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ARE CONSUMER INFLATION EXPECTATIONS AN INTERNATIONAL PHENOMENON?
Results of spatial panel regression models

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Are consumer inflation expectations an international phenomenon? Results of spatial panel regressions models[1]

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Abstract

This study examines the potential drivers and their spatial components of inflation expectations of consumers in 22 European Union countries by using the spatial Durbin model. The potential determinants are drawn from the macrosphere (oil prices, food prices, house prices, industrial production), financial sphere (money market interest rates, nominal effective exchange rate, key policy rate), and economic favourable cognition variables (consumer confidence indicator, short-term inflation volatility, medium–term memory reversal of inflation expectations). The implemented binary spatial weight matrices are based on the geographical and economic distances. The economic distance weights define the European Union global trade partners as the most proximal neighbours. Our results confirm the existence of an inherent spatial component in short-term consumers' inflation expectations even when excluding effect of inflation rate anchoring. This finding may provide a possible explanation for disruptions found in monetary policy transmission mechanism in small and open economies. From other perspective, the more interlinked consumers' expectations may open the path to better business cycle synchronisation and strengthen the process of EA convergence, improving the conditions for efficient and effective monetary policy conduct.

Keywords: consumers' inflation expectations, spatial analysis, European Union

JEL codes: E52, E61, C21

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Introduction

The forward-looking attitude of monetary policy focuses on influencing inflation expectations of economic agents. This modern monetary policy approach has its origins in the new Keynesian Philips curve (NKPC) setting, in which one of the main determinants of current inflation are inflation expectations of economic agents, and has been well described by Roberts (1995), Goodfriend & King (1997); Clarida, Gali & Gertler (1999, 2000), Woodford (2003), Blanchard & Gali 2007, Galí (2008) and Romer (2012).

The inflation expectations of households and small entrepreneurs are, according to our review of the literature, analysed to a lesser degree than the expectations of professional forecasters or market-based inflation expectations. The private agents are perceived as highly heterogeneous non-specialists whose choices and economic behaviour are affected by economic situations and cognitive mechanisms. Berge (2018) confirmed that models with which households form the short term inflation expectations differ and are less described by typical macroeconomic indicators than those used by professionals. The consumers' expectations are also more dispersed than the professionals' expectations (Mankiw et al. 2003). Notably, the importance of consumers' expectations should not be omitted. Coibion et al. (2018) argued that implementing inflation expectations channel as more formal monetary policy tool requires focusing on households and firms inflation expectations (even more than on professionals' expectations). The inflation expectations of private agents are biased expectations, strongly affected by different prices components and factors from different sources. The recognition of these factors and mechanisms connected with this bias may provide a better understanding of spending, pricing, and wage setting (Sousa & Yetman 2016). The use of consumers as price-setters was introduced by Coibion and Gorodnichenko (2015) and is in line with Kumar et al. (2015). This approach assumes the use of consumers as proxy price-setters of households, small entrepreneurs, and managers because of their poor economic knowledge (Kumar et.al. 2015) .

The inflation expectations collected by central banks to conduct monetary policy are short (mainly one-year-ahead), medium, and long term. The medium- and long-term expectations anchoring is monitored by central bankers because their fluctuations over the target level may compromise the monetary policy effectiveness (Cote 2015). The analysis of short-term inflation expectations updates harmonises with the analysis of consumers' expectation bias and economic choice mechanisms. As the medium- and long-term inflation expectations should be anchored to the target level, the short-term inflation expectations may be more volatile, in line with the business cycle and reacting to economic shocks. Notably, this volatility should not affect the long- and medium-term expectations anchoring significantly (Posen 2011). The analysis of the potential divers of short-term inflation expectations of consumers may provide a better understanding of the expectations formation mechanism. By investigating the sensitivity of short-term expectations' reaction to different factors, we hope to gain valuable insights into the possible effects of changes in domestic and foreign factors and consumers anticipation of a current state of the economy (i.e. domestic and global) and its rapid changes. Consequently, these factors may further influence the anchoring of long-term expectations.

In the current highly interconnected world economy, the role of globalisation in shaping monetary policy has been widely debated. As argued in Borio (2017), globalisation, technological changes, and the greater role of global value chains in production may strongly affect price mark-ups. Overall domestic inflation in the NKPC setting is consequently shaped by imported inflation and foreign competition channels (further discussion in Abbas et al. 2016). Hence, although the issue of price formation by firms in open economy conditions has attracted its well-earned attention, the role of trade interlinkages stemming from deepened trade integration in shaping consumers' inflation expectations has not been satisfactorily discussed in a wider literature.

