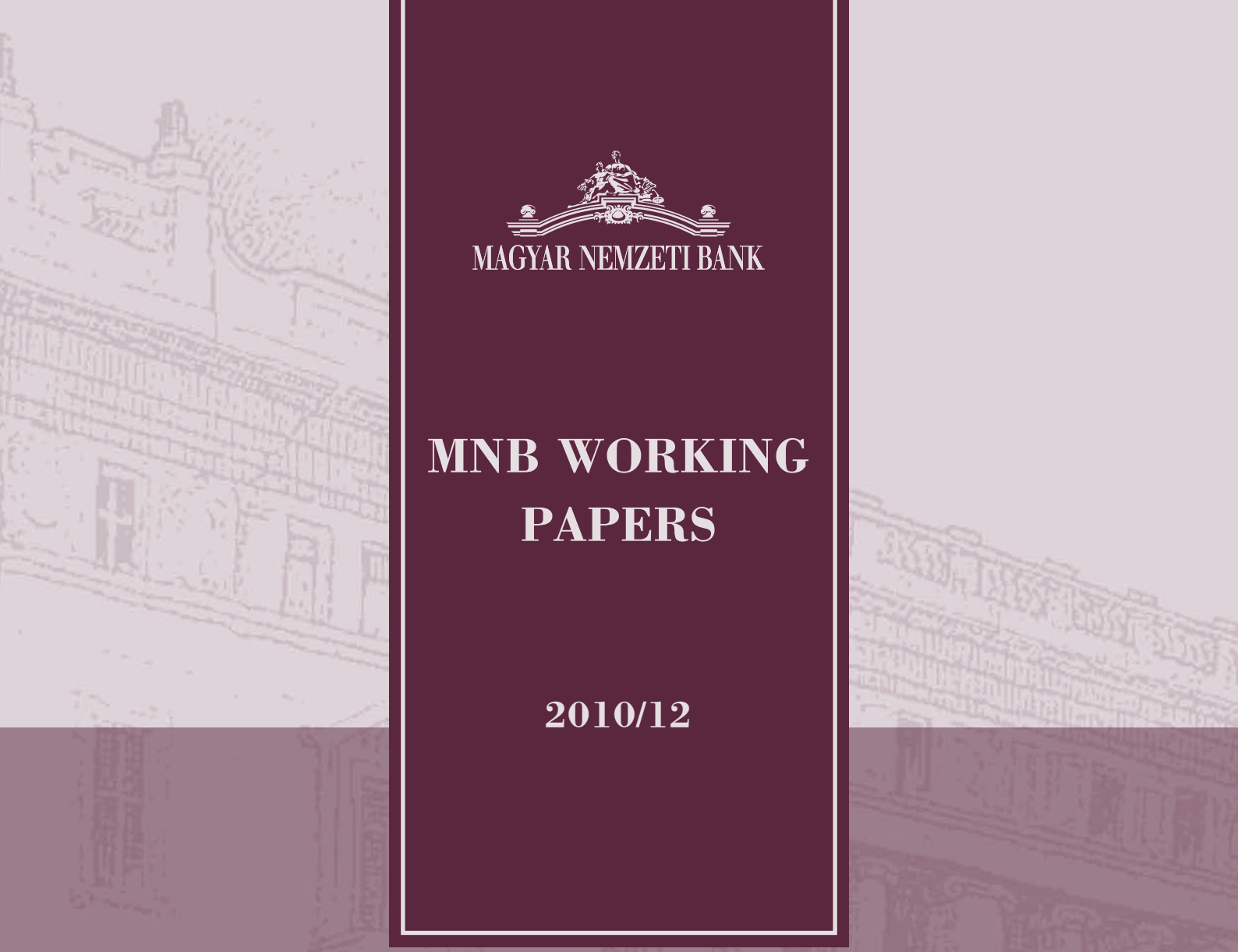

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Household inflation expectations and inflation dynamics

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Household inflation expectations and inflation dynamics*

(Lakossági inflációs várakozások hatása az inflációra)

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Contents

Abstract

Although in modern monetary economics it is usually assumed that inflation expectations play a prominent role when economic agents set prices and wages, the empirical evidence for this link is scarce. This paper aims to identify the effect of changes in inflation expectations on prices and wages in an SVAR framework for three inflation targeting countries (Czech Republic, Hungary and United Kingdom). The results show that in all countries the effect is significant. In comparison with the United Kingdom and the Czech Republic, inflation expectations in Hungary are more volatile and less anchored, which can be an important source of the high volatility of the inflation rate.

JEL: C83, D84, E31.
Keywords: inflation expectations, consumer survey.

Összefoglalás

Az elméleti monetáris politikai modellek egyik legfontosabb feltételezése, hogy az inflációs várakozások kiemelt jelentőséggel bírnak a gazdasági szereplők árazási és bérezési döntéseiben. A feltételezés helyességét ugyanakkor kevés empirikus tanulmány vizsgálta. A tanulmány három inflációs célkövető országban (Csehország, Magyarország, Egyesült Királyság) vizsgálja az inflációs várakozások árakra és bérekre gyakorolt hatását SVAR elemzési keretben. Az eredmények azt mutatják, hogy a várakozások hatása mindegyik országban jelentős. A másik két országgal összevetve az inflációs várakozások Magyarországon volatilisebbek és feltehetően kevésbé horgonyzottak, ami részben magyarázhatja az inflációs ráta magas volatilitását.

Introduction

Managing inflation expectations is crucial in modern monetary policy. Although in the short run demand and supply effects (e. g. government spending shock or increasing commodity prices) are the main causes of changes in the inflation rate, in the long run expectations gain in importance and have the dominant role in determining inflation.

Inflation expectations influence prices through numerous channels. Investors need reliable inflation projections to make well-founded investment decisions. Firms need to determine their expected inflation rate in order to set prices, to make capital investment and deciding on borrowing and liquidity needs. Expected inflation is crucial in contracts which are not continuously renegotiated, like wages. Consumers use information on the future inflation rate when allocating consumption between today and tomorrow. If inflation expectations are high consumers tend to consume today, which may increase prices further.

Although expectations are important because of several reasons, the empirical literature on inflation expectation formation had a quite limited scope in general. Most of the literature analyzed whether expectations (of households, producers or investors) are unbiased and efficient predictors of future inflation rates. For the euro area Forsells and Kenny (2002) and Dias et al. (2008), for the United Kingdom Mitchell and Weale (2007) tested the rationality of household expectations. The finding of these papers was that expectations are biased. Although expectations do not satisfy the rationality assumption, they may convey valuable information. For the US Ang et al. (2006) showed that household inflation forecasts outperformed many alternative methods of forecasting. A second wave of papers tried to explore more carefully how expectations are formed (e.g. Brachinger, 2008; Lein and Maag, 2008). The findings showed that expectations are backward looking to a great extent. Furthermore consumers do not weight products and services the same way as statistical offices. They tend to overweight frequently purchased products and expectations overreact big and transparent price increases.

On the other hand a promising new strand of literature demonstrates, that the deviation from rational expectations and introduction of different learning mechanism in macroeconomic models can help a lot to explain economic fluctuations. As expectations are not observable, survey data can be important as a proxi variable. Del Negro and Eusepi (2009) and Orphanides and Williams (2005) used survey data about inflation expectations to inform the choice of different learning mechanisms. Ormeno (2009) and Milani (2010) moved even further and used survey data to estimate general equilibrium models.

Although the assumed linkage between expectations and other macroeconomic variables is crucial, it was rarely tested in simple multiple-equation context. Among the examples Millet (2006) found evidence that expectations influence inflation dynamics. Benkovskis (2008) examined inflation expectations in the new members of the European Union and found that changes in expectations have a long-run effect on inflation.

