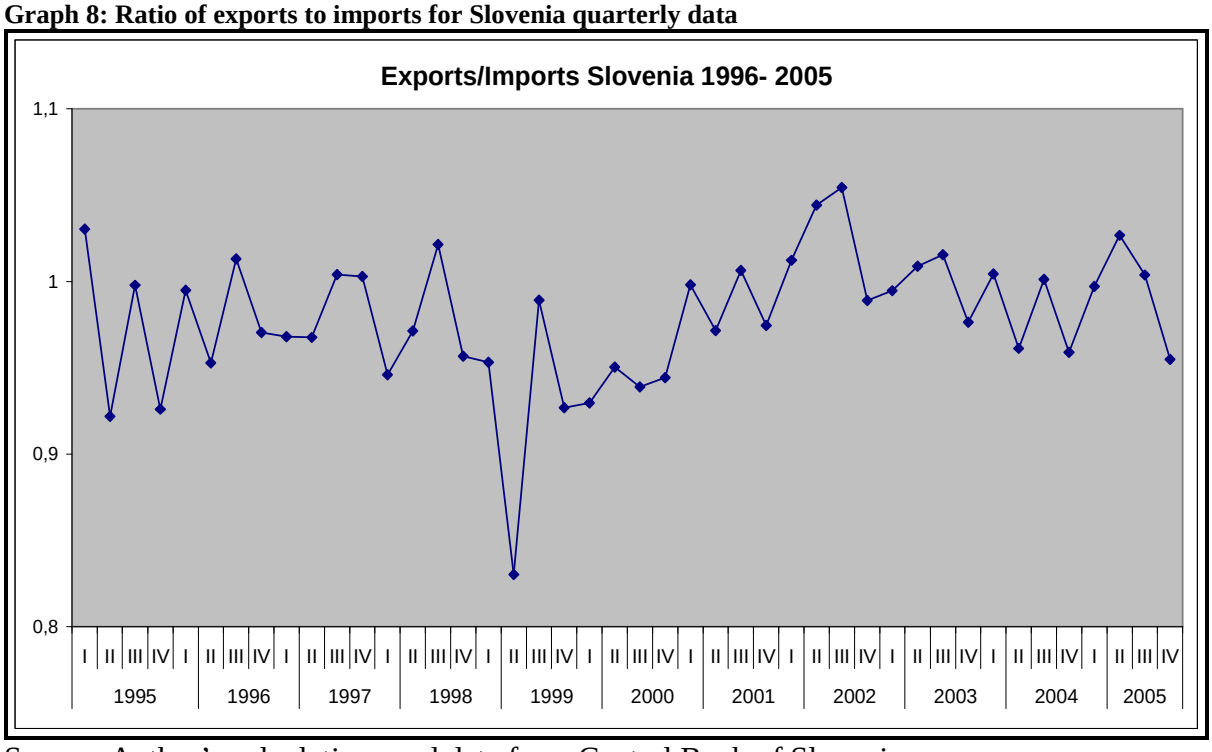
Going back to the section 3.1 we have seen that neither country has absolute increase or decrease in the real exchange rate. However we have noted Slovenia has less volatility in the real exchange rate and overall smaller real appreciation. Using this data we should see that neither country has a clear cut deficit or a clear cut surplus, however we should see a trade deficit on a smaller magnitude in case of Slovenia then in the case of Croatia.
The parameter we shall pay attention to is the coverage of imports by exports. As noted the data for imports and exports includes both goods and services.

We could use absolute level of imports and exports, but that would not tell us anything about the true implication of the imports and exports on the economy. The same problem is if we use a ratio of exports to GDP, or imports to GDP. These two parameters would only tell us the degree of openness of the economy. They would not tell us anything about the impact of current account of the economy.

Keep in mind we are also looking for an economic restructuring from importing towards exporting economy in the case of Slovenia.

The main reason for the use of this parameter is the relation of the trade deficit to the foreign debt and the parameter of foreign debt shall be analysed in the next section.