By addressing all the aforementioned relevant issues, this study investigates the drivers of short-term inflation expectations of consumers in the European Union (EU) member states from 2005–2016 by incorporating the spatial components of inflation expectations and their determinants. The influence of economic conditions in neighbouring countries on domestic inflation expectations of consumers is expected to be transmitted through geographical distance and a trade-based matrix of global trade partners. We first employ a standard fixed effect panel model and then introduce spatial Durbin model (SDM) framework.

According to our review of the literature, two elements distinguish our research from the relevant strands in the literature. The first is the presence of the spatial dimension of consumers' inflation expectations. The spatial dimension incorporates geographical and economic distance concepts that hypothesise that changes in the neighbouring economic conditions are transmitted into domestic inflation expectations due to their close economic relatedness. The second element builds on the assumption that the determinants of aggregate short-term inflation expectations of consumers are from the macro- and financial sphere and economic favourable cognition. Despite the high heterogeneity of expectations of consumers, we assume that an examination of these cognitive drivers will provide logical results also on the macrolevel, on the aggregate data, and may affect the expectations through their spatial linkages.

In this study, we examine the potential drivers of aggregate one-year-ahead survey-based inflation expectations in 22 EU member states: Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, the Netherlands, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. The EU may be perceived as a single market and custom union. The free flow of goods and services and movement of people within the EU may affect the formation of inflation expectations by consumers in member states and increase the significance of the spatial component. In this study, the potential determinants of consumer inflation expectations are divided into macrofactors (oil prices, food prices, house prices, industrial production), financial and monetary sphere factors (money market interest rates, nominal effective exchange rate, key policy rate), and factors concerned the economic favourable cognition factors (consumer confidence indicator, short-term inflation volatility, medium-term memory reversal of inflation expectations).

The main research findings and our contribution to the literature include the confirmation of the existence of spatial component in shaping short-term inflation expectations. From the perspective of monetary policy, managing the inflation expectations of domestic consumers should consider the domestically driven economic determinants and spatial dimension of agents' expectations in the EU as a whole.

The paper is structured as follows. The first two sections describe the theoretical model, main assumptions, and potential drivers of inflation expectations of consumers. The next three sections present the methodology and data description. The last two sections are divided to empirical results and conclusions with implications for implementing monetary policy in the EU.

1. Theoretical model and main assumptions

Three main strands in the literature are oriented on consumer inflation expectations. The first prospects for the potential drivers of consumer expectations and looks for the factors with a significant impact on inflation expectations. This approach examines the consumer inflation expectations on the aggregate level. In the literature, these potential drivers have their origin in macrotheory, especially the modern Philips curve. The approach includes, in addition to headline inflation, several factors from the real economy and financial sector. According to the narrowed Muthian rationality theory, economic agents cannot transform all the economic indicators (Muth 1961) to define their inflation expectations based on a broad context of the whole economic situation. Instead, they require simplifications. The necessity to transform many economic indicators into simplifications to create an expectation is stated by the theory of bound rationality expressed by Simon (1978) and Radner (1975) and in cognitive science by Li & Vitanyi (1997) and Chater & Vitanyi (2003). These simplifications may be conveyed to consumers by the monetary policy authorities or private broadcasting and print media, and may take a direct form of previously prepared most common to the public macro- and financial indicators. This strand of literature presents a broad list of potential determinants of inflation expectations, explained in the next section.

As consumer inflation expectations are highly heterogeneous, different factors may be important for different consumers. This view was emphasised by Pfajfar (2013), who showed that consumers shape their inflation expectations based on different datasets and sources. According to this view, we move from the macrolevel inflation expectations' determinants shaping and anchoring inflation expectations to the microlevel. The conclusions from the microlevel analysis show great heterogeneity among the groups of consumers. This heterogeneity includes the use of adaptive learning models or different abilities to process the information (Pfajfar 2013). Heterogeneity has also its origins in consumers' socioeconomics and demographics (Pfajfar & Santoro 2009), financial situation, purchasing and choice habits (Ehrmann et al. 2015), and savings attitudes (Acedański 2017). At the microlevel, researchers have not focused on determinants shaping inflation expectations but on the process of their formation and searching for cognitive patterns. Claus & Nguyen (2018) confirmed the significant role of consumers' emotional responses in shaping the expectations. As consumers are non-specialists, the list of potential drivers of inflation expectations must be expanded by cognition factors. At the aggregate level, these factors may be titled as economically favourable cognitions and represent the consumers' conviction on the state of the economy.