This paper explores whether changes in expectations have an impact on other macroeconomic variables in three countries (Czech Republic, Hungary and the United Kingdom). The selection of countries was motivated by that all countries have inflation targeting monetary regimes, so managing expectations is in the focus of monetary policy and for all countries relatively long time series are available about inflation perceptions and expectations. In this paper I quantify qualitative survey responses about inflation perceptions and expectations and use a SVAR framework to identify the effect of changes in the expected inflation rate. Previous papers usually used simple ordering assumptions to put inflation expectations into VARs. The main contribution of this paper is that it proposes a different SVAR framework with sign restrictions, which can be more appropriate to identify the effect of expectation shocks. Nominal wages are also included among the variables of the SVAR, to underpin one of central banks' main concerns, namely that non-anchored expectations may have an impact also on wage setting. The results show that an increase in inflation expectations raises prices and nominal wages in all the three countries. By comparing impulse responses I also evaluate how anchored expectations are in the three countries. Expectations are the most anchored in United Kingdom and the least in Hungary.

The paper is organized as follows. First I discuss the quantification method of qualitative survey responses and quantify inflation expectations. Second I describe the variables used in the SVAR. Third I discuss the SVAR framework I use to identify the effect of changes in expectations, then I summarize the results of the estimated SVAR. In the last section I conclude.

1 The extended Carlson–Parkin method of quantification

I use qualitative data about inflation perceptions and expectations from the Business and Consumer Surveys of the European Commission. The surveys are conducted on monthly basis in all EU countries, including the new member states. Monthly data for the selected countries are available from 1995 for the Czech Republic and from 1993 for Hungary and United Kingdom. Although in general the survey responses available monthly, several data points are missing so I quantify quarterly perceptions and expectations by taking the simple average of available monthly survey responses.

The survey questions on the perceived and expected inflation rate are the following:

"How do you think that consumer prices have developed over the last 12 months?" The possible response categories are: (1) "risen a lot", (2) "risen moderately", (3) "risen slightly", (4) "stayed about the same", (5) "fallen" and (6) "don't know".

"Given what is currently happening, do you believe that over the next 12 months prices will: (1) rise faster than at present, (2) rise at the same rate, (3) rise more slowly, (4) stay at their present level, (5) go down, (6) difficult to say".

The proportions of respective survey responses for the three countries are shown in Chart 1-6. Some differences among countries are worth to mention. Although perceptions and expectations seem to be disperse in all countries, in the United Kingdom the proportions are more stable than in the other two countries. The proportion of respondents perceiving and expecting an increase in the inflation rate is the highest in Hungary and the lowest in the United Kingdom.

The quantification of qualitative survey responses is done with the extended Carlson–Parkin method (henceforth called the Carlson–Parkin method), proposed by Berk (1999). The quantification is done in two steps. First the perceived inflation rate is quantified, then using perceived inflation expected inflation can be also determined.

Table 1

Survey data on perceived price changes

Response	Czech Republic	Hungary	United Kingdom
(1) "risen a lot"	16.1%	30.7%	12.4%
(2) "risen moderately"	29.1%	32.8%	23.0%
(3) "risen slightly"	29.4%	23.5%	35.2%
(4) "stayed about the same"	17.1%	7.9%	22.7%
(5) "fallen"	4.5%	3.9%	4.8%
(6) "don't know"	3.7%	1.2%	1.9%

Note: Average fraction of respondents choosing respective responses.

Table 2

Survey data on expected price changes

Response	Czech Republic	Hungary	United Kingdom
(1) "rise faster than at present"	23.2%	27.9%	17.1%
(2) "rise at the same rate"	42.5%	52.0%	35.8%
(3) "rise more slowly"	6.7%	13.1%	20.0%
(4) "stay at their present level"	9.9%	1.4%	18.7%
(5) "go down"	1.9%	0.5%	3.4%
(6) "difficult to say"	15.7%	5.1%	5.1%

Note: Average fraction of respondents choosing respective responses.

During the quantification it is assumed that the aggregate distribution of both perceived and expected inflation rate is normal. This assumption has some theoretical motivations. The necessary and sufficient conditions for the existence of the aggregate normal distributions are that the individual, subjective distributions are independent and have finite mean and variance. In this case the Central Limit Theorem applies.[1]

Although the normal distribution assumption is the most frequently used, empirical studies have mixed results about the normality of inflation expectations.[2] Normality was rejected by Carlson (1975) for the US, by Batchelor (1981) for Germany, France and UK, and more recently by Murasawa (2009) for Japan. The main findings of these papers were that compared to the normal distribution survey responses are more centrally peaked and tend to be distributed asymmetrically. On the other hand Balcombe (1996) found no evidence to support the hypothesis that price expectations are drawn from skewed or kurtotic distributions using a survey on inflation expectations in New Zealand. Although the normality assumption is questionable, Berk (1999) and Liziak (2003) found that different distribution assumptions (normal, central t, non-central t and uniform) caused relatively small changes in the quantified inflation rate.

Chart 7 illustrates the aggregate distribution of the perceived inflation rate. If the "moderate" inflation level is taken as given, there are four unknown parameters of the distribution and four independent proportions, so the unknown parameters are uniquely determined. Algebraically the quantification of the perceived inflation rate is done as follows. Define a, b, c, d and e, as:

$$a = P(\pi^p < -t) = F(-t) \tag{1}$$

$$b = P(-t < \pi^p < t) = F(t) - F(-t) \tag{2}$$

$$c = P(t < \pi^p < \pi^m - s) = F(\pi^m - s) - F(t) \tag{3}$$

$$d = P(\pi^m - s < \pi^p < \pi^m + s) = F(\pi^m + s) - F(\pi^m - s) \tag{4}$$

$$e = P(\pi^m + s < \pi^p) = 1 - F(\pi^m + s) \tag{5}$$

where F(.) is the normal distribution function, m is the average and σ is the standard deviation of the aggregate distribution of perceived inflation rate. The moderate rate of price increases is denoted by π^m, and parameters t and s show how wide the ranges are, where respondents consider inflation rate to be zero or moderate. After solving the equations (1)–(5), one can show that

$$m = \frac{\pi^m (C + D)}{C + D - (A + B)} \tag{6}$$

$$\sigma = \frac{-2\pi^m}{C + D - (A + B)} \tag{7}$$

$$s = \frac{\pi^m (B - A)}{C + D - (A + B)} \tag{8}$$

$$t = \frac{\pi^m (D - C)}{C + D - (A + B)} \tag{9}$$

where $A = N^{-1}(1-e)$, $B = N^{-1}(1-d-e)$, $C = N^{-1}(1-c-d-e)$, $D = N^{-1}(1-a)$.