**Graph 8: Ratio of exports to imports for Slovenia quarterly data**



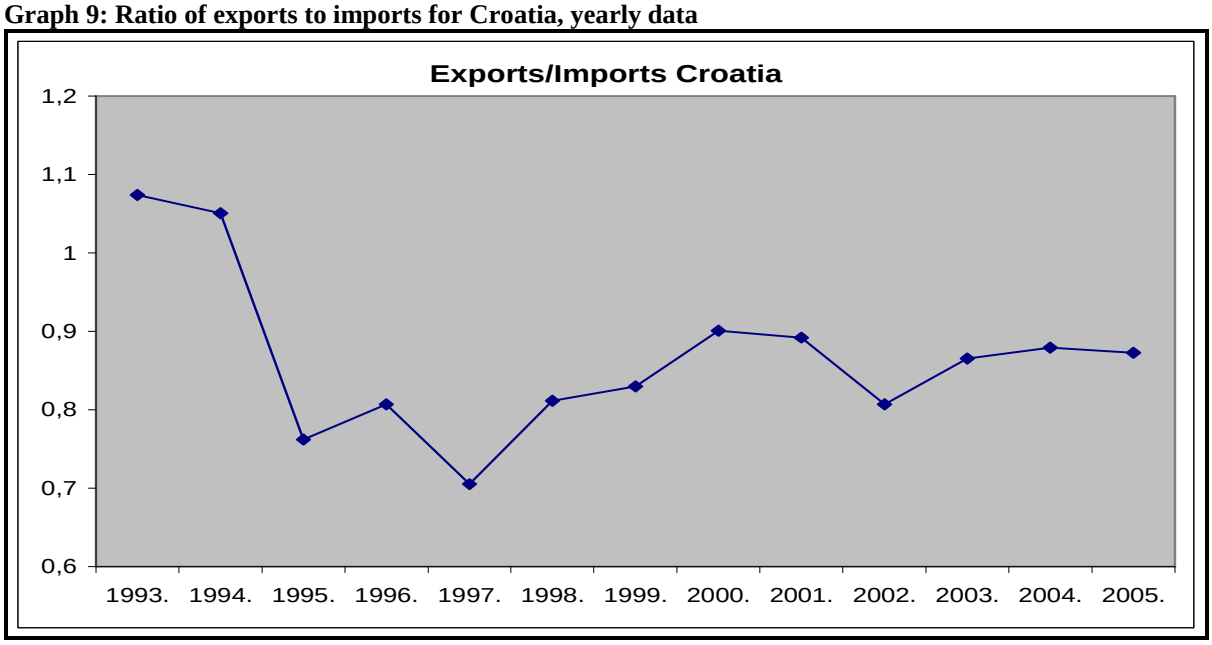

Source: Author's calculations and data from Central Bank of Slovenia

What we see in the data is consistent with the theory only to a certain point. In Slovenia the ratio of exports to imports is mostly constant and it is averaging 0,96. this implies there is no significant rise in the level of exports nor a decrease in the level of imports.

This data is somewhat negative to the model. We see the imports and exports are rising at the same rate, but there is no vast restructuring of the economy towards exports.

Another explanation can be that this ratio if looked from alternative perspective proves the points. Once the socialism was over Slovenia like any other post socialist countries was overrun by the western mechanise not available until the fall of socialism, so the fact the ratio of imports and exports is the same means the domestic exporters were able to handle the rise in demand for imports due to the change of trading polices and were able to off set the rise in demand for imported goods by increasing their exports.

**Graph 9: Ratio of exports to imports for Croatia, yearly data**




Source: Author's calculations and data from CNB

In Croatia on the other hand we are seeing a constant level of average 0,86. What is interesting here is the shape of the curve. It moves from very positive to negative, from +1,07 in 1993, to 0,7 in 1997. This has a simple explanation. The war in Croatia was over in 1995 the whole territorial integrity was achieved in 1997 and Croatia opened towards the world and new imports flooded the market. The explanation for this is the same as in Slovenia. New goods, previously unavailable in Yugoslavia became obtainable, this naturally caused the imports to rise.

