A Note on the Dynamics of Inflation Expectations in Sweden 1981-2008

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Abstract

The recognition of inflation expectations as central to the understanding of inflation dynamics has become increasingly important in recent years. In this study, we use a structural VAR similar to that in Mehra and Herrington (2008), to provide insight in the sources of movements in inflation expectations in a Swedish context during 1981 - 2008. Using a survey measure of expected inflation generated by the general public, we examine the elasticity of inflation expectations to changes in certain macroeconomic variables. We also seek to identify possible changes in the dynamics of inflation expectations during this time period. We find that expected inflation moves in an intuitive manner in response to shocks in expected inflation itself, actual inflation, commodity prices, unemployment and a short-term nominal interest rate. Shocks to expected and actual inflation as well as unemployment are found to be the most important sources of variability in inflation expectations. Before 1995, which was the year the Riksbank committed to inflation targeting, the responses of expected inflation to macroeconomic shocks are stronger and more long-lived than in the latter time period. These results indicate that inflation expectations have become increasingly anchored.

***Keywords**: inflation, inflation expectations, structural VAR*

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1 Introduction

Under its mandate, the Riksbank (the Central Bank of Sweden) seeks to obtain stability of prices by maintaining a low and stable level of inflation. The common notion, that price stability in itself is a good thing, is evident through a number of mechanisms. Experience has shown, that the public's confidence in the economic system and monetary policy is undermined by high and persistent inflation. Furthermore, inflation may have negative effects on productive activities that are sensitive to expectations about economic stability, such as risk-taking and investment. In the longer run, low and stable inflation facilitates growth, efficiency and stability – which, all else being equal, promotes the achievement of efficient resource utilisation (Bernanke 2007).[1]

What causes inflation has been carefully studied in the economic literature. Most economists today agree that in the long run, inflation can be explained by the growth rate of money supply. In the shorter run, inflation may however be influenced through a number of channels, such as supply and demand pressures in the economy as well as the relative elasticity of wages, prices and interest rates to the general development of the price level (Williamson 2008). A widely recognised framework in inflation analysis is the relationship between inflation and resource utilisation as illustrated by the Phillips curve. In this framework, inflation expectations occur as a key driving force behind actual inflation.

The intuition for how expectations can feed through to actual inflation, i.e. when expectations become self-fulfilling, can be thought of as if households expect a higher inflation rate, they will demand higher salaries corresponding to the increase in inflation. When salaries increase, companies' production costs rise and they may accordingly be forced to charge higher prices to compensate for the increased costs. This may create a price/wage spiral through which increased inflation expectations may lead to a persistent increase in actual inflation. Inflation expectations may also

[1] Since it is difficult to measure the long-run relationship between growth and inflation, it is possible that low inflation, to some extent, has followed good economic performance. It is nevertheless evident that inflationary policies intended to promote long-run employment growth have led to poor outcomes whenever they have been pursued (Bernanke 2007).

feed through to actual inflation through the households' savings decisions. For a given nominal interest rate, higher expected inflation implies a lower expected return on saving. Hence, spending today tends to become relatively more attractive to saving, generating a demand pressure that may lead to inflated prices. Arguably, self-fulfilling expectations may not only be initiated on a household level, but can also be spurred by price setters. Companies need to assess the expected development of the price level of competing products in order to estimate the likely demand for their own products. Expectations about higher prices may consequently induce companies to raise their own output prices (Bank of England 2008). Consequently, it is crucial for policymakers to monitor and to understand the dynamics of inflation expectations, since these may lead to a persistent increase in actual inflation, which obviously makes it difficult for the Riksbank to achieve its objective of price stability.

The recognition of expectations as central to the understanding of the behaviour of the aggregate economy has grown in importance over time. This is reflected in the way central banks closely follow the development of inflation expectations and regard it as an important input in their monetary policy formulations.[2] Furthermore, Mishkin (2007) suggests that a natural first place to look for explanations of changing inflation dynamics is a possible change in the expectations-formation process. Bernanke (2007) also points out that a deeper understanding of the determinants and effects of the public's expectations of inflation could have significant practical payoffs. This may include an improved ability by central banks to assess their own credibility and to evaluate the implications of their policy decisions and how these decisions are communicated. Furthermore, improved knowledge of how inflation expectations react to changes in macroeconomic variables can serve as useful input in models describing the inflation process. Models of this kind are frequently used by central banks for forecasting and policy analysis. For other agents, like investors, an understanding of inflation expectations may be a valuable input for assessing the attractiveness of investment opportunities.

It is in light of these developments this thesis intends to provide insight in the sources of movements in inflation expectations. We also seek to identify possible changes in

[2] The importance of inflation expectations for monetary policy formulation is highlighted in numerous publications, such as Riksbanken (2008), Bank of England (2008) and Bernanke (2007).

the dynamics of inflation expectations. In a recent paper, Mehra and Herrington (2008) use a structural VAR to determine the influence of some macroeconomic variables on a survey measure of expected inflation in the United States. We will build on this study, but focus on Swedish conditions. Given the many differences between the Swedish and U.S. economies, we believe that the use of Swedish data is motivated.

We find that expected inflation moves in an intuitive manner in response to shocks in expected inflation itself, actual inflation, commodity prices, unemployment and a short-term nominal interest rate. Shocks to expected and actual inflation as well as unemployment are found to be the most important sources of variability in inflation expectations. Before 1995, which was the year the Riksbank committed to inflation targeting, the responses of expected inflation to macroeconomic shocks are stronger and more long-lived than in the latter time period. These results indicate that inflation expectations have become increasingly anchored.

The thesis is structured as follows: Section two introduces the reader to some theoretical frameworks that are of importance in order to better understand the formation process and relevance of inflation expectations. We also reproduce the main findings of related previous research and motivate any confinements of our study. In section three, we describe the methodology deployed, section four presents our empirical results and section five includes a critical discussion.

2 Theoretical Background and Previous Research

2.1 Expectations

The recognition of expectations as fundamental to many segments of macroeconomics has resulted in a number of different theories that seek to explain how expectations are formed. The most integral theoretical frameworks treat expectations as either adaptive or rational.

Adaptive expectations mean in essence that people form their expectations about the future, based on what happened in the past. The adaptive expectations hypothesis can be traced back to Fisher (1930), but was formally introduced in the 1950s in e.g.

Cagan's (1956) study of hyperinflation. The notion of adaptive expectations played an important role in macroeconomics during the 1960s and 1970s.

The adaptive expectations framework was however found unsatisfactory by many economists, who argued that a fixed autoregressive representation might lead to systematic expectation errors and thus provide poor forecasts in certain contexts. Furthermore, no knowledge about how economic agents are believed to behave in the future is incorporated, for example how economic policy is assumed to be conducted. The shortcomings of such a model for policy evaluation were emphasised by Lucas (1976) and as a response, a rational expectations theory gained in popularity in macroeconomic research in the 1970s and 1980s. Rational expectations basically assumes that agents make forecasts that are not systematically biased, but correct on average, taking into account all available information. The rational expectations theory was originally formulated by Muth (1961) and during the 1970s Lucas (1972), Sargent (1973) and Sargent and Wallace (1975) introduced rational expectations in a macroeconomic context. This framework has been very influential in macroeconomic research in recent years.

The assumption that individuals have access to and process all available information in a perfectly rational way has prompted researchers to develop models that relax these assumptions. This may for example be due to the fact that information is costly to obtain and process. Instead, economic agents may use a model that lies somewhat in between purely adaptive and rational expectations. Mankiw, Reis and Wolfers (2003) suggest a sticky-information model, in which economic agents update their expectations only periodically due to costs of collecting and processing information. Other approaches incorporate learning behaviour in the expectation-formation. Influential works in this field is adaptive learning models by Evans and Honkapohja (2001) and Orphanides and Williams (2005).

There is still no consensus in how expectations are formed and the field is under continuous development. As indicated above, finding a true model for how inflation expectations are formed is likely to be very difficult, especially given the heterogeneity of forecasters.