The aggregate distribution of the expected inflation rate is illustrated in Chart 8. The respondents of the survey have to compare price increases in the future to the inflation "…rate as at present". I assume that this rate is equal to the quantified

[1] For a more technical discussion about the assumptions necessary for the Carlson–Parkin method see Pesaran (2005).
[2] Normality cannot be tested on qualitative surveys. The papers cited above used cross sectional quantitative data about inflation expectations.

perceived inflation rate.[3] By taking this rate as given the quantification of the expected inflation rate is basically the same as the quantification of the perceived rate of inflation. Define f, g, h, i and j, as:

$$f = P(\pi^e < -u) = F(-u) \tag{10}$$

$$g = P(-u < \pi^e < u) = F(u) - F(-u) \tag{11}$$

$$h = P(u < \pi^e < m - v) = F(m - v) - F(u) \tag{12}$$

$$i = P(m - v < \pi^e < m + v) = F(m + v) - F(m - v) \tag{13}$$

$$j = P(m + v < \pi^e) = 1 - F(m + v) \tag{14}$$

Let n and ω denote the mean and the standard deviation of the aggregate distribution of expected inflation rate π^e. The average perceived inflation rate is denoted by m as before and parameters u and v show how wide the ranges are where respondents consider expected inflation rate zero or equal to the perceived inflation rate. After solving the equations (10)–(14), one can show that

$$n = \frac{m(H + I)}{H + I - (F + G)} \tag{15}$$

$$\sigma = \frac{-2m}{H + I - (F + G)} \tag{16}$$

$$v = \frac{m(G - F)}{H + I - (F + G)} \tag{17}$$

$$u = \frac{m(I - H)}{H + I - (F + G)} \tag{18}$$

where $F = N^{-1}(1 - j), G = N^{-1}(1 - i - j), H = N^{-1}(1 - h - i - j), I = N^{-1}(1 - f).$

The crucial assumption to quantify inflation perceptions – and indirectly inflation expectations – is how the "moderate" rise in prices is defined. In the related literature the "moderate" inflation rate is assumed to be constant. There are two ways to choose its constant level. The first one is to take the average inflation rate through a longer period as the "moderate" inflation rate. The second is to set the "moderate" level so, that on average perceptions are equal to the actual inflation rate. However these approaches are acceptable only if the inflation rate is stationary, otherwise assuming a constant level for the "moderate" inflation rate can be misleading. The inflation rate was stationary in United Kingdom, but not in the other two countries.

To quantify perceptions I assumed that the perceived inflation rate is equal to the headline inflation rate on average. In case of Czech Republic and Hungary I relaxed the constant "moderate" inflation rate assumption. In both countries at the beginning of the sample period the inflation rate fluctuated at a relatively high level, which was followed by a disinflation period and then the inflation rate leveled out at a lower level. I assumed that the households' perceptions about the "moderate" inflation rate followed similar pattern. Technically I divided the sample into three subperiods. In the first and the third subperiod the moderate rate of inflation was assumed to be constant, and in the second subperiod it assumed to decrease gradually. The constant level in the first and third period and the beginning and the end of the second period was set by minimizing the squared difference of the perceived and actual inflation rate on the whole sample. According to the results of

[3] In Berk (1999) it was assumed that the aggregate perceived inflation rate is known by every consumer, and this is what they use when they form expectations and answer survey questions. This assumption is controversial as it is not consistent with the assumptions used to quantify the perceived rate of inflation. Fortunately the assumption can be relaxed. If individual expectations are based on the individual perceptions, the aggregate perceived inflation rate can still be used to scale the expected aggregate inflation rate.

Table 3

Relative volatility of inflation perceptions and expectations

	Czech Republic	Hungary	United Kingdom
Average quarterly absolute change of the headline inflation (percentage points)	0.82	1.46	0.19
Average quarterly absolute change of the perceived inflation (percentage points)	0.45	0.84	0.15
Average quarterly absolute change of the expected inflation (percentage points)	1.03	1.18	0.30

minimizing squared differences the length of the second period is much longer in Hungary than in Czech Republic, which is acceptable as the disinflation was also more gradual.[4]

The quantified perceived and expected inflation rates for the three countries are shown in Chart 9-11. The perceived and expected inflation rates are the least persistent in Hungary, but relative to the headline inflation rate they are quite volatile also in the other two countries (Table 3). Focusing on the end of the sample periods it is apparent, that during the oil and food price shock beginning in 2007 inflation perceptions and expectations remained below the headline inflation rate in Czech Republic and United Kingdom – although perceptions and expectations rose considerably also in these two countries – but in Hungary they exceeded the official numbers. These stylized facts may indicate that inflation expectations are the least anchored in Hungary. This feature of expectations will be discussed in a more formal way later.

[4] As a result of the chosen method to set the "moderate" inflation rate in the second subperiod the "moderate" and actual inflation rate decreases parallel. It can be argued that perceptions follow the disinflation only with some delay and the decrease of the perceived "moderate" inflation rate should be slower. To address this issue I used an alternative method to set the "moderate" inflation level. I set the level in each period so, that if the households perceptions of the "moderate" inflation level had have been that constant during the previous three years, the perceived and actual inflation rate would have been equal on average during that period. By using this method the perceived "moderate" inflation level is much more backward looking. The results discussed later proved to be robust to the different methods of quantifying inflation rates. This is a consequence of that the results depend on the short run dynamics of the quantified inflation rate, which is not sensitive to the selection between alternative methods.

2 Data for the SVAR estimation

After deriving the time series of the quantified inflation expectations and perceptions, the next step is estimating the SVAR to investigate the relationship between inflation expectations and other macroeconomic variables, most importantly the headline inflation rate. In the SVAR four endogenous variables are used: inflation expectations, CPI, average nominal wage in the private sector and the volume of retail sales. I included CPI and nominal wage, as my main interest is to explore whether changes in expectation influence prices and wages. I added retail sales as a business cycle indicator, which helps to identify structural shocks. Estimating the SVAR I used the log differences of CPI, nominal wage and retail sales and simple differences of inflation expectations.

The data for the SVAR was picked from different sources. The time series of expected inflation is the result of the Carlson–Parkin quantification method as previously discussed. All other data I use is publicly available. The volume of retail sales, CPI and average nominal wage in the private sector for Hungary are published by the Central Statistical Office[5]. In case of UK and Czech Republic the volume of retail sales is from the national statistical offices' websites, CPI is from the IFS database and nominal wage in the private sector is from the Eurostat database. Before estimating the SVAR the time series of retail sales, nominal wage and CPI data were seasonally adjusted.

I also included VAT change dummies as exogenous variables in the SVAR. The importance of this variable will be discussed later. The dates of VAT changes are available from the European Commission's homepage.[6]

To estimate the SVAR I used shorter sample than what was available. The reason was that in the full sample some variables were not stationary, so the estimation of the SVAR did not provided plausible parameters in the sense that without shocks the endogenous variables did not converge to plausible values. To ensure the validity of the estimation I chose the sample period 1999 Q1–2009 Q1 for the Czech Republic, 1996 Q1–2009 Q1 for Hungary and 1993 Q1–2009 Q1 for United Kingdom.

The robustness of the results was checked extensively. Instead of retail sales I used also consumption as business cycle indicator. As in Hungary the monetary regime was different in the first half of the sample I estimated the SVAR also on a shorter sample, which included observations between 2001 Q1 and 2009 Q1. For all specifications the qualitative results remained the same.

[5] The wage data for Hungary is quite volatile and occasionally distorted by government measures. These measures included tax changes, actions to battle bogus contracts and the tightening of inspections by the tax authority. Tax changes also led to change in the timing of bonus payments. Eppich and Lőrincz (2007) developed several methods to filter out the effect of government measures from the wage dynamics. The estimation was repeated with this filtered data, but the results remained unchanged.

[6] URL: http://ec.europa.eu/taxation_customs/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf.

3 Identifying the SVAR parameters

For the identification of the effect of expectations on prices and wages I defined three shocks: a demand, a supply and an expectation shock. Using demand and supply shocks is quite standard in SVARs. The supply shock can be interpreted as a technology shock, demand shock can be regarded as a preference or a government spending shock. Because of the nature of these shocks, after they occur inflation expectations are expected to move parallel with or follow the headline inflation rate. Hence these shocks are accounting for the periods when inflation expectations were mainly adaptive which seemed to be the case in most of the sample periods. However expectations sometimes seemed to be less adaptive and inflation and expectation dynamics were different. These episodes could happen because of various reasons.