After 1997 the index rises to the level of 0,8 and it stays there for the rest of the period. It would be very tempting to conclude the model fails here. After stressing the real exchange

rate and the impact of the flexible exchange rate so many times looking at the graph 9 it seems the model is defunct. But that is not the case. Please keep in mind we are including the services in exports. Tourism is included into exports as a service! It is correct to conclude the rise in tourist activities was able to off-set the rise in imports, so this data does not affect the model. If we look at exports and imports and exclude the services (tourism) we get the average of 0,5 in the time period 2000-2005. This fact dramatically reverses the data and actually supports the model.

## 4.5 Foreign Debt

The issue in this section presents the most important problem for a small open economy. A small economy is not self-sufficient, as such it has to import and export goods. The trade with the rest of the world for a small open economy does not present just economic activity but also a survival.

As we shall see in the analysis of the data as much as free trade is necessary for a small open economy if uncontrolled it can present large problems for the capital structure of the economy and development of that economy as well.

In the global world like the one in which we live it is paramount for a small open economy to have free flow of goods and services. Openness to the free flow of goods and services also leads to the free flow of capital.

But as small economy does not have the freedom to control the flow of goods and services[24] it does have some limited ability to control the flow of capital in and out of the country. Some countries have restrictions of inflow, some on outflow, some of both. Croatia has marginal reserve requirement , a special reserve requirement for non resident funding the banks obtain.

Croatia has limitations on the outflow of capital for its citizens. There are limits to how much money can be taken across the border and how much money can be sent through bank wires.

The purpose of this section is to look into the impact of the choice of the monetary policy and its relation to the foreign debt.

We are going to have three segments of analysis; the two monetary regimes in Croatia and one in Slovenia. We can expect the changes in foreign debt in Slovenian and in Croatia under the flexible exchange rate are the same. However there should be a radical change in foreign

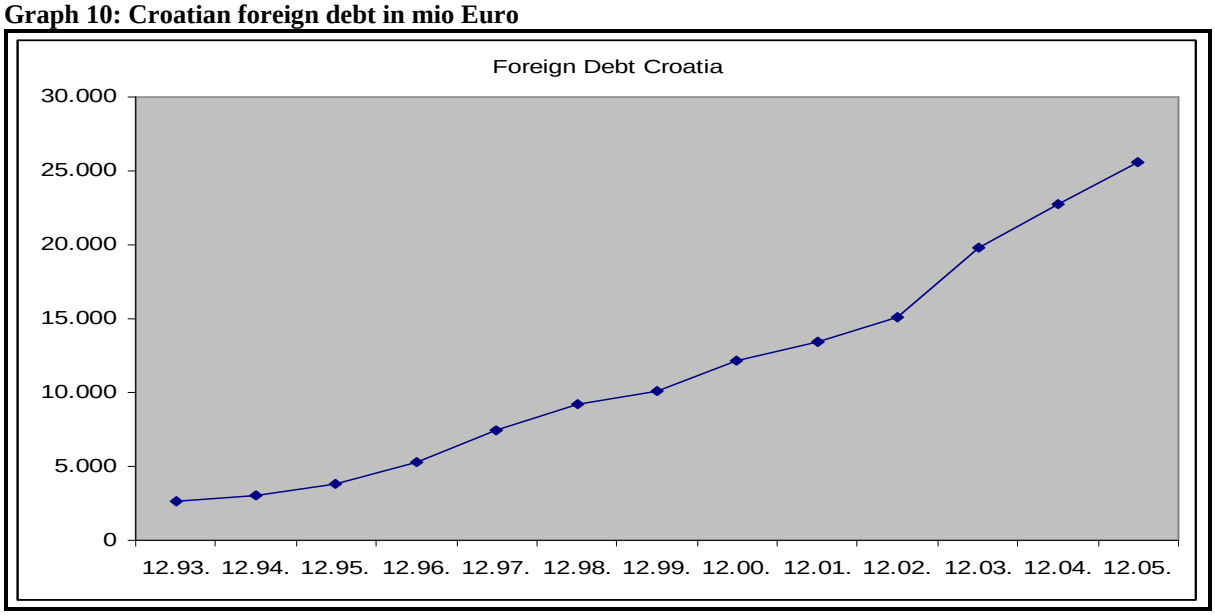
[24] If the country is a part of the WTO the flow of goods is controlled by the WTO agreement and services are free to flow, as long as they are legal.