2.2 The Phillips Curve and Anchoring of Inflation Expectations

Today, economists referring to the Phillips curve generally mean the link between inflation and some measure of output. This is a modification of the original Phillips curve, first emphasised in Phillips (1958). Early extensions of the Phillips curve were confident that there was a permanent trade-off between inflation and unemployment (Samuelson and Solow 1960). Later research contended that there was no such trade-off in the long run, although inflationary policies in the short run may have a stimulating effect on employment. This framework, known as expectations augmented Phillips curve, was introduced by Phelps (1967) and models of this kind included expectations in the specification. As discussed above, it was initially assumed that agents' expectations were adaptive. Later works on the Phillips curve modelled expectations as rational in combination with flexible prices and instantaneously clearing markets. In the New Keynesian literature, rational expectations have been combined with sticky prices and nominal rigidities, see for example Clarida, Galí, and Gertler (1999) and Blanchard and Galí (2007).

As noted above, when accounting for expectations in the Phillips curve, researchers have argued that there is a short-run trade-off between inflation and unemployment. In the longer term, however, rational individuals would realise that a policy seeking to decrease unemployment is inflationary. Individuals then revise their inflation expectations upwards, which would bring unemployment back to a natural rate. This problem becomes evident through the notion of time-inconsistency; for example, at an initial stage, the central bank may present a preferable rate of inflation and households form their expectations. Later, when expectations are formed, policy makers may opt to abandon the policy for short-term objectives like inflating slightly in order to reduce unemployment. If households realise this, they will adjust their inflation expectations upwards, resulting in a higher inflation and lower employment in the long run. The problem is often addressed by central banks by committing to an explicit inflation target, which is also the case in Sweden today. This helps the Swedish Riksbank to maintain a stable price level as it creates predictability and reliability (Williamson 2008). In the absence of an explicit target, households need to appraise the level of inflation based on the information they have. The explicit target is likely to guide households into what might be a good guess - a guess that is credible if households believe that the Riksbank will bring deviating inflation back to the target.

The Riksbank commits to meet the inflation target within a time period of two years, within which the inflation rate is allowed to vary by one percentage point. In a similar fashion, inflation expectations could vary in the short run whilst we would want long-run expectations to be relatively unaffected by variations in macroeconomic data. If, for example, households experience a shock to some important variable, short-run expectations may change but the long-run expectations should remain unaffected. When this is the case, we say that inflation expectations are anchored. Studies on American inflation expectations during the last 30 years have shown that expectations have become increasingly anchored, see for example Mishkin (2007), who contends that this is the most attractive explanation for recent changes in inflation dynamics. A recent study by Stock and Watson (2007) supports the notion of increasingly anchored inflation expectations, but indicates that the anchoring is imperfect in the U.S.

It is hence reasonable to claim that well-anchored inflation expectations are what could mitigate the price-wage spirals that translate expectations into higher inflation. When expectations are anchored, there is no need to revise prices or wages, since costs are assumed to level out in the longer term. Higher costs would then merely lead to a change in short-term relative prices. This is somewhat implied in the functioning of an inflation-targeting regime. As implied above, shocks to variables should be able to disturb the economic system in the short run, but an inflation-targeting central bank is committed to take the economy back to the long-run goal. A dual mandate or some other regime accounting for the real economy explicitly could have a tougher time building credibility, since it works with more ambiguous objectives (Gürkaynak, Sack and Swanson 2005). The notion that inflation targeting leads to more anchored inflation expectations is also supported by Levin, Natalucci and Piger (2004), who compare how survey measures of expected inflation behave between countries with and without an inflation targeting policy.

The reasoning above implies that it would be interesting to see what immediate effects changes in macroeconomic variables have on inflation expectations, but also to see whether the effects are long-lived. That could give an indication of how well-anchored inflation expectations are in Sweden, and consequently show how exposed the Swedish economy is to the expectations that breed inflation. This can also be expressed by pointing out that if expectations respond less to macroeconomic variables, and if actual inflation depends on these expectations, then inflation will be less sensitive to variations in this economic data, all else being equal. Noting that this sensitivity is what is often illustrated as the slope of the Phillips-curve, our attempts to understand the mechanics of expectations may thus make a note on the slope of the Swedish Phillips-curve (Bernanke 2007).

2.3 Survey Data as a Proxy for Expectations

Inflation expectations cannot be observed directly, but there are nonetheless a few measures available that can act as a guide in order to quantify inflation expectations. One commonly used and fairly straight-forward method is the surveying of professionals and the general public, but expectations can also be derived from the prices of financial market instruments that are linked to inflation.

Ang, Bekaert and Wei (2006) conduct a comprehensive analysis of different methods for forecasting inflation. They find that survey measures outperform time-series ARIMA models, regressions with real activity measures and term structure models in forecasting US inflation. Based on these findings, there is strong indication that survey measures of inflation expectations by the general public contain useful information for forecasting inflation. The approach of using survey data on inflation expectations as a proxy for expectations has also been done in a Swedish context by Hallsten (2000).

As pointed out above, the general public's expectations about inflation are arguably an important determinant of actual inflation, with well-grounded theoretical as well as empirical support. The use of survey measures could therefore serve as a highly relevant variable when studying the movements in inflation expectations.

2.4 Studies on the Movement of Inflation Expectations

In the absence of consensus of how inflation expectations are formed, researchers have tried to address these issues by studying models of how measures of inflation expectations respond to economic variables. The previously mentioned paper by

Mankiw, Reis and Wolfers (2003) employs single equation regressions that relate inflation expectations to several macroeconomic variables. They find that agents seem to under-react to recent available information, which is in line with the findings of Ball and Croushore (1995), also using a univariate modelling approach. Gürkaynak, Sack, and Swanson (2005) show that inflation expectations measured as the difference in yields between nominal and inflation-indexed bonds, respond to macroeconomic and monetary policy surprises instead of remaining unaffected. In a Swedish study, Jonung (1981) uses cross-sectional household survey data, and suggests that the public's knowledge about the historical behaviour of the price level, i.e. the perceived rate of inflation, plays an important role in the formation of inflationary expectations. Furthermore, it is concluded that demographic characteristics, in this case sex and age, are significantly related to perceived and expected inflation. This would imply that individual experience is an important determinant of inflationary perceptions and expectations and highlights that inflation expectations are likely to be heterogeneous among forecasters.

We argue, that the use of univariate regressions and cross-sectional data, are likely to be insufficient means of capturing the dynamics in the complex formation process of inflation expectations. Thus, a modelling approach that allows for richer dynamic interaction among variables will provide better estimates of the influences of macroeconomic variables on inflation expectations. Mehra and Herrington (2008), building on a study by Leduc, Sill and Stark (2007), address these issues using a structural VAR approach with an identification scheme based on the scope of information forecasters are assumed to have access to when forming their expectations. This methodology presents evidence on how shocks to macroeconomic variables affect inflation expectations and how persistent these effects are. For example, while studying the effects of an unexpected change in the instrument rate, policymakers may be interested in the magnitude of the impact as well as the time horizon of the influence. Working with a target horizon of two years, the Riksbank needs to comprehend this development in order to act in a timely manner. An additional strength of the VAR analysis is that it allows individuals to take both past and present developments into account when forming their expectations.

Mehra and Herrington (2008) find that a survey measure of expected inflation of professional forecasters moves intuitively in response to several macroeconomic shocks. Unanticipated increases in actual inflation, commodity prices, oil prices or expected inflation itself, imply an increase in expected inflation, whereas it declines if there is a temporary increase in unemployment. It is further concluded that the strength and durability of those responses, as well as their relative importance in explaining the variability of expected inflation, have changed over time. Shocks to actual inflation, commodity prices and expected inflation itself, have historically been three major sources of movement in expected inflation. The increases in inflation expectations following such shocks are large and long-lasting in their first sample period, ranging from 1953-79, but muted and short-lived in later sample periods. As an explanation to this pattern, it is put forward that the Federal Reserve accommodated exogenous movements in inflation expectations in the first sample period, but not in the second.

Whereas Mehra and Herrington (2008) provide useful insights on the response of expected inflation in an American context, we do not find any similar contributions explicitly addressing Swedish conditions. In many aspects, the Swedish experience deviates from that of the U.S. see for example Sandberg (1997). In recent history, Sweden has moved from a fixed to a floating exchange rate regime. Another interesting feature is the introduction of an explicit inflation target of the Riksbank. Furthermore, surveys of professional forecasters reflect in essence the views of companies. As pointed out in the introduction, increases in actual inflation may not only be generated via increased inflation expectations of professional agents, but may also be induced on a household level. Thus, exploring the movements of inflation expectations by the general public, in response to changes in macroeconomic variables, may provide additional insights not revealed using data of professional forecasters.