First of all households' expectations are not fully rational forecasts and occasionally may be influenced by news from the media. Lamla and Lein (2008) showed that newspaper articles and TV news have an important role in forming consumers' inflation expectations. They showed that higher intensity of reporting makes consumers more likely to update their expectations and brings them closer to the full information rational forecast. On the other hand eventually the media causes bias in consumer expectations. The media tends to use exaggerated and incomplete information, and consuming these reports distorts the consumers' forecasts.

One empirical example for the bias caused by the media was the period before the EU accession, when in the new member states expectations rose considerably although economic theory suggested that a drop in inflation was to be expected. Expectations also rose rapidly in the eurozone countries before introducing the euro.

Consumers' expectations may become also biased, because they tend to overweight frequently purchased items, like food and gasoline. Also products with regulated prices can be overweighted, because their prices are more transparent and attract more media attention. Furthermore consumers are more sensitive to price increases than decreases, so during the period of big relative price changes consumers tend to perceive a price increase on average.

Although in the previous examples consumers did not act as professional forecasters of the headline inflation rate, their expectations may still play an important role in price and wage setting decisions and can prove to be self-fulfilling. The third shock, the expectation shock is defined to account for these types of changes in inflation expectations and to explore this self-fulfilling nature of expectations. As it was discussed before expectation shocks are hard to connect to specific macroeconomic variables and they can be taken as the "noise" when looking at the time series of inflation expectations. On the other hand exactly this feature of expectation shocks make them helpful to assess whether expectations affect the price index.

It is important to note, that expectations lead inflation also in case of previously announced changes of consumption taxes, but obviously did not cause the change in the inflation rate. During the sample periods the VAT rate changed in each country. As I am interested in whether changes in expectations affect prices and wages, it is essential to control for these episodes. Technically I used two dummy variables to filter out the effect of each VAT rate change. The first one was used to control for the effect of the tax change on the endogenous variables – most importantly on expectations – one period before the tax change, the second was introduced to control for the effect on endogenous variables – most importantly on inflation – in the period when the tax change happened.

Formally I impose the following zero and sign restrictions.[7] I assume that after the demand shock – for example a government spending shock – both retail sales and inflation rises and I do not impose any restriction on the average nominal wage and inflation expectations. Theoretically the effect of the demand shock is expected to be positive on both variables. A positive supply shock – for example a positive technology shock – is assumed to increase retail sales and decreases the inflation rate. There are no restrictions on inflation expectations and on the nominal wage. The expected sign of supply shock on inflation expectations is negative. After the supply shock a real wage increase is expected, but as inflation is falling the effect of the

[7] The sign restrictions are imposed for four periods. The number of restricted periods was chosen to distinguish between noise and meaningful shocks in the data. However using less restricted periods does not change the results qualitatively.

Table 4

Zero and sign restrictions in the SVAR

	Demand shock	Supply shock	Expectation shock
Retail sales	+	+	0
CPI	+	–	0
Nominal wage	?	?	0
Expected inflation	?	?	+

shock on nominal wage is ambiguous. I assume that the expectation shock affects immediately only inflation expectations, and the other variables are affected only one period later. There are no restrictions on the effect on retail sales, CPI and nominal wage after the first period.

4 Estimating the SVAR with sign restrictions

First a VAR(2) model was fitted to quarterly observations for the three countries. The number of lags in a VAR is usually determined by the Akaike or Swartz criteria. In the estimated VARs the value of the Akaike and Swartz criteria are very similar in case of using one or two lags. Because of bigger flexibility I chose two lags.[8]

The identification of the SVAR parameters was done as the following. Consider a general reduced form VAR(p) model[9]:

$y_t = A(L)y_t + e_t$, where $A(L) = A_1 L + ... + A_p L^p$ is a p[th] order matrix polynomial and L is the lag operator.

The MA representation is $y_t = (I - A(L))^{-1} e_t = B(L)e_t$.

Assume that ε_t is the shock in the structural form of the VAR, $E[\varepsilon_t \varepsilon_t'] = I$ and $e_t = H\varepsilon_t$. Then $E[e_t e_t'] = HH' = \Sigma$.

As H has more free parameters than Σ, restrictions should be imposed. I use both zero and sign restrictions.

Note that by putting the expectation shock last the Choleski decomposition of Σ satisfies the zero restrictions. Denote this decomposition as $\Sigma = PP'$, where P is a lower triangular matrix.

Let Q be an orthonormal matrix, that is a matrix with the property $QQ' = Q'Q = I$. Since $\Sigma = PP' = PQQ'P'$, PQ is also a potential candidate for the relationship between shocks of the reduced form and the structural form of the VAR, if all restrictions are satisfied.

The estimation of the structural parameters was done with the following algorithm:

1. First the reduced form is estimated with two lags.

2. Take the Choleski decomposition ($\Sigma = PP'$) of the estimated covariance-variance matrix.

3. Generate a random orthonormal matrix of the form:

$$Q = \begin{bmatrix} q_{11} & q_{12} & q_{13} & 0 \\ q_{21} & q_{22} & q_{23} & 0 \\ q_{31} & q_{32} & q_{33} & 0 \\ q_{41} & q_{42} & q_{43} & 1 \end{bmatrix}.$$

Q is the rotation matrix. PQ is a candidate matrix for the structural relationships and satisfies the zero restrictions.

4. Calculate the impulse responses, and check sign restrictions. If they are satisfied store PQ.

5. Repeat the steps from the third to take enough draws of Q to scan the space of possible impulse responses that satisfy the restrictions.

6. The draws that satisfy the restrictions provide a range of responses. To summarize the result one should calculate mean and probability bands.

[8] I also repeated the estimation of structural parameters based on a VAR with one lag. The qualitative results were the same.

[9] The exogenous variables play a role only in the estimation of the reduced form of the VAR. For simplicity I left these variables out throughout the discussion of the estimation method.

5 Results

Chart 12-14 show the mean and – as quite common in the VAR literature – the 16th and the 84th quantiles of the impulse responses for each horizon between zero and 20. Although sign restrictions are considered to be weak in general some results are quite significant on shorter horizons.[10]

The sign of the estimated impulse responses are broadly in line with theoretical considerations in case of all countries. Demand and supply shocks have an effect until 4-8 quarters in general. In case of demand and supply shocks the sign of responses was restricted for retail sales and inflation. Considering the unrestricted impulse responses demand shocks had relatively small effect on wages and a quite persistent positive effect on expectations in case of Czech Republic and Hungary. In case of supply shocks wages remain more or less unchanged in all countries, so real wage increases. This is consistent with what we expect after a technology shock. Supply shocks also have a strong effect on expectations up to more than one year. Expectation shocks played an important role in inflation and wage dynamics. The effect on inflation and nominal wage is quite persistent in general.

To evaluate and interpret the magnitude of the responses I compared the impulse responses for the three countries. Chart 15-17[11] compare the effect of the expectation shock on expectations, inflation and wages. Expectation shocks had the biggest impact in Hungary. The effect of the expectation shock on inflation expectations and inflation is quite persistent for all countries. Central banks tend to focus also on the connection between inflation expectations and wage bargaining. If expectations are high, then employees demand higher wages which may be hard to resist for employers. Higher wages may lead to loss in competitiveness and higher prices. The results show that expectation shocks increase nominal wages in all countries. In case of Czech Republic and Hungary the effect is also quite persistent.

According to Chart 18-19 the effect of demand shocks on inflation is quite big in all countries, but the impact on expectations is relatively small. The effect on inflation expectations and inflation is the most persistent in the Czech Republic, in the other two countries demand shock are less important in the evolution of inflation expectations and inflation. The small and delayed effect of the demand shock on expectations also indicates that expectations are updated gradually, and even on the long run the change in the inflation rate and inflation expectations can differ considerably.