debt in Croatia after 2000 and in Slovenia in 2005 once the exchange rate got fixed in preparation for the EMU.

As we saw there is a large current account deficit in case of Croatia. The basic economic theory tells us the current account deficit has to be financed with the capital account surplus (foreign debt) and as we are seeing in the data this is absolutely correct. The foreign debt in Croatia has been steadily rising and it has reached alarming levels.

As of June 2006 foreign debt in Croatia was 85% of GDP and it was not showing any sings of stopping. As we can see from the model and in the data there is nothing mystical about the situation in Croatia. The state of the imports, exports, foreign debt it is all a very simple circle.

**Graph 10: Croatian foreign debt in mio Euro**




Source: Source CNB.

The cycle can be described as follows: fixed exchange rate has led to supply side shocks in the economy increasing the rate of inflation above the rate of inflation in the rest of the world; this has led to the real appreciation of the currency. The direct effect of the real appreciation was the substitution of domestic goods for foreign goods, as the households noticed the foreign goods are relatively cheaper then the domestically produced goods. Substitution effect has increased the demand for imports, thus increasing the trade gap. Since Croatia in the long run can not finance the trade gap, it has to obtain the money somehow and the only way to do obtain money was through the foreign debt.

So one thing has led to the other, real depreciation has also led to the change in the business climate and switch of companies from production to the importing of goods even further

worsening the current account and increasing the foreign debt from the business side of the economy.

The model presented this correlated recursive relationship between the choice of the monetary policy and the behaviour of the participants in the economy. Given what was presented here the economic facts we are seeing from the data should not be concerning at all. In fact the economic indicators should have been expected by the Croatian monetary and fiscal authority, because they were the direct result of the monetary policy choice.

Now we shall look at foreign debt in two periods, the first period is from 1993 to 1999. The second period is from 2000 to 2005. As we can see the foreign debt in that period has doubled. So in time span of six years, under the flexible exchange rate the foreign debt did not rise significantly. It should also be noted the main source of the rise in foreign debt was the government which was issuing bonds.

The second period 2000-2005 however is vastly different. In time span of seven years the foreign debt has increased three times. In this time the main source of foreign debt were companies and banks.

There is nothing surprising in the data. Under the flexible exchange rate there was a strong stochastic element, as the model points out against the foreign debt. The only entity with unlimited amount of money was the government and the government was not susceptible to the foreign exchange rate risk. It can always print more money.

Once the currency risk was removed the inflow of capital into the economy started. Remember the main distinction between the fixed and the flexible exchange rate model is the fact that under the flexible exchange rate model there is a stochastic element, under the fixed exchange rate model there isn't one.

This stochastic element can easily be seen in the treatment of credit. If the foreign banks are importing capital they will need a currency risk protection. Under fixed exchange rate they do not need this protection, but under the flexible exchange rate they have to hedge their positions. The banks usually do this by transferring the exchange rate risk on clients by giving loans in foreign currency clause, effectively transferring the exchange rate risk onto the client. When there is stochastic barrier imposed the households shun credit, because they have no protection against the exchange rate risk, we see this in the stochastic bellman equation (eq. 42 page 55)