2.5 Confinements

In this study, we will specifically address how a survey measure of inflation expectations generated by Swedish households reacts to movements in macroeconomic variables. By building on the structural VAR suggested by Mehra and Herrington (2008), this study seeks to scrutinise the elasticity of inflation expectations to certain macroeconomic variables from 1981 to 2008. The choice of time period is restricted by the availability of survey data on inflation expectations. Furthermore, by dividing the time series, we may examine the development of expectation responsiveness over time. This is of particular interest since the Riksbank introduced an explicit inflation target within the time frame covered in our study.

We may hence formulate the following two questions:

1. How does a survey measure of households' inflation expectations in Sweden respond to changes in certain macroeconomic variables?

2. How has the responsiveness of a survey measure of households' inflation expectations to changes in certain macroeconomic variables evolved in Sweden during the time frame 1981-2008?

To put our findings in a broader context we will also discuss to what extent our results may be generalised.

3 Empirical Methodology

As outlined above, we believe that the most adequate method for the purpose of this study will be a structural vector autoregression (SVAR). We use impulse response functions to examine the responses of inflation expectations to temporary shocks in macroeconomic variables, including expected inflation itself. Further, we use forecast error variance decomposition (FEVD) to explore the relative importance of the variables in explaining the variability of expected inflation. The primary software used for our modelling purposes is JMulTi.[3]

The next section will give a brief introduction to SVAR analysis. Any reader familiar with this method may skip this section and move on to section 3.2 that presents our model without losing continuity.

[3] JMulTi (Java-based Multiple Time series software) is an open source program that was originally designed as a tool for certain econometric procedures in time series analysis, such as impulse response analysis with bootstrapped confidence intervals for VAR modelling. The underlying software framework is JStatCom and it was developed at the Humboldt-Univärsität zu Berlin. The program uses a Java interface that allows the user to run GAUSS programs (Lütkepohl and Krätzig 2004).

3.1 Introduction to SVAR Analysis

If we are unsure about the true relationship between economic variables, one way of describing a phenomenon is to let the time path of variables of interest provide us with deeper insight. Sims (1980) popularised the use of VAR models for this purpose, and it turned out that predictions generated by these models were surprisingly good. These models do not require a priori knowledge of the extent certain variables can be regarded as exogenous, instead, all variables that enter the model may be treated symmetrically. One advantage of VAR analysis is the ability to account for feedback in the economic system. As a general case, we may think about two variables, each being affected by its own past values and the other variables' current and past values. In this way, the dynamic interaction among variables can be analysed.

The use of VAR models for econometric purposes has, however, been subject to criticism. Without any reference to a specific economic structure the models may be difficult to interpret, since for example estimated coefficients do not have an economic meaning. Instead of focusing on the identification of autoregressive coefficients, Sims (1981) and Bernanke (1986) among others responded to this critique and introduced models that focused on the identification of errors in the system. These errors may be interpreted as exogenous shocks. A prerequisite for the identification of structural shocks is that certain restrictions are imposed in the estimation of some of the parameters. One way of restricting the VAR is to use a recursive system, so that there is no contemporaneous feedback from the restricted variables. In early VAR models, the design of these restrictions was, however, arbitrary and hence the restrictions imposed did not provide any economic intuition. In order to better depict reality, later research has made specific assumptions about the restrictions based on economic theory.

The SVAR allows us to extract impulse responses for each variable to shocks in any of the variables included in the model. More specifically, this enables an analysis of the effect of a one-time surprise increase in one variable with respect to another variable. Impulse responses trace out the effect over a time period, making the longevity of the shock identifiable. A useful complement to impulse response analysis is to study forecast error variance decomposition. This will tell us the proportion of variability in expected inflation that comes from a shock to a certain variable relative to shocks to the other variables.

3.2 Our Model

3.2.1 Choice of Variables

The natural first step in specifying our model is to determine which variables may have an impact on our survey measure of inflation expectations. Mehra and Herrington (2008) include inflation expectations, actual inflation, a commodity price index, the unemployment rate and a short-term nominal interest rate in their structural VAR. In addition, they use an oil shock dummy variable. We argue that these variables make economic sense for the purpose of our study as well. Furthermore, choosing the same variables would make any comparisons easier.

Starting off with inflation expectations itself, it is intuitive to claim that when households form expectations, they do this in relation to their expectations in previous periods. Perhaps even more intuitive, is that households are likely to form their expectations in relation to the development of the price level of goods and services they consume. It is likely that certain goods, especially those purchased more frequently, have a larger impact than goods purchased less regularly. Food and energy prices are often variables mentioned in this context. However, since individuals have heterogeneous consumption patterns it makes more sense to use an aggregate measure of the development of the price level for a typical basket of goods and services. Such a measure is provided by the consumer price index (CPI). The inclusion of subsets of the CPI, such as food and energy price indices, is disregarded for reasons associated with multicolinearity.

The connection between households' inflation expectations and commodity prices is arguably less obvious. The intuition is that increases in commodity prices may be passed on to consumer prices and that households anticipate this. The inclusion of a commodity price index is also regarded as standard in the literature (Leduc, Sill and Stark 2007).

Inflation expectations should furthermore respond to economic activity in some way. In this aspect, the unemployment rate is a possible choice, since pressure on the capacity implies price pressure. Specifically, if unemployment goes down, demand rises over supply so that households should expect a higher inflation rate. We could naturally think of other measures of economic activity, such as GDP. As pointed out by Leduc, Sill and Stark (2007), however, the use of GDP could lead to real-time data issues when measures of GDP are revised.

The inclusion of a short-term interest rate as a measure of monetary policy is also intuitive. A lower interest rate implies, for example, a lower cost of money, which should lead to an increase in demand and hence higher prices. Households understanding this mechanism should therefore revise their expectations about inflation in response to monetary policy actions.

Mehra and Herrington (2008) also use an oil shock dummy variable, accounting for the extreme movements in oil prices in times such as the 1973-Arab-Israel war. For the purpose of this study, we do not find it apt to employ this variable, since oil shocks during the time period under consideration are not easily identifiable. It would consequently be difficult to make assumptions about when oil shocks are of relevance. Furthermore, Mehra and Herrington (2008) conclude that there are no significant effects of oil shocks on expected inflation in recent time periods. This conclusion is also supported in a recent paper by Blanchard and Galí (2007), that examines the impact of oil shocks on actual inflation. It is important to note that the exclusion of the dummy variable does not affect the comparability of their study and ours substantially, since the dummy variable is treated as predetermined.

3.2.2 Data Measurement

Household inflation expectations are measured by the National Institute of Economic Research (NIER) and are published quarterly in the report *Hushållens Inköpsplaner* (The Households' Purchasing Plans). In this survey, 1,500 Participants are asked to predict the one-year-ahead inflation rate every quarter. We thus have quarterly data on the mean of expected annual percentage change in prices from 1980, which is the year NIER started to monitor households' inflation expectations. The measure is expressed as the mean value, but excludes extreme values. We move this measure four quarters ahead to align it with the inflation rate it is supposed to predict, hence the initial observation in our time series correspond to the first quarter of 1981.

Actual inflation is calculated through the annual percentage change in CPI, recorded by Statistics Sweden. CPI is constructed to include a representative set of consumer goods. The commodity price index is the S&P GSCI, which includes some principal commodities, weighted for their relative importance. Important components are crude oil (38 percent), natural gas (7.36 percent) and wheat (4.13 percent), but metals and livestock also make up notable parts. The index has been obtained from Thomson Datastream and we have calculated the annual percentage changes based on quarterly observations. The source of the unemployment rate data is the International Labour Organization. Finally, the nominal interest rate has been obtained from the Riksbank. We use a 30-day rate for *statsskuldsväxlar* (similar to T-bills), which represent the expectations on the control rate, *reporäntan,* for the relevant time period. This instrument was however not introduced until 1983. For the first two years, we therefore use the Riksbank discount rate. For this instrument, there is no clear maturity and the rate was changed when considered necessary. Using a quarterly average of this rate still provides a measure of short money.