The shape, source, form and method of creation of the economic state simplifications are even more important than the state of an economy. How economic information is processed, transformed, and communicated to consumers also affects the macrofactors used in shaping inflation expectations. Consequently, consumers may shape their inflation expectations based on commonly available, up-to-date, macrofactors. According to review of the literature, different information channels and their distortions [the epidemiological theory of expectations by Caroll (2003)] influence expectations; however, because the analysis is performed on aggregate data, searching for channels and their distortions is difficult. Instead, we assume the lagged influence of selected factors on consumers' inflation expectations. Notably, the time of reaction of consumers on the chosen factors' updates may also depend on the type of this factor. At this stage, we may only assume that the consumers react with a different time lag on (1) the updates of factors published in the media (lag connected with the information channel delays), and on (2) updates of factors consumers are already experiencing (the lags connected with the updates which are very quick to be exposed). The lags incorporate the time lags between the available information and their transformation by consumers into the inflation expectations.

Additionally, we assume that consumers, in shaping their inflation expectations, manage two dimensions that interpenetrate. The first dimension is domestic and supposes that consumers' inflation expectations are shaped by domestic macro- and financial factors and domestic economic favourable cognition. Secondly, every analysis of today's open economies requires considering the second dimension—the foreign one. The second dimension includes the macro- and financial factors and economic favourable cognitions from the surrounding economies which have an influence on domestic inflation expectations. This dimension builds on the presence of particular information channels and lags which have a significant impact on consumers' domestic expectations. According to the first Tobler's Law, 'everything is related to everything else, but near things are more related than distant things' (Tobler 1970). This second dimension depends on the how the neighbour economy is defined.

The aforementioned discussion determines three main assumptions which must be stated before we empirically test for drivers of consumer inflation expectations. Firstly, consumers, in shaping the inflation expectations, follow the economic situation simplifications based on chosen macroeconomic and financial factors and economic favourable cognition. The chosen macroeconomic factors are understandable, freely available, and up-to date. Secondly, because the information channels are imperfect, the chosen factors affect the consumer inflation expectations with the time lag. Thirdly, in an open economy, the consumers, in shaping their inflation expectations, consider two dimensions: domestic and foreign. These dimensions are interpenetrating. Based on previous considerations, several questions must be posed. (1) What are the potential macro- and financial factors that may influence consumer inflation expectations? (2) What measure may be used to include at least part of the economic favourable cognition? (3) What are the lags of each domestic and foreign factor that influence the consumer inflation expectations? Finally, we have questions concerning the second, foreign dimension of inflation expectations updates.

(4) Do and which foreign economies affect domestic consumer inflation expectations? (5) How to specify the economies with the greatest influence on domestic consumers' inflation expectations?

2. Potential drivers of consumer inflation expectations

The first and mostly used determinants of inflation expectations are the on-going inflation rate, past inflation rate (introduced as an expectations determinants by Carlson & Parkin 1975), and predicted future inflation (Roberts 1998, Oshima & Nakayama 1999). These factors overcome and specify the forward- and backward-looking component of shaping consumer inflation expectations. Geberding (2001) showed the significance of each component for France, Germany, Italy, and the EMU-3. The results for consumers were compared with those from consensus forecasts. In both cases, the backward-looking component approximated by a lagged inflation rate was significant and much larger (even of a half) than the forward-looking. The forward-looking component is significant but small, that is, there are the fractions of forward- and backward-looking consumers. Notably, the backward-looking fraction of consumers is dominant and much larger (Geberding 2001). The significance of backward-looking components on consumer inflation expectations has positive implications for conduct of monetary policy because it constipates the transmission of the monetary policy impulses from the aggregate demand to prices (Lagola 2017). The forward-looking component was analysed by Hubert (2014, 2015), who reported that inflation forecast has significant impact on inflation expectations. The recent studies performed by Łyziak & Paloviita (2018) confirmed the small direct impact of ECB projections on SPF's inflation expectations and pronounced the flexibility in switching between the forward- and backward looking information used in forming expectations. What is more, Coibion et al. (2018) proved that under low inflation environment the households and firms have become more inattentive to monetary policy announcements. Based on empirical evidence showing a less-pronounced impact of forward-looking component and that the ECB forecast is shared by majority of our sample (i.e. only four member states produce their own macroeconomic forecasts), we do not incorporate the forward-looking component of expectations into our study.