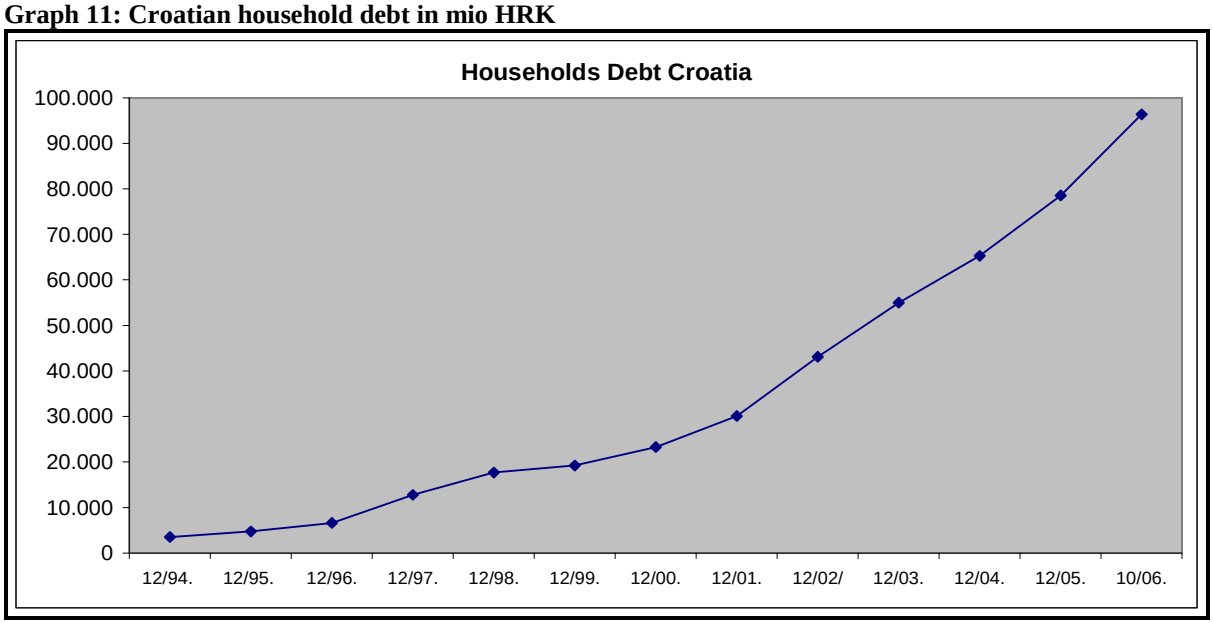
Once the exchange rate barrier is removed, the bellman equation looses its stochastic component and the households have no uncertainty about their consumption and their debt. In this economic set up they can obtain credit and know the real value of their remaining credit balance in the next period.

What the model is telling us is that we should see a sharp change in the rise of household credit when there is a regime change.

In this case we are looking at the foreign debt, because that is the way the banks are going to fund their loans to retail clients. But if we look at the household debt data in Croatia we can see the same patter.

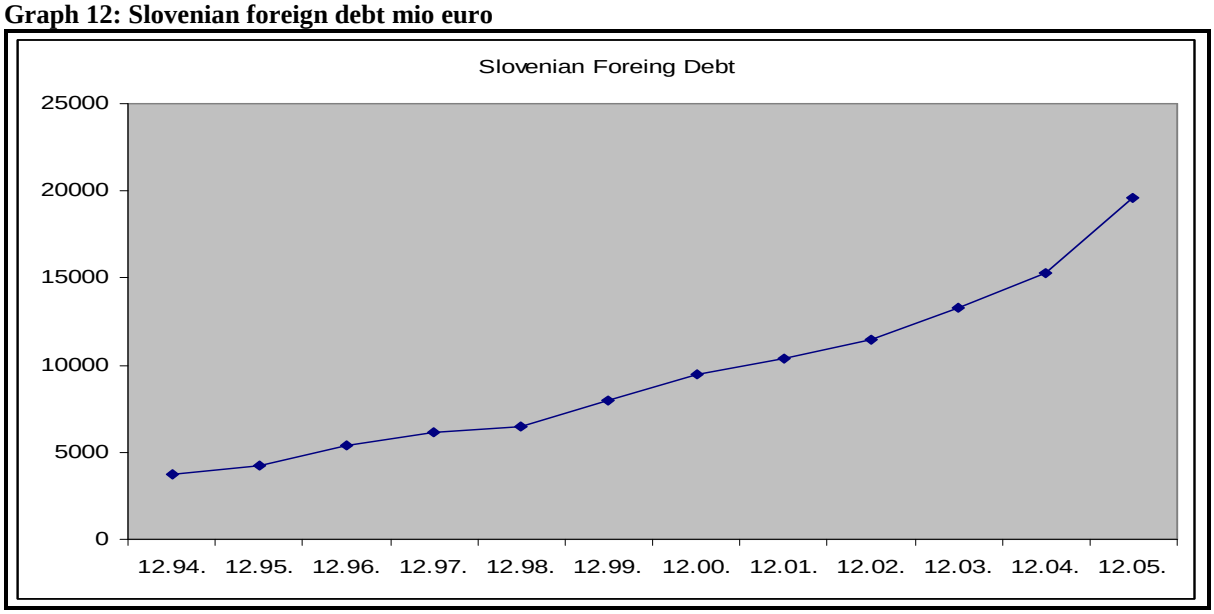
As we can see there is a rise in the loans to households in every period, but the sheer magnitude of rise in HRK is simply astounding.