The use of quarterly observations, as opposed to biannual as in Mehra and Herrington (2008), provides us with more observations for a given time period. This increases the precision of our model and consequently we consider this to be a strength of our study.

3.2.3 Two Sample Periods

In order to observe how the influence of the chosen variables on expected inflation might have changed over time, we split the time series into two sample periods. The choice of time periods must be done so that the underlying structure of the economy remains relatively similar throughout the sample period. In the first half of the time period considered in this study, the exchange rate of the Swedish krona was fixed in order to keep the domestic price level close to that of our most important trading partners. Despite this policy and several devaluations, prices and wages increased. This could partly be attributed to stabilisation policies that were too expansionary. In the end, the fixed exchange rate was not credible and the krona was allowed to float in 1992. The fixed rate that would anchor prices in the earlier period was replaced by the inflation-targeting regime in 1993-95, in which fiscal policy was to become more restrained and monetary policy would work independently to keep the price level stable (Riksbanken 2006). Strictly speaking, the inflation target was formulated in 1993 but during the first two years, the Riksbank was supposed to steer the economy towards lower inflation by other means, such as the control of money supply (Riksbanken 1993).

Consequently, the first sample period starts with the earliest available data in 1981 and runs to the end of 1994. The second sample period begins at the implementation of the explicit inflation target in the first quarter of 1995 and ends in the third quarter of 2008.

3.2.4 Model Specification

Like the model suggested by Mehra and Herrington (2008), our specification takes its economic intuition from the design of the survey and the timing of when information becomes available to forecasters. Such a setup allows us to identify exogenous movements in expected inflation. In order to see this, we may first look at an unrestricted model that allows for contemporaneous feedback among the variables. π_t^e is the households' inflation expectations, π_t is the actual inflation, cp_t is the annual percentage change in the commodity price index, ur_t is the unemployment rate and sr_t is the short term nominal interest rate. For illustrative purposes, we show the notation of a model using one-period lagged values of all variables.

Expressed with matrix algebra, we may write the system as:

$$BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + \varepsilon_t, \tag{1}$$

where X_t is a 5×1 vector of our variables; B, Γ_0 and Γ_1 are 5×5 matrices of structural coefficients; and ε_t is a 5×1 vector of white noise shocks, i.e. we assume that structural shocks have zero means and are uncorrelated with each other. To see this more clearly, the system may be written as:

$$\begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} \end{bmatrix} \begin{bmatrix} \pi_t^e \\ \pi_t \\ cp_t \\ ur_t \\ sr_t \end{bmatrix} =$$

$$\begin{bmatrix} \gamma_{10} \\ \gamma_{20} \\ \gamma_{30} \\ \gamma_{40} \\ \gamma_{50} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} & \gamma_{15} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} & \gamma_{24} & \gamma_{25} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} & \gamma_{34} & \gamma_{35} \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & \gamma_{44} & \gamma_{45} \\ \gamma_{51} & \gamma_{52} & \gamma_{53} & \gamma_{54} & \gamma_{55} \end{bmatrix} \begin{bmatrix} \pi_{t-1}^e \\ \pi_{t-1} \\ cp_{t-1} \\ ur_{t-1} \\ sr_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix}.$$

We can also describe the system by explicitly writing the equations that constitute our VAR:

$$\pi_t^e + b_{12}\pi_t + b_{13}cp_t + b_{14}ur_t + b_{15}sr_t = \\ \gamma_{10} + \gamma_{11}\pi_{t-1}^e + \gamma_{12}\pi_{t-1} + \gamma_{13}cp_{t-1} + \gamma_{14}ur_{t-1} + \gamma_{15}sr_{t-1} + \varepsilon_{1t}, \tag{1.1}$$

$$b_{21}\pi_t^e + \pi_t + b_{23}cp_t + b_{24}ur_t + b_{25}sr_t = \\ \gamma_{20} + \gamma_{21}\pi_{t-1}^e + \gamma_{22}\pi_{t-1} + \gamma_{23}cp_{t-1} + \gamma_{24}ur_{t-1} + \gamma_{25}sr_{t-1} + \varepsilon_{2t}, \tag{1.2}$$

$$b_{31}\pi_t^e + b_{32}\pi_t + cp_t + b_{34}ur_t + b_{35}sr_t = \\ \gamma_{30} + \gamma_{31}\pi_{t-1}^e + \gamma_{32}\pi_{t-1} + \gamma_{33}cp_{t-1} + \gamma_{34}ur_{t-1} + \gamma_{35}sr_{t-1} + \varepsilon_{3t}, \tag{1.3}$$

$$b_{41}\pi_t^e + b_{42}\pi_t + b_{43}cp_t + ur_t + b_{45}sr_t = \\ \gamma_{40} + \gamma_{41}\pi_{t-1}^e + \gamma_{42}\pi_{t-1} + \gamma_{43}cp_{t-1} + \gamma_{44}ur_{t-1} + \gamma_{45}sr_{t-1} + \varepsilon_{4t}, \tag{1.4}$$

$$b_{51}\pi_t^e + b_{52}\pi_t + b_{53}cp_t + b_{54}ur_t + sr_t = \\ \gamma_{50} + \gamma_{51}\pi_{t-1}^e + \gamma_{52}\pi_{t-1} + \gamma_{53}cp_{t-1} + \gamma_{54}ur_{t-1} + \gamma_{55}sr_{t-1} + \varepsilon_{5t}. \tag{1.5}$$

In this model, variables are affected by past and present values of all other variables as well as past values of the variable itself. This implies that all variables included are treated endogenously. In order to extract the exogenous component of expected inflation, i.e. the shock, we must restrict those coefficients that allow for contemporaneous feedback among the variables. The structure should coincide with the way households form their expectations. Specifically, we should design the VAR so that households may only take into account information that is available at the time when expectations are formed. In line with Mehra and Herrington (2008), we assume that expected inflation is unaffected by contemporaneous values of the other variables. Hence, by imposing the following restrictions on the B matrix, we obtain a recursive identification scheme, meaning that a certain variable is only correlated with contemporaneous values of variables that precede it in the identification scheme:

$$\left.\begin{array}{c} b_{12} = b_{13} = b_{14} = b_{15} = 0 \\ b_{23} = b_{24} = b_{25} = 0 \\ b_{34} = b_{35} = 0 \\ b_{45} = 0 \end{array}\right\}. \tag{2}$$

With this configuration, variables become increasingly endogenous further down the scheme, making the interest rate the most endogenous, since it accounts for contemporaneous values of all other variables. To illustrate this more clearly, the restrictions imposed enable us to write the structural equation for expected inflation as:

$$\pi_t^e = \gamma_{10} + \gamma_{11}\pi_{t-1}^e + \gamma_{12}\pi_{t-1} + \gamma_{13}cp_{t-1} + \gamma_{14}ur_{t-1} + \gamma_{15}sr_{t-1} + \varepsilon_{1t}. \tag{3}$$

Equation (3) is a common VAR equation, and generally, by premultiplying (1) by B^{-1}, we get the standard VAR:

$$X_t = A_0 + A_1 X_{t-1} + e_t, \tag{4}$$

$$\text{where } A_0 = B^{-1}\Gamma_0,\ A_1 = B^{-1}\Gamma_1 \text{and } e_t = B^{-1}\varepsilon_t,$$

where e_t is a 5×1 vector of reduced form errors and A_0 and A_1 are matrices of reduced form coefficients. We should then be able to find estimates of the structural parameters and shocks given our estimates of the reduced form parameters and residuals. Our recursive identification scheme imposes 10 restrictions, which is enough to recover the structural parameters and shocks.[4]

This setup illustrates a general case where one lag is used. It is of course possible and in some cases desirable to include additional lags into the model. Mehra and Herrington (2008) use one lag on their bi-annual observations. We will run the model with two lags, capturing the effects of two quarterly observations. Firstly, this will

[4] An $n \times 1$ VAR with white noise shocks requires $(n^2 - n)/2$ restrictions in order for structural parameters and shocks to be identified

enhance the comparability between the studies and secondly, when forecasting inflation, agents are likely to put more emphasis on information obtained in more recent time periods.