Chart 20-21 show the effect of supply shocks on inflation expectations and inflation. The size of the effect is similar in case of expectations and inflation. This can be a sign of that households are more sensitive to supply than to demand shocks. This is consistent with empirical findings, which showed that households are particularly sensitive to energy prices. In the selected countries an increase in energy prices can be considered as a negative supply shock and during the sample periods these prices were quite volatile. Relative to the increase in the inflation rate, the increase in expectations is the biggest in Hungary, which may indicate that the Hungarian households' expectations are the least anchored.[12]

Using the mean impulse responses I also did a shock decomposition exercise for the evolution of the inflation rate. Calculating the contribution of shocks to inflation volatility for the three countries, it's apparent that inflation was the most stable in the UK and the contribution of expectation shocks is low (Table 5). In the Czech Republic inflation volatility is higher, but the contribution of expectation shocks is still relatively low. In Hungary the inflation volatility caused by the identified shocks is also high and the contribution of expectation shocks is much more important than in the other countries.

[10] The impulse responses show the effect of the structural shocks of the size of one standard deviation. In case of inflation expectations the effect is measured in percentage points. In case of retail sales, inflation and nominal wage the impulse responses show the effect on the quarterly indexes.

[11] In Chart 15-21 in case of retail sales, inflation and nominal wages the impulse responses show the impact on the annualized quarterly indexes, so the effects on expectations and on the other variables are directly comparable.

[12] Using this simple SVAR framework does not allow to compare the stability of inflation expectations in different countries directly. There is no obvious way to distinguish anchored expectations from not-anchored expectations in periods with small aggregate shocks. To overcome this problem one can proxy the size of the shock with its effect on inflation. If the effect of the one standard deviation shock on inflation is similar for countries A and B, but the impact on expectation is bigger in A than B, then one can argue that expectation are less anchored in country A.

Table 5

Contribution of shocks to the variation of the inflation rate

	Czech Republic	Hungary	United Kingdom
Absolute contribution of expectation shocks (quarterly average)	0.15	0.20	0.12
Absolute contribution of demand shocks (quarterly average)	0.13	0.13	0.10
Absolute contribution of supply shocks (quarterly average)	0.26	0.17	0.13
Absolute contribution of VAT shocks (quarterly average)	0.15	0.31	0.05
Total absolute contribution of shocks (quarterly average)	0.78	0.81	0.56

Table 6

Contribution of shocks to the variation of inflation expectations[13]

	Czech Republic	Hungary	United Kingdom
Absolute contribution of expectation shocks (quarterly average)	0.14	0.23	0.11
Absolute contribution of demand shocks (quarterly average)	0.05	0.02	0.04
Absolute contribution of supply shocks (quarterly average)	0.09	0.14	0.07
Absolute contribution of VAT shocks (quarterly average)	0.05	0.30	0.02
Total absolute contribution of shocks (quarterly average)	0.33	0.70	0.24

The decomposition of changes in inflation expectations reinforce the previous statement that expectations seem to be the most anchored in the United Kingdom and the least in Hungary (Table 6). The volatility of expectations are the highest in Hungary and comparable to the volatility of the inflation rate. In the other two countries the volatility of the expected inflation rate is less than the half of the volatility of the headline inflation rate. Expectation shocks play an important role in all countries. In Hungary changes in the VAT rate are also important sources of the variability in expectations and may explain why monetary policy was relatively less successful in anchoring expectations.

[13] Inflation expectations are referring to annual inflation indexes. To make the values comparable to Table 5 I divided the average contributions with 4 as the inflation rate is a quarterly index.

6 Conclusion

This paper explored the connection between inflation expectations, inflation and nominal wages. To quantify household survey responses about perceived and expected inflation the extended version of the Carlson–Parkin method was applied. I argued that increases in inflation expectations can be self-fulfilling and used an SVAR framework to provide empirical evidence for Czech Republic, Hungary, and United Kingdom, that changes in expectations influence prices and wages considerably. The results may be taken as an empirical support to the new strand of modeling literature, which relaxes the rational expectations hypothesis. The SVAR methodology enables to evaluate the stability of the households' inflation expectations. Comparing the impulse responses inflation expectations seems to be the most anchored in United Kingdom and least in Hungary.

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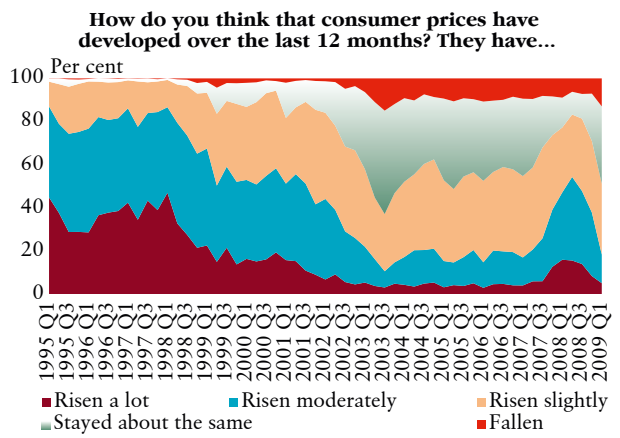
Appendix

Chart 1

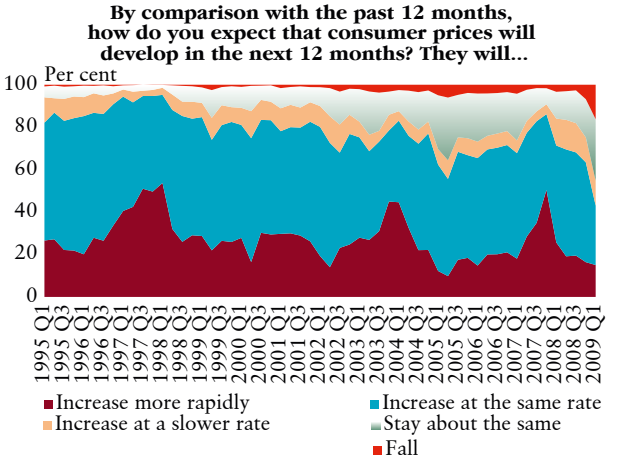
Inflation perceptions in the Czech Republic



Note: Fraction of respondents choosing respective responses, sample 1995 Q1–2009 Q1.

Chart 2

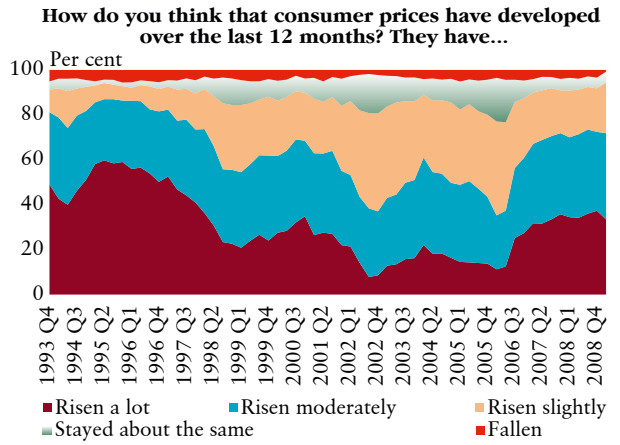
Inflation expectations in the Czech Republic



Note: Fraction of respondents choosing respective responses, sample 1995 Q1–2009 Q1.