**Graph 11: Croatian household debt in mio HRK**




Source: CNB

**Graph 12: Slovenian foreign debt mio euro**




Source: Slovenian statistical institute

As expected we clearly see and inflection point in 2000 when there was a regime change. Here we are seeing another validation of the model in the data.

Seeing the actual numbers of foreign debt might give us another perspective on the matter. Table with the data gives us a much clearer perspective on the problem:

**Table 6: Croatian and Slovenian foreign debt (gross)**

| | CRO | SLO |
|---|---|---|
| **12.93.** | 2638 | |
| **12.94.** | 3020 | 3706 |
| **12.95.** | 3809 | 4275 |
| **12.96.** | 5308 | 5380 |
| **12.97.** | 7452 | 6166 |
| **12.98.** | 9173 | 6459 |
| **12.99.** | 10101 | 8012 |
| **12.00.** | 12109 | 9491 |
| **12.01.** | 13458 | 10403 |
| **12.02.** | 15055 | 11484 |
| **12.03.** | 19811 | 13256 |
| **12.04.** | 22781 | 15271 |
| **12.05.** | 25541 | 19565 |

Source: CNB and Slovenian Statistical Institute in million of Euros

The same analysis can be done on the Slovenian data. If we look at the Slovenian data the foreign debt is increasing as well thought the period, but what has to be noted is the rate of the rise in the foreign debt.

While Croatian foreign debt has risen from the end of 1994 until the end of 2005 8,45 times. In Slovenia it rose by 5,27 times. If we exclude 2005 since in this year Slovenia was on the fixed exchange rate regime the growth of foreign debt falls to 4,12 times in the time span of 10 years.

Again we are seeing another validation of the model. We have completely opposite behaviour of the foreign debt under two alternative monetary regimes.

However the absolute values of foreign debt are not telling us much about the state of the economy and its relationship to the foreign debt. In order to fully understand the relationship of foreign debt to the economy we need to look at the ration of foreign debt to the GDP (table 7 page 77).

As expected the ratio in Croatia is much worse. It should also be noted that ratio in Slovenia has significantly worsened once Slovenia started to adjust for the EMU and it has to fix its exchange rate. In 2004 and 2005 we can see a clear change in the growth of the foreign debt. The implications of the rise in foreign debt are far reaching to put it mildly.

**Table 7: Croatian and Slovenian foreign debt as percentage of GDP**

| | SLOVENIA | CROATIA |
|---|---|---|
| **1993** | | 24,20% |
| **1994** | | 20,70% |
| **1995** | 29,44% | 20,20% |
| **1996** | 34,42% | 26,70% |
| **1997** | 36,58% | 37,10% |
| **1998** | 34,90% | 47,60% |
| **1999** | 40,66% | 54,10% |
| **2000** | 47,13% | 60,60% |
| **2001** | 47,43% | 60,70% |
| **2002** | 49,35% | 61,50% |
| **2003** | 53,97% | 75,50% |
| **2004** | 58,57% | 80,20% |
| **2005** | 71,46% | 82,50% |

Source: CNB and Slovenian Statistical Institute in million of Euros

Debt is something that has to be paid off. It represents a burden on the households and companies of individual economies and it presents future decrease in consumption and disposable income.