The rationale for the restrictions imposed can be seen in the following reasoning: When households report their inflation expectations, they do not have access to contemporaneous information of real time realisation of actual inflation and the other variables included in our VAR. For example, an individual who predicts the one-year-ahead inflation in December only knows the actual inflation up until November, since the survey is conducted in the beginning of every month, generally before CPI figures are released. It is also reasonable to assume that the Riksbank can adjust the instrument rate in response to contemporaneous information of all variables. This justifies placing the interest rate last in the recursive identification scheme.

As put forward above, the use of a recursive identification scheme may appear somewhat arbitrary, unless there is a theoretical justification for the specific structure used. The effects of the shocks may depend on the way the variables are ordered in the time series vector X_t. Choosing a different order of variables will, in general, produce different shocks. To account for this difficulty, Sims (1981) recommended trying different triangular orthogonalisations in order to check for the robustness of the results. Since it takes some time for the survey to be conducted, it might be that when forecasters form their expectations for the survey, they may have knowledge about within-period information of actual inflation. In essence, this would imply that inflation expectations to some extent could respond to contemporaneous information about the other variables. To account for this possibility, we test the robustness of our model by considering an alternative identification scheme, in which expected inflation is allowed to respond to contemporaneous values of the other variables.

4 Empirical Results

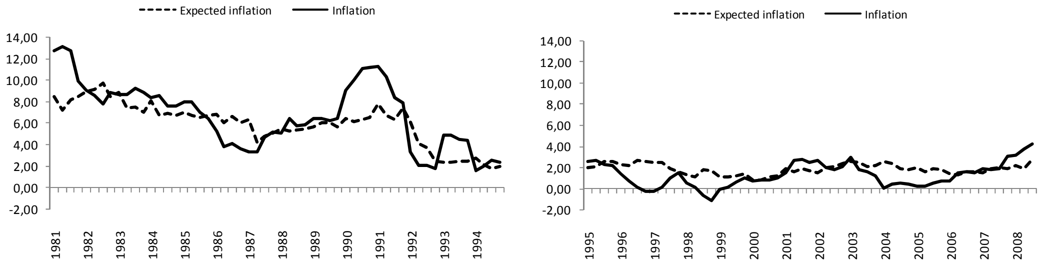
4.1 An Overview of the Time Series

Figure 1 illustrates the development of expected and actual inflation, commodity prices and the real interest rate, split over the two sample periods. A visual look at data reveals that inflation and inflation expectations were generally higher and more

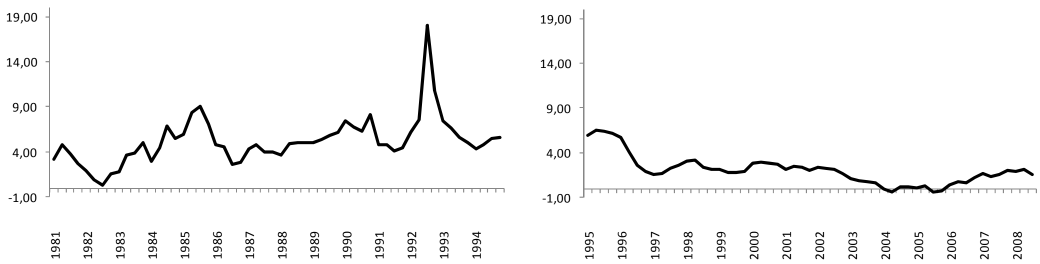
Figure 1 A Visual Look at Data over Two Sample Periods

1981:1 – 1994:4 **1995:1 – 2008:3**

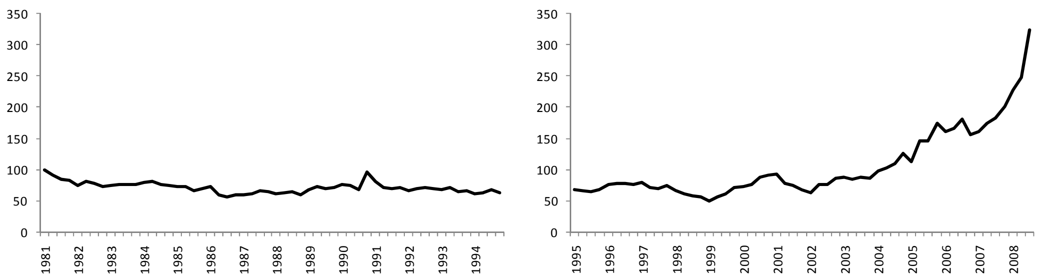
Expected and Actual Inflation



Expected Real Rate



Commodity Price Index



Unemployment

Note: The numbers on the y-axes are denoted in percentage points. The expected real rate is calculated according to the Fisher equation as the nominal interest rate less expected inflation. Source: National Institute of Economic Research, Statistics Sweden, Thomson Datastream, International Labour Organization and the Riksbank.

variable in the first sample period. In this time period, households seem to have under-predicted inflation at several occasions when inflation was relatively high, and over-predicted inflation somewhat in the mid-1980s when inflation was relatively low. The second sample period shows less deviation between perceived and actual values of inflation. Expectations hovered around the inflation target of two percent, while actual inflation deviated somewhat occasionally from this level.

To get a better understanding for the development of the macroeconomic environment we turn to the development of the real interest rate. According to the Fisher equation, the real interest rate is approximately the nominal interest rate less expected inflation. In the first sample period, there are at least three important occasions of movements in the real interest rate. Firstly, in 1981-82, we can see the effects of devaluation of the domestic currency. Sweden had, as well as most other Western countries, been subject to cost shocks in the late 1970s and early 1980s. The krona was devalued by 27 percent in these two years only, but costs kept creeping up. Devaluation effectively makes imports more expensive and domestic products relatively cheaper. When this happens, a stronger demand for domestic products leads to price pressures. If the nominal interest rates are not raised, the real interest rate is bound to fall, which was the case in Sweden at the time. Secondly, the drop in the real interest was followed by an increasing real rate over some years, but at the end of 1985 it fell markedly again, when the Swedish credit market was deregulated. A final point to note is the exceptionally high rate in 1992. This event was due to the Riksbank raising the nominal interest rate to defend the fixed exchange rate regime. In the second period, the expected real rate was less volatile, which consequently implies a more stable real economy (Arai and Kinnwall 1998).

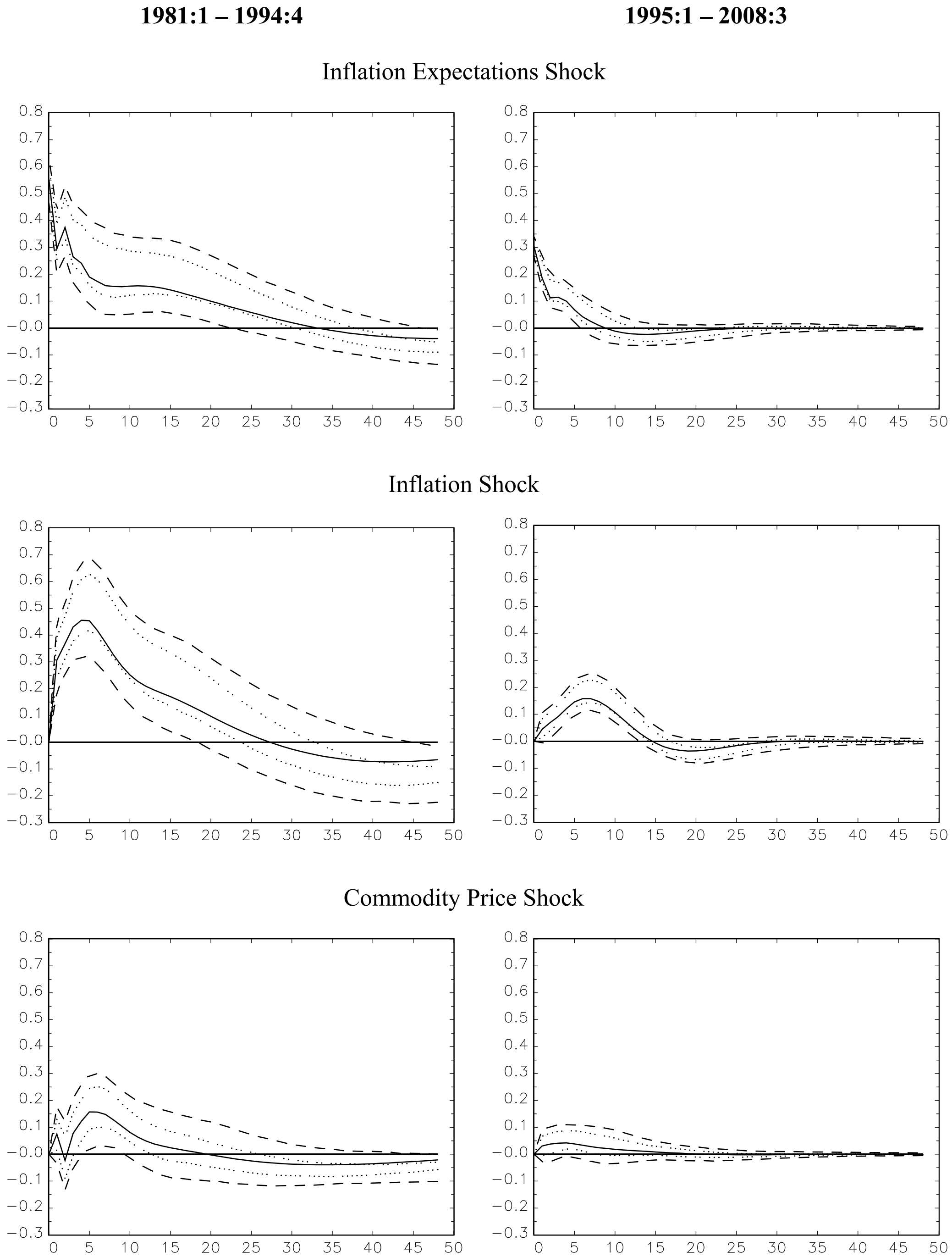
Commodity prices were stable until the beginning of the 21st century, but in recent years they have increased notably. Interestingly, we do not observe any clear increases in inflation expectations that seem to coincide with the increase in commodity prices. This may suggest that commodity prices do not play an important role in explaining the variability in inflation expectation, or alternatively, that the general public is confident in the Riksbank bringing inflation back to the target.