Chart 3

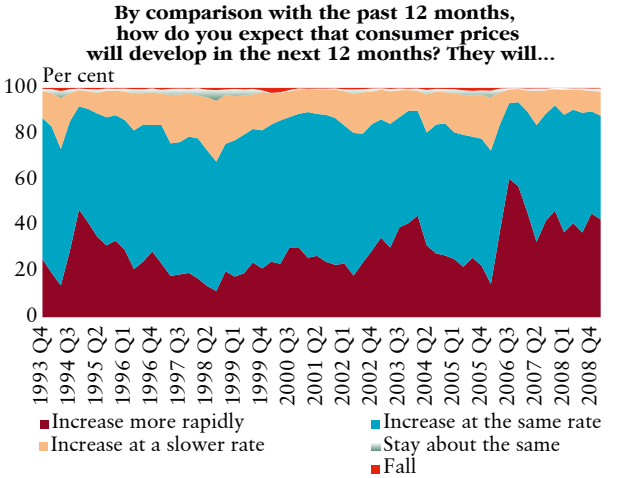
Inflation perceptions in Hungary



Note: Fraction of respondents choosing respective responses, sample 1993 Q1–2009 Q1.

Chart 4

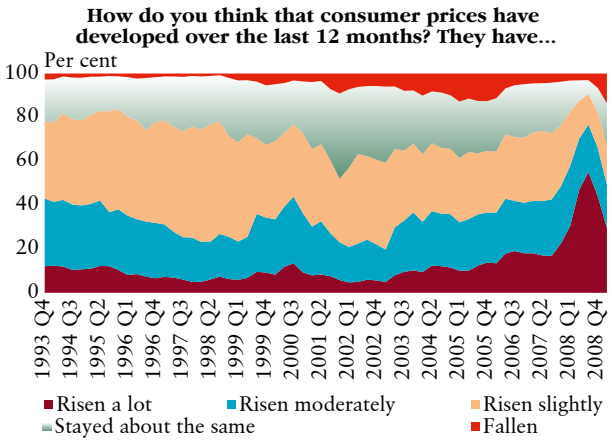
Inflation expectations in Hungary



Note: Fraction of respondents choosing respective responses, sample 1993 Q1–2009 Q1.

Chart 5

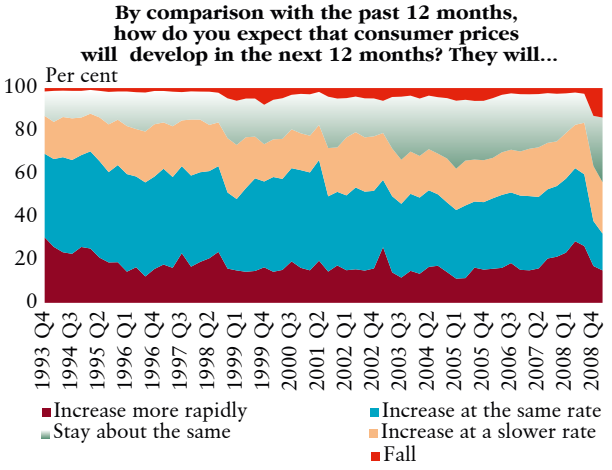
Inflation perceptions in the United Kingdom



Note: Fraction of respondents choosing respective responses, sample 1995 Q1–2009 Q1.

Chart 6

Inflation expectations in the United Kingdom



Note: Fraction of respondents choosing respective responses, sample 1995 Q1–2009 Q1.