One thing has to be noted, foreign debt is not an economic variable, but an accounting one. It just represents the net summation and accumulation of the inflows and outflows from one country, due to this nature of foreign debt as such, it is not possible to decrease foreign debt though conventional measures like CNB is attempting to do through reserve requirement restrictions on non resident funds. The foreign debt is a necessary by-product of a monetary regime. The only way to decrease foreign debt is to change the very thing that is causing foreign debt to rise and that is: fixed exchange rate monetary regime.

What we have noted in this section there is that nothing surprising in the data. We have two opposite monetary regimes and two opposite effects. It would be really surprising to see the same rate of rise in foreign debt in both Slovenia and Croatia. In that case there would be something wrong with the theory, but what we have in this case is that the data completely confirms the economic theory and vice versa.

## 4.6 Final word on real life implication of the model

In this section we have analysed inflation, imports and exports, growth rates, new capital formation and foreign debt in order to see how does real life economic data compare with the theoretical assumptions of the model.

In all the data we have found confirmation of the theory presented in the model expect in the level of exports and imports.

The data from imports and exports slightly negates the model. The model predicts a rise in exports and fall in imports for Slovenia, however we are seeing the ratio of the two remains the same and close to one in the case of Slovenia. In Croatia the ratio remains the same as well for the most of the period, but the average is around 0,8.

All other aspects of the data analysed are pointing out to the validation of the model. We see a strong new capital formation in Slovenia and slow rise in foreign debt. In Croatia on the other hand we see small rise in new capital, much smaller then in Slovenia and a huge rise in foreign debt.

This brings us back to the analysis of growth of GDP. As already noted it is highly speculative to decidedly blame one economic parameter as the reason for growth rates we are seeing in the data. However some notes should be made. We see that the averages of growth are same for both countries; however the volatility of growth rates in Croatia is much larger. Also peak growth rates of Croatian GDP are in times of the largest increase of foreign debt. I am not saying the growth rates are caused by the increase of foreign debt, but without more research and modelling this can not be totally excluded.

In the end we have to note the data is supportive of the model.

# 5. CONCLUSION

This paper looks at the importance of the actual choice of the monetary regime for a small open economy. In a big closed economies we have the problem of conducting the monetary policy and the interplay of the monetary authority with the economy and economic participants. This interplay has been described in the "Conquest of US Inflation" by Thomas Sargent in (Sargent 1999). The monetary regime is tied to the control of inflation thorough the control of monetary aggregates, interest rates or inflation targeting. In a small open economy the monetary policy is tied to the control of the exchange rate. There are principally two regimes: fixed and floating.

A small open economy is not only faced with the actual conduct of the monetary policy, but also the choice of the monetary policy. As demonstrated in this paper the choice of the monetary policy has effect of the whole future path of the economy.

The two main monetary policies are the fixed exchange rate, in which the central bank is trying to keep the currency inside some determined band or precisely fixed. The second alternative is the variable monetary policy in which central bank is constantly depreciating the exchange rate.

The focus of the paper was not to try to create one model and then test it on the data, but to create two alternative models, one for each monetary regime and then test them on the data.

The main foundation of the paper is the building blocks of the households and the business firms in a small open economy. These economic participants are faced with the monetary policy determined for them exogenously by the central bank. It is assumed each choice of the monetary policy creates an alternative economic set up.