Unemployment was very low in the late 1980s and early 1990s, but increased dramatically after this period and remained high throughout the 1990s. In recent years, unemployment has been lower but fairly volatile. It appears that the low unemployment around the turn of the decade 1980 coincided with increasing inflation expectations. In addition, the rapid increase in unemployment that followed concurred with a notable drop in expected inflation.

4.1 Impulse Responses of Expected Inflation

In order to observe how expected inflation responds to shocks in actual inflation, commodity prices, unemployment, a short term nominal interest rate and expected inflation itself, we initially turn to the impulse response functions illustrated in *Figures 2a* and *2b.* The charts show the effect on expected inflation of a one-percentage point increase in the variable of interest. Consequently the numbers on the y-axes are percentage points. We study the effect over a period of 48 quarters, i.e. 12 years. The solid line represents the point estimate, the dashed lines indicate a 90 percent confidence interval and the dotted lines a 67 percent confidence interval. The confidence intervals are obtained using the Hall percentile method with 1,300 bootstrap replications. To make a comparison across sample periods possible, we let the leftmost charts show the impulse response functions of the first sample period (1981:1 – 1994:4) and the rightmost charts show the responses in the second sample period (1995:1 – 2008:3).

Figure 2a Impulse Responses of Expected Inflation to Shocks in Expected Inflation, Inflation and Commodity Prices over Two Sample Periods

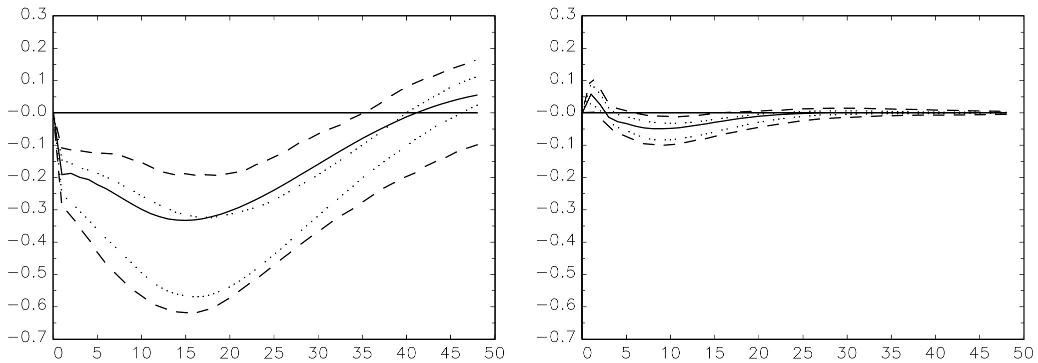


Note: The solid line represents the point estimate, the dashed lines indicate a 90 percent confidence interval and the dotted lines a 67 percent confidence interval. The numbers on the y-axis are in percentage points, the numbers on the x-axis are quarters.

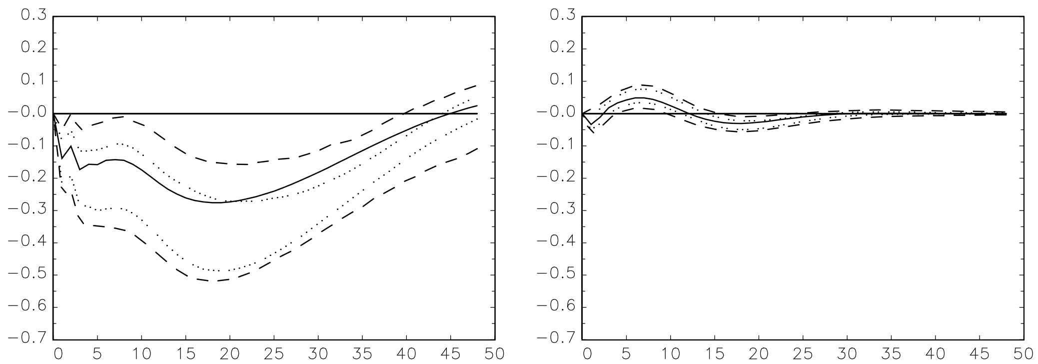
Figure 2b Impulse Responses of Expected Inflation to Shocks in Unemployment and Interest Rate over Two Sample Periods

1981:1 – 1994:4 **1995:1 – 2008:3**

Unemployment Shock



Nominal Interest Rate Shock



Note: The solid line represents the point estimate, the dashed lines indicate a 90 percent confidence interval and the dotted lines a 67 percent confidence interval. The numbers on the y-axis are in percentage points, the numbers on the x-axis are quarters.

Initially, we turn to the responses of expected inflation to expected inflation itself, actual inflation and commodity prices depicted in *Figure 2a*. A surprise increase in any of these variables is expected to render an increase in inflation expectations, as discussed in section 3.2. We observe that expected inflation increases intuitively in response to a shock in each of these three variables in both sample periods. For example, a one percentage point surprise increase in expected inflation itself generates an initial increase in expected inflation by approximately 0.5 percentage points in the first sample period. The initial increases in expected inflation in response to shocks in inflation and expectations are statistically significant on the 10 percent level in both sample periods. The impulse response of a commodity price shock provides a less clear-cut picture; as can be seen, the 90 percent confidence interval includes negative responses of expected inflation.

To make a note on the relative strength of the impulse responses to these shocks, the immediate response of expected inflation is strongest for shocks in expected inflation itself, followed by actual inflation. The responses of expected inflation resulting from exogenous movements in commodity prices are much weaker in comparison to the responses generated from shocks in actual and expected inflation. A similar pattern appears in both sample periods. To highlight a specific example, a one-time one percentage point surprise increase in actual inflation increases expected inflation with approximately 0.4 percentage points one year after the shock in the first sample period, whereas the corresponding number for a commodity price shock is 0.15 percentage points.

In a comparison between sample periods, it is evident that the strength as well as the longevity of the responses differ between the periods. In the first sample period, responses are generally stronger and more long-lived. To emphasise this further; in response to a shock in expected inflation, the lower bound of the 90 percent confidence interval for the point estimate of expected inflation crosses the x-axis after approximately 20 quarters in the first sample period, whereas this occurs after only five quarters in the second sample period. The crossing of the x-axis can be interpreted as the turning point where there is no statistically significant effect on expected inflation remaining from the shock. The same pattern is apparent for the other variables as well, which goes to show that effects from shocks in these variables have less enduring consequences in the sample period where inflation targeting was practiced. As mentioned, a one-time one percentage point surprise increase in actual inflation, generates an increase in expected inflation that is approximately 0.4 percent one year after the shock. In the second sample period, the corresponding increase is only around 0.14 percent, which may serve as an illustration of the difference between sample periods.