Chart 7

Aggregate distribution of the perceived inflation rate

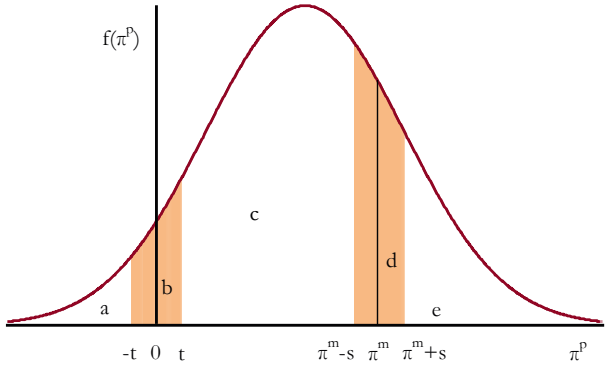


Chart 8

Aggregate distribution of the expected inflation rate

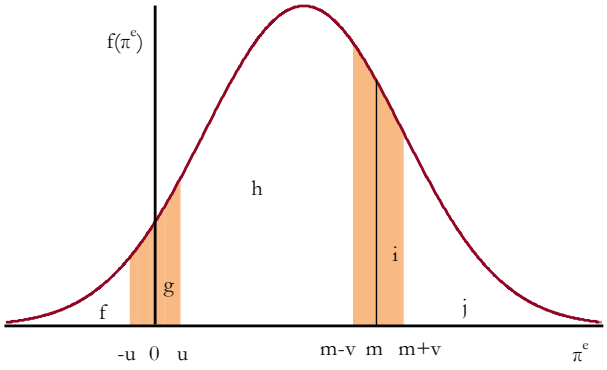


Chart 9

Quantified inflation perceptions and expectations in the Czech Republic

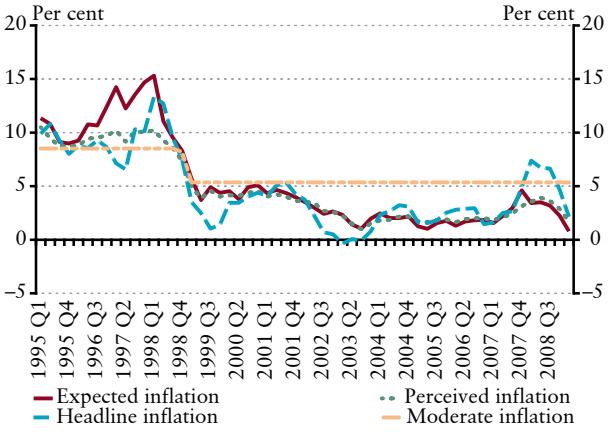


Chart 10

Quantified inflation perceptions and expectations in Hungary

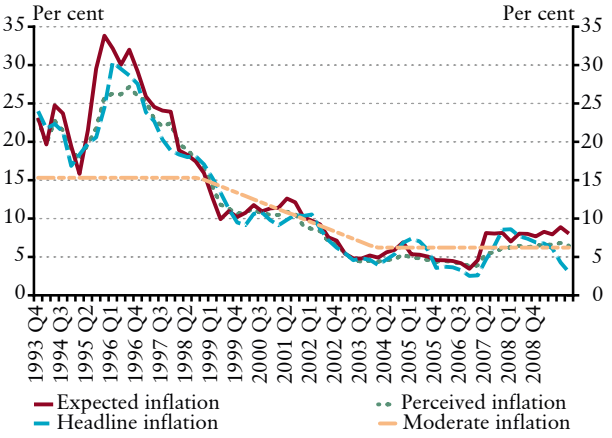


Chart 11

Quantified inflation perceptions and expectations in the United Kingdom

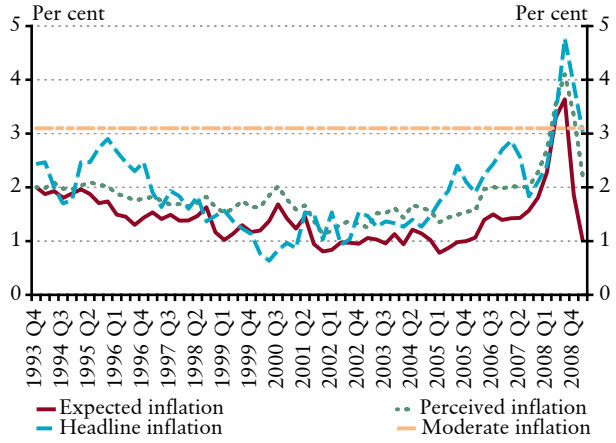


Chart 12

Impulse responses estimated for the Czech Republic

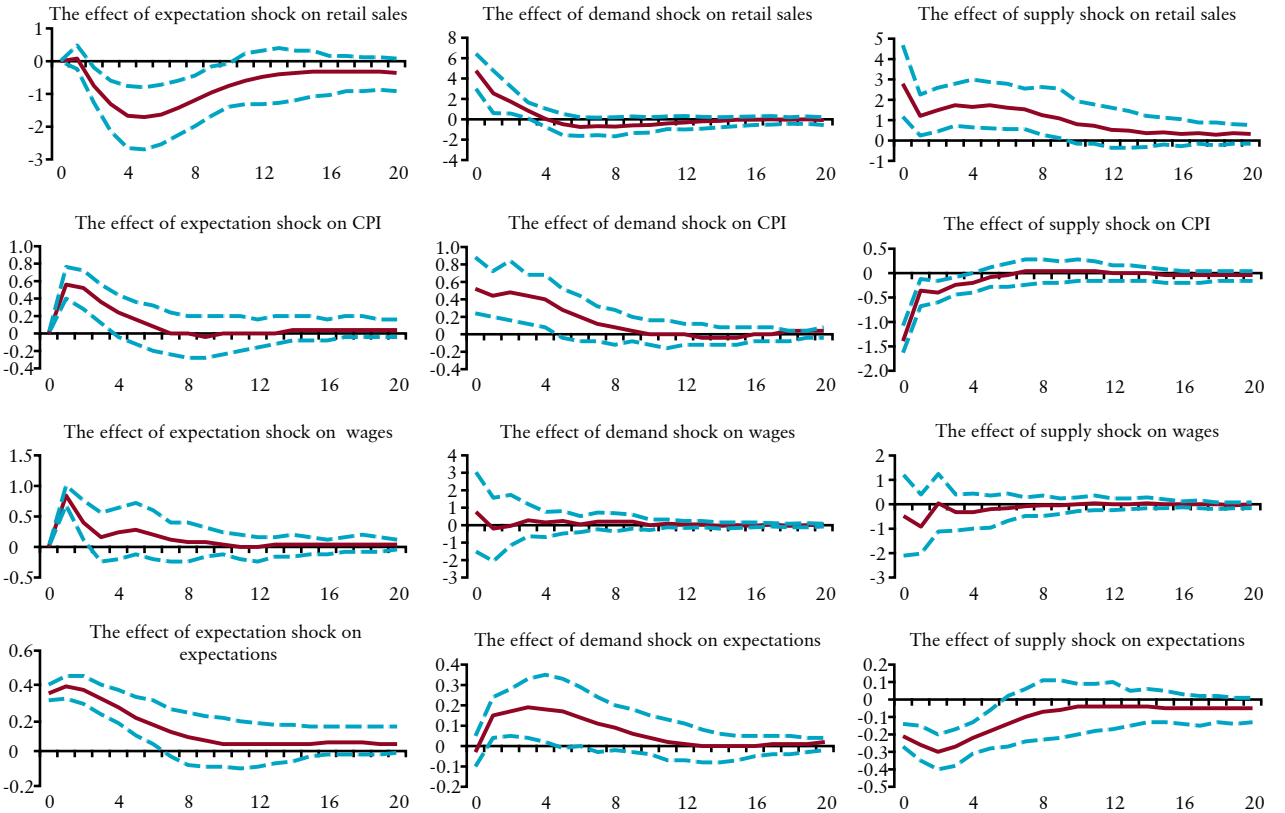


Chart 13

Impulse responses estimated for Hungary

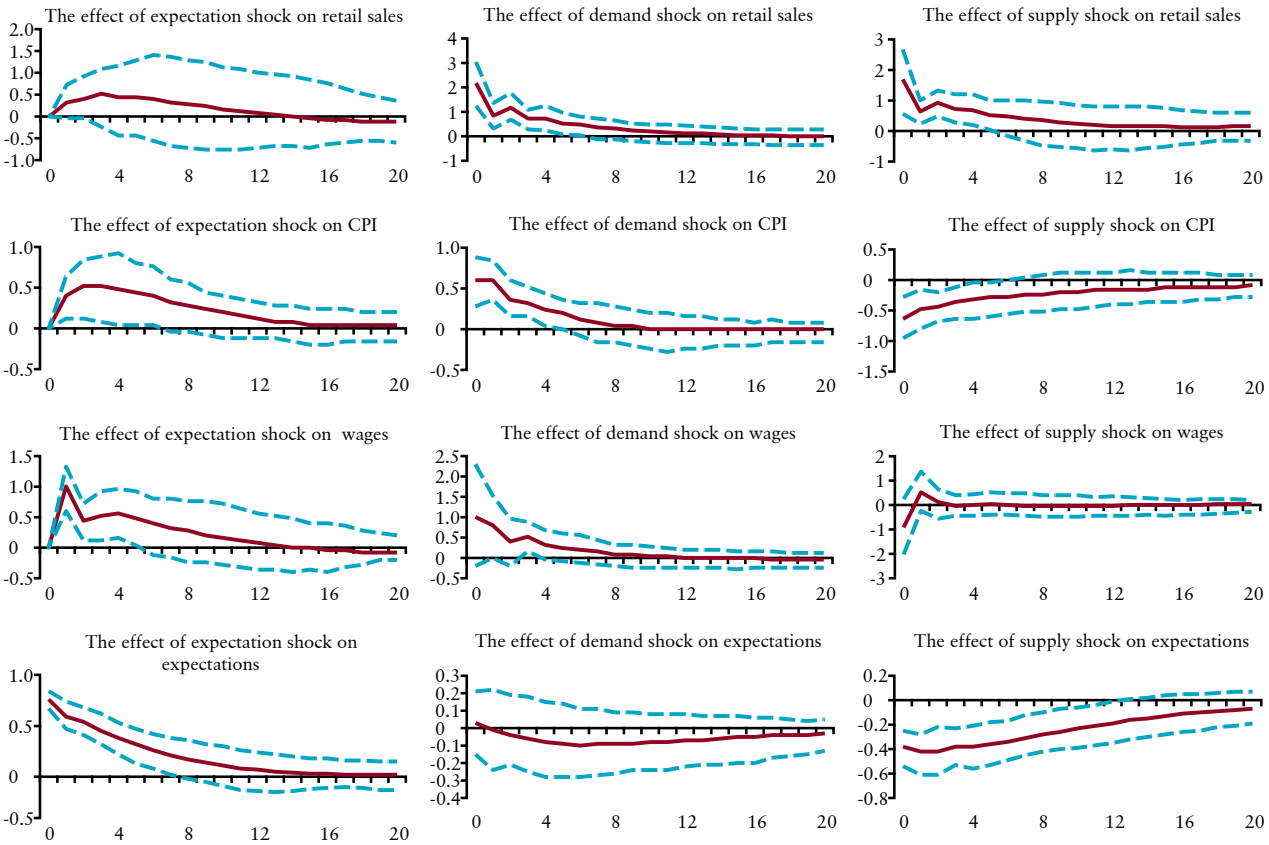


Chart 14

Impulse responses estimated for the United Kingdom