The paper explores the behaviour of the economic participants under alternative monetary regimes and finds the underlying behaviour of the economic participants. The model uses monetary policy as a sort of system definition. The choice of monetary policy in effect determines the frame in which the economic participants have to be modelled. Since we are dealing with two economic set ups we also have two models. One for each set up

The model used here is the rational expectations model. There are three main reasons why rational expectations are used. The first reason is the fact rational expectations provide an easy framework for the solution of models with forward looking agents. The second reason is the easiness how the rational expectations can be combined with the dynamic programming tools. The third is the fact that there are no time lags in the change in the behaviour of rational agents once the monetary regime changes. The change in the behaviour of rational agents is instantaneous. Once the regime changes so does the behaviour of economic participants.

The rational expectations have the implicit assumption the expectations of economic participants are endogenous, in modelling and econometrics this is manifested though the cross equation restriction. This restriction is the fundamental for solving the rational expectations models. The second fundamental property of the rational expectations is the implication of the Lucas Critique, which is best manifested in the changes of the monetary policy regimes. The implications of the Lucas Critique and the cross equation restriction are best manifested empirically and can be found in Sargent's "The End of Four Big Inflations" (Sargent 1986 p. 40-110).

Behaviour of both households and consumers in the model is conditioned on the real exchange rate. It has been demonstrated under the fixed exchange rate regime the real exchange rate is much more susceptible to the real appreciation. The real appreciation leads households to purchase foreign goods, since they are cheaper. The real appreciation also leads firms to orient towards importing and not production of goods. This process caused by the fixed exchange rate regime leads to the increase in foreign debt and overall destabilization of the country.

The outcome of the model is that the flexible exchange rate monetary regime is vastly superior to the fixed exchange rate regime. Fixed exchange rate regime leads to foreign debt, destruction of the producers, creation of the importers and large trade deficits; on the other hand the flexible exchange rate regime gives the monetary authority the tools to fight the real depreciation and offsets the above described pattern.

The findings of the paper are not only theoretical, but are also supported by the economic data. In order to make the data compatible I had to use two countries similar in economic size, with a similar economic history and different monetary regimes. I have used as an example Croatia and Slovenia. In the most of the time periods observed Slovenia has had flexible monetary regime of the depreciating exchange rate. Croatia has had two monetary regimes, up to 2000 flexible exchange rate regime and fixed exchange rate regime from year 2000 onwards.

Most of the predictions from the model are clearly seen in the data. Slovenia has had smaller real depreciation of the currency, smaller foreign debt, more new capital created, more firm oriented towards production.

As predicted in the model, in case of Slovenia flexible exchange rate regime has opened room for the businesses interested in the production of goods instead of importing of goods. This can be seen in the amount of the newly created capital.

The export to imports coverage ratio for Slovenia is also around 1 (imports are completely covered by exports). On the other hand this ratio in Croatia on average is about 0,8, and it should be noted the main reason for this rate of coverage is the exports of services, in case of

Croatia that is tourism. The fixed exchange rate in Croatia has led to the massive explosion of foreign debt in Croatia. Also in Croatia we are observing a very small amount of the newly created capital (in comparison with Slovenia) indicating most of the new business started is in fact oriented towards imports not production.

All this information leads to just one conclusion: **the fixed exchange rate regime is fatal for a small open economy.** This assertion was made theoretically in the model, but it was also supported by the data.

The models and the consequences of the data are not important from the historical perspective only. It would have been better to choose the flexible exchange rate regime, like Slovenia did instead of the fixed exchange rate regime, like Croatia did.

The main question asked in the introduction to this paper was the question: what is the importance of the monetary policy?

The paper, in its introduction argued the choice of the monetary policy has a fundamental importance for the future path of the economy, especially a small open economy. I believe that I have presented a clear argument about the importance of the correct pick of the monetary policy. As we saw in both the model and in the data the economic developments under certain monetary policy exchange regime are nothing new or stunning, in fact any economic development under both monetary regimes could have easily been predicted.

The economic data from either of the regimes is completely natural and it would have been astounding to see the data in any other direction other then was presented.

At the same time the purpose of this paper was not to serve as a historical analysis of monetary policy in two countries, but as an introduction to the choice of the monetary policy for future research.

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