For the remaining two variables, unemployment and the interest rate depicted in *Figure 2b*, the general pattern appears to be similar to what we have seen above. As pointed out in section 3.2, we expect that an unexpected increase in these variables will cause expected inflation to fall. Our results indicate that expected inflation moves in an intuitive manner in response to a positive shock in unemployment and monetary policy in the first sample period. The initial responses are found statistically significant on a 10 percent level. The results in the second sample period are, however, more ambiguous. Nevertheless, the responses in the second period are very small; a one percentage point surprise increase in the unemployment rate renders a decrease in expected inflation by only 0.06 percentage points approximately two years after the shock. This should be compared against the result of a one percentage point surprise increase in unemployment in the first sample period, which generates a drop in inflation expectations by 0.3 percentage points approximately two years after the shock.

4.2 Forecast Error Variance Decomposition

To gain a better understanding of the relative importance of different shocks in accounting for the variability in expected inflation, we examine the forecast error variance decomposition. The results are reproduced in *Table 1*. The left column shows the results obtained with the identification scheme that does not allow expected inflation to be contemporaneously influenced by the other variables in the VAR. The right column reproduces the results obtained by the alternative ordering, in which expected inflation is allowed to be influenced by contemporaneous information of all other variables. We trace the results from one to 32 quarters ahead, i.e. eight years.

In both sample periods, we observe a decline in the relative importance of expected inflation itself in accounting for the variability of expected inflation as we move ahead in time. Another observation made is that shocks to commodity prices appear to play a modest role in explaining the forecast error variance of expected inflation in both sample periods. In the first sample period, unemployment and the interest rate both represent an increasing component of the variability in expected inflation as time passes. This pattern is, however, not as apparent in the inflation targeting sample period, in which the importance of these variables is considerably smaller. Actual inflation remains an important source of the variability in both sample periods.

Table 1 Forecast Error Variance Decomposition of Expected Inflation over Two Sample Periods

Sample Period 1 (1981:1-1994:4)

Steps	Ordering: π^e, π, cp, ur, sr					Ordering: π, cp, ur, sr, π^e				
n	π^e	π	**cp**	**ur**	**sr**	π^e	π	**cp**	**ur**	**sr**
1	1.00	0.00	0.00	0.00	0.00	0.81	0.02	0.16	0.00	0.00
4	0.50	0.35	0.01	0.09	0.05	0.37	0.44	0.06	0.08	0.05
6	0.37	0.44	0.03	0.11	0.06	0.28	0.52	0.04	0.09	0.06
8	0.31	0.46	0.04	0.13	0.06	0.24	0.54	0.04	0.11	0.07
16	0.22	0.37	0.03	0.26	0.12	0.18	0.44	0.03	0.23	0.12
32	0.16	0.26	0.02	0.33	0.22	0.13	0.31	0.02	0.31	0.23

Sample Period 2 (1995:1-2008:3)

Steps	Ordering: π^e, π, cp, ur, sr					Ordering: π, cp, ur, sr, π^e				
n	π^e	π	**cp**	**ur**	**sr**	π^e	π	**cp**	**ur**	**sr**
1	1.00	0.00	0.00	0.00	0.00	0.89	0.02	0.03	0.03	0.03
4	0.85	0.02	0.00	0.09	0.00	0.81	0.06	0.08	0.03	0.03
6	0.75	0.14	0.01	0.08	0.03	0.66	0.17	0.09	0.04	0.04
8	0.64	0.21	0.01	0.08	0.06	0.53	0.29	0.08	0.05	0.06
16	0.54	0.25	0.02	0.11	0.08	0.42	0.39	0.07	0.07	0.06
32	0.50	0.28	0.02	0.10	0.10	0.40	0.39	0.07	0.07	0.07

Note: Proportion of forecast error in expected inflation accounted for by respective variable. The entries in the steps-column refer to the n-steps-ahead forecasts for which variance error decomposition is done, where each step is equivalent to a quarter.

To exemplify, we focus on the variance of the sixteen steps ahead forecast error, corresponding to four years. In the first sample period, shocks to expected inflation itself, actual inflation and unemployment account for 85 percent of the variability in expected inflation. In the second sample period, the variability in expected inflation due to shocks in unemployment is much smaller, and shocks to expected and actual inflation now account for nearly 80 percent of the variability in inflation expectations.

The responses of expected inflation to the generated shocks are found very similar with the alternative structural identification discussed above. This also applies to the general pattern of the FEVD. Hence, we conclude that our results appear to be robust to specifications of the VAR.

4.4 Conclusions

The results indicate that expected inflation moves in an intuitive manner in response to shocks in all VAR variables. The results are most evident with regards to shocks in expected and actual inflation, followed by unemployment, suggesting that these variables are the most important sources of movements in inflation expectations.

The contribution of commodity prices to the variability in expected inflation is evidently small throughout both of the sample periods. Furthermore, the increase in expected inflation due to a shock in commodity prices is not found statistically significant at the 10 percent level. These results stand out as a difference to Mehra and Herrington (2008), who find that changes in commodity prices account for a fairly large proportion of the variability in inflation expectations. One plausible explanation may be that the survey measure of inflation expectations employed in this study is generated by the general public, whereas Mehra and Herrington (2008) use a measure of inflation expectations generated by professional forecasters. It is likely that professionals respond more to fluctuations in commodity prices than the general public. Furthermore, Mehra and Herrington (2008) conclude that the effect of commodity prices on expected inflation has decreased over time. It is therefore not surprising that our results more resemble those obtained in their later sample periods. Another important difference between our studies is the role of unemployment. Where we find that unemployment accounts for a fairly large proportion of the variability in expected inflation, they attribute a less prominent role for this variable. It is likely that the modest impact of commodity prices obtained in our study renders a relatively larger impact of unemployment on expected inflation.

With regards to the development of inflation expectations dynamics, the primary conclusion that can be drawn is that responses of expected inflation to shocks in our

VAR variables are weaker and less persistent in the second sample period. Also, the relative importance of unemployment and the interest rate in accounting for the variability in expected inflation, appear less substantial in the second sample period. The above-mentioned observations suggest that there has been an important shift in the way the general public forms its inflation expectations between the sample periods. As previously stated, stronger and more long-lived movements in inflation expectations, like the ones observed in the first sample period, are more likely to become self-fulfilling, i.e. translate into higher actual inflation. Thus, it seems that the Swedish economy has become more protected from the mechanism that generates persistent increases in actual inflation induced by movements in inflation expectations, i.e. inflation expectations have become increasingly anchored. These findings are in line with several other studies, including Mishkin (2007), who puts forward that better anchored inflation expectations is the most attractive explanation for recent changes in inflation dynamics. Expressed in other words, as expected inflation has grown less elastic to changes in macroeconomic data, actual inflation has similarly become better shielded against turbulence in the macroeconomic environment, all else being equal. This observation implies that there have been effects working towards a flattening of the Phillips curve during the time period covered by our study.

As previously indicated, Mehra and Herrington (2007) identify a shift in the longevity of inflation expectation responses to shocks in primarily expected inflation, actual inflation and commodity prices. In the pre-1979 sample period, responses are long-lasting, whereas they are muted and short-lived in the post-1979 sample period. They attribute this change to monetary policy and argue that the Fed accommodated increases in inflation expectations before, but not after 1979. Similarly, we believe that for reasons outlined above, changes in monetary policy i.e. the introduction of an explicit inflation target, explain the patterns of more firmly anchored inflation expectations observed in our latter sample period. This may also help explaining why the responses of expected inflation to shocks in unemployment and the interest rate are weaker in the second sample period. In the absence of an explicit inflation target, forecasters are likely to consider e.g. the interest rate to contain more information about the future level of inflation. Without an inflation target, there is greater uncertainty about the desired level of inflation in the longer term.