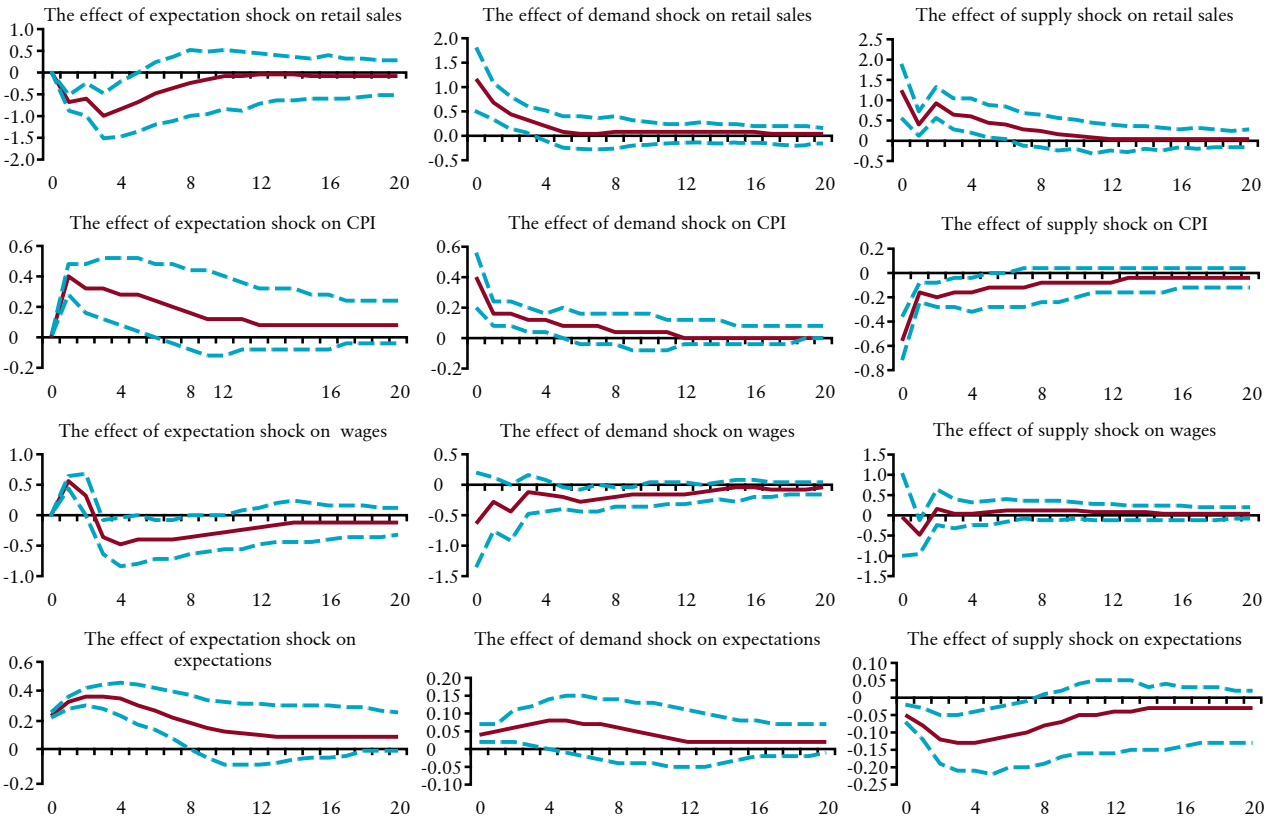


Chart 15

The effect of the expectation shock on inflation expectations

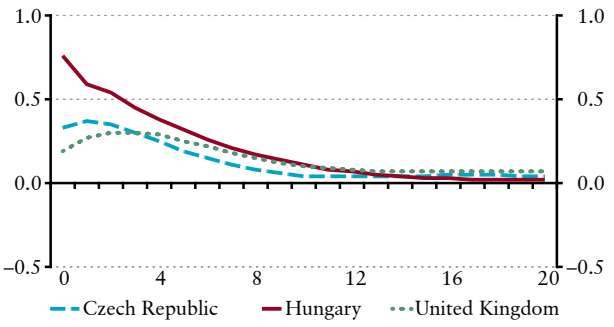


Chart 16

The effect of the expectation shock on inflation

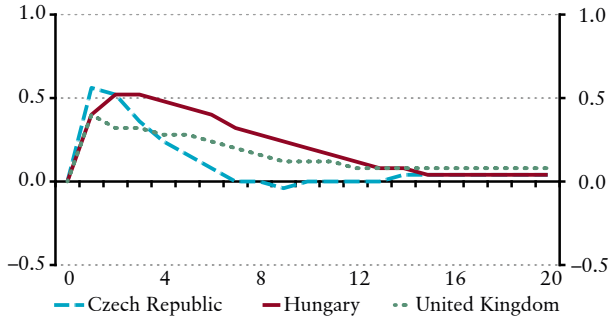


Chart 17

The effect of the expectation shock on nominal wage

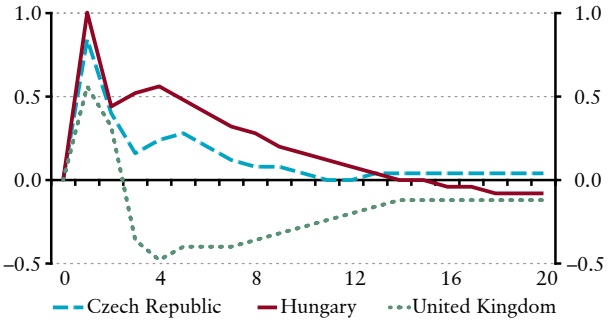


Chart 18

The effect of the demand shock on inflation expectations

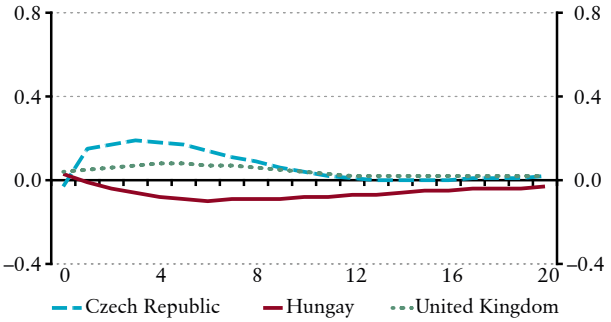


Chart 19

The effect of the demand shock on inflation

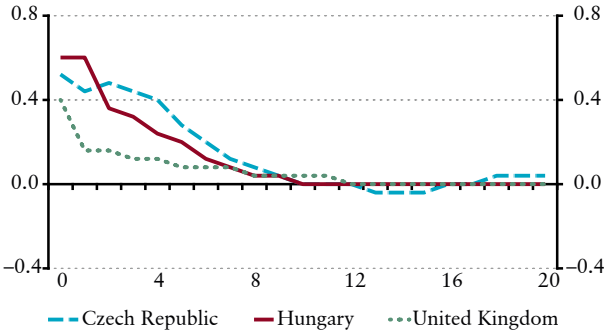


Chart 20

The effect of the supply shock on inflation expectations

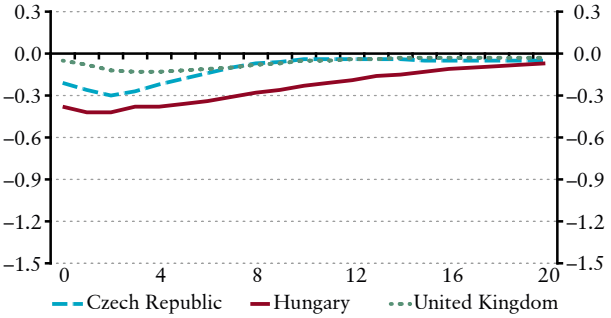
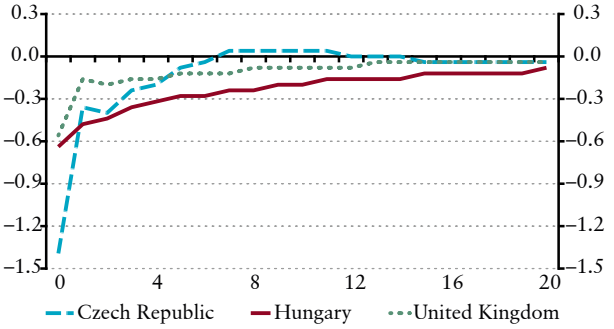


Chart 21

The effect of the supply shock on inflation



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