Expected inflation itself remains an important source of variability in inflation expectations throughout both sample periods. In the first sample period, 31 percent of the variability in expected inflation is attributable to shocks in expected inflation at a horizon of two years ahead. The corresponding figure in the second sample period is 64 percent. This finding indicates that it is important for the Riksbank to continue monitoring inflation expectations, in order to ensure that these do not translate into persistent increases in actual inflation. Another argument in favour of this position is the findings by Stock and Watson (2007), that inflation expectations are imperfectly anchored.

In an attempt to generalise our findings, we note that there are several similarities between the results of our study and that of Mehra and Herrington (2008). In both cases, there seems to be support for a shift in the dynamics of the inflation expectations formation process, induced by a stricter commitment by central banks to mitigate inflation. With regards to the relative importance of different variables in accounting for the variability in expected inflation, it seems harder to draw any general conclusions. Evidently, the results obtained are highly dependent on the time period under scrutiny. Furthermore, economies differ in several aspects. As indicated by our study, different monetary policy regimes seem to have a large impact on the dynamics of the formation of inflation expectations. It is therefore necessary to evaluate different time periods and economies separately, since general conclusions cannot easily be drawn. Moreover, the fact that survey measures only serve as proxies for inflation expectations indicates that results are likely to differ depending on the choice of proxy variable.

We hence conclude, that given the many differences between economies and time periods, as well as the amount of methodological considerations needed, specific cases need to be evaluated separately in order to give a more complete picture of the sources of movements in inflation expectations. Consequently, further research is needed to support more comprehensive generalisations of the dynamics of the formation of inflation expectations. One interesting extension would be to employ panel data in order to take into account the heterogeneity of forecasters, i.e. to analyse how a specific forecaster revise its assessment of expected inflation in response to changes in macroeconomic variables over a longer time period.

5 Discussion

5.1 Choice of Sample Periods

The turbulent macroeconomic environment during the 1980s and early 1990s is likely to have had an impact of our results, since it might not reflect a similar underlying structure of the macro economy. The VAR is a good tool to describe patterns in an economic system, given that the fundamental structure remains somewhat unchanged over the sample period. We believe that the implementation of an explicit inflation target is an example of one such fundamental change that motivates a split of our sample periods. It could be argued that the abandoning of a fixed exchange rate regime, deregulation of the credit market, repeated devaluations and the extreme increases in short term interest rates that followed speculative attacks to the krona might be other such structural shifts that may motivate a split of sample periods. Consequently, we have tested our VAR for a sample period ending in the third quarter of 1991, as opposed to the end of 1993. The results of this VAR appear qualitatively similar to our original model. However, it seems that there is a slight decrease in the level of persistence in the responses of inflation expectations in the first sample period, i.e. the effects of the shocks become somewhat more short-lived. This may imply less support for our argument that inflation expectations have become more anchored in the inflation-targeting era.

5.2 The Meaning of Expectations Shocks

In line with Mehra and Herrington (2008), we find that exogenous shocks to expected inflation itself contributes to the variability in expected inflation to a large extent. This result gives rise to the question, whether the identified expectation shocks actually represent purely exogenous movements in the variable. This could be attributed to that our model does not include some variables that have an influence on movements in inflation expectations. In this case, the shocks identified instead represent the omitted fundamentals. Another possible explanation may be that the shocks represent non-fundamentals, such as random movements in the mood of survey participants, i.e. so called sunspots. Mehra and Herrington (2008) provide a discussion about these issues, and in the following we will reproduce their most important conclusions of relevance for our study.

One argument in favour of the notion of omitted fundamentals can be derived from the findings of Ang, Bekaert and Wei (2006). They put forward that a single model is likely to be outperformed by surveys in forecasting inflation. The reason being that survey respondents collect information from many different sources that cannot be incorporated in a single model.

In addition, our model includes lagged values of the variables, which in turn means that the information captured is backward-looking. It is possible that the respondents of the survey used take into account information that is forward-looking, such as expected values of fundamentals. It may also be that there exist nonlinear relationships among the variables that cannot be captured by our VAR. The possibility that the exogenous movements in expected inflation represent sunspots, have been discussed in Goodfriend (1993). The author puts forward that financial market participants may have experienced inflation scares due to the failure of the Fed to keep inflation low during the 1970s. This may have resulted in increased expectations about future inflation.

It is naturally difficult to identify and test for all potentially omitted fundamentals that might drive movements in inflation expectations. To gauge the exogeneity of the expected inflation measure, Leduc, Sill and Stark (2007) back out the structural shocks to expected inflation and test them for exogeneity with respect to a number of macroeconomic variables that might affect inflation expectations. When regressing expected inflation shocks on the Producer Price Index, the S&P 500 stock index, the monetary base and the U.S./Canada and U.S./U.K. exchange rates they find that none of the variables predict expectation shocks at a 5 percent significance level and that they explain very little of the variation in expectation shocks. Hence, there is support for that the measure of expectation shocks can be thought of as exogenous.

5.3 Further Modelling Issues

The small impact of commodity prices on the variability of expected inflation has induced us to test a VAR that does not include commodity prices. We find the results to be very similar to the ones generated by the model that is used throughout this paper. However, we believe that the inclusion of a commodity price variable is theoretically justified and in order to keep our study as comparable as possible to

Mehra and Herrington (2007) we have chosen not to exclude this variable from our model.

As pointed out previously, we have used a survey measure of inflation expectations generated by the general public, as opposed to professional forecasters as in Mehra and Herrington (2008). This may affect the comparability of our studies, but we believe that households to a large extent should respond in a similar fashion as professionals, at least when it comes to the variables employed in this study. Households as well as professional forecasters are both represented by individuals and should therefore respond rationally to macroeconomic variables. In addition, it can be argued that households closely follow the rational expectations of professionals, in that they form their expectations based on second-hand information of professional forecasts e.g. via various news channels. One difference noted is, however, the role of commodity prices. Households are furthermore much more heterogeneous as a group and may for this reason not respond as strongly or as rational as professionals. The heterogeneity of households might call for the inclusion of other variables, but this has been ruled out for reasons mentioned in the discussion about the choice of variables in section 3.2.

6 Summary

The purpose of this study is to provide insights in the sources of movements in inflation expectations and to identify possible changes in the dynamics of inflation expectations. This is of importance since increased inflation expectations can become self-fulfilling, i.e. they can translate into increases in actual inflation.

Today, central banks closely follow the development of inflation expectations and regard it as an important input in policy formulations. As emphasised in the literature, a deeper understanding of the public's expectations of inflation could have significant practical payoffs. This may include an improved ability for central banks to assess their own credibility and to evaluate the implications of their policy decisions and how these decisions are communicated. Furthermore, improved knowledge of how inflation expectations react to changes in macroeconomic variables can serve as useful input in models describing the inflation process.

There is no consensus in how expectations are formed and the field is under continuous development. Finding a true model is difficult, especially given the heterogeneity of forecasters and the complex relationships among variables. Consequently, the methodology used is a structural VAR approach, similar to that in Mehra and Herrington (2008). We specifically study how a survey measure of expected inflation by Swedish households responds to changes in actual and expected inflation, commodity prices, the unemployment rate and a short-term interest rate. In addition, we examine how the responsiveness of expected inflation has evolved in Sweden over the past twenty years, by looking at two different sample periods, 1981-94 and 1995-2008.

We find that expected inflation moves in an intuitive manner in response to shocks in expected inflation itself, actual inflation, commodity prices, unemployment and a short-term nominal interest rate. Shocks to expected and actual inflation as well as unemployment are found to be the most important sources of variability in inflation expectations. Before 1995, which was the year the Riksbank committed to inflation targeting, the responses of expected inflation to macroeconomic shocks are stronger and more long-lived than in the latter time period. These results indicate that inflation expectations have become increasingly anchored.

We conclude that there is support for a shift in the dynamics of the inflation expectations formation process, induced by a stricter commitment by central banks to mitigate inflation. In addition, modelling of the sources and dynamics of inflation expectations provides useful insights when analysing a specific case. Given the differences between economies and monetary policy regimes as well as the impact of the results stemming from the choice of time period and the choice of proxy for inflation expectations, it is hard to make further generalisations. Given the limited research in this field to date, we conclude that there is considerable interest in conducting further research on the sources and dynamics of inflation expectations.

7 References

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