The consumer inflation expectations are quantified by the Harmonised Index of Consumer Prices (HICP) inflation rate scaling factor. To avoid the potential distortions, our model does not include inflation rate as one of the independent variables, but incorporates only selected HICP components (food and fuel prices). In our study, because we look for determinants of short-term inflation expectations of consumers, instead of the HICP rate, we use the most volatile (Parker 2018) and 'closer to households' components of prices: oil prices, food prices, house prices, and inflation volatility.

Ueda (2009) investigated determinants of households' inflation expectations in Japan and the United States (US) by using inflation expectations, inflation rate, short-term nominal interest rate, and output gap as endogenous variables, and food and energy prices as exogenous variables. The study concluded that inflation expectations adjust more quickly to changes in energy, food prices, and monetary policy shocks than to the realised inflation. Effects of price changes are greater in Japan, in the short-term, and smaller but longer-lasting in the US economy (Ueda 2009). The correlation between the gas prices and consumers' inflation expectations has been confirmed by Binder (2018). The effects of rapidly changing oil prices were examined by Celasun et al. (2012), and oil and food prices on US consumer inflation expectations were examined by Aurora et al. (2013). The importance of food prices volatility for households has been recently confirmed by Kaplan and Schulhofer-Wohl (2017). Results from above mentioned studies indicate the substantial impact of food and energy prices on consumer inflation expectations. Their conclusions are in line with Treban (2011) and Coibion & Gorodnichenko (2015), who demonstrated that consumers are highly sensitive to changes in commodity prices in revising their short-term inflation expectations (i.e. more sensitive than historical relationships warrant). The impact of energy prices on market-based inflation expectations was confirmed for the EU (Ciccarelli and Garcia 2009), and the impact of oil prices for Australia, the EU, Japan, Sweden, the UK, and the US (Gambetti and Moretti 2016). Milani (2009) investigated the relationship between oil prices and macroeconomic variables with a structural general equilibrium model. The results indicate that changes in oil prices may be perceived as an additional channel that incorporates the learning rules and affects the economy through their impact on the formation of agents' beliefs, which are understood as consumer inflation expectations' updates in this study (Milani 2009). By contrast, Gerdesmeier et al. (2015) investigated EU countries and concluded that oil prices have insignificant impact on consumer prices in high-inflation periods; instead, house prices have significant impact on consumer expectations in high- and low-inflation periods. The relationship between house prices and inflation expectations was confirmed by Li and Qiu (2013). The direct effect of house prices on consumer inflation expectations has been shown by Goodhart and Hofmanrh (2000) and Wang and He (2005) and indicates that movements in house prices provide useful extra information on future inflation.

The other macrofactors are represented by the industrial production and nominal wages. According to Ueda (2009), Berk (2000), and the modern Philips curve theory, the significant indicators of adaptive consumer inflation expectations are output gap or industrial production. The influence of wage deviation from wage trend values on market-based inflation expectations was confirmed by Cicarelli and Garcia (2009, 2017). This is in line with the concept of downwards wage rigidities and assumes that inflation expectations are asymmetric and these asymmetric beliefs regarding inflation can generate downwards wage rigidities which further change the characteristics of business cycles (Baqae 2014). According to this hypothesis, including a measure of change of nominal wages into the benchmark model is a necessity.

Several empirical works have examined the impact of finance-related factors on the formation of inflation expectations. Berk (2000) reported the significant impact of the domestic money market rate and its foreign equivalent and money stock on inflation expectations. Ueda (2009) also confirmed the effect of the short-term nominal interest rate. The list of drivers was expanded by Cerisola and Gelos (2009), who reported the significant effect of inflation target, fiscal policy (approximated by consolidated primary surplus to GDP ratio), real interest rate, and real effective exchange rate on inflation expectations in Brazil. In our study, we use money market interest rates, nominal effective exchange rate, and key monetary policy interest rate as financial-based indicators of inflation expectations.

Berge (2018) compared the inflation expectations of consumers and professionals. Whereas the professionals' inflation expectations are affected by financial variables (such as interest rates, stance on monetary policy in Kiley, 2009), the consumers' react rather on macroeconomic conditions, understood as economic sentiments, and on movements on commodity prices (Berge 2018). The necessity to analyse the factors which might put light on agents' subjective conviction of the state of the economy was pronounced by Ciccarelli & Garcia (2009) by confirming the significant impact of EC Consumer Confidence Indicator on short-term inflation expectations.

The backward-looking component of inflation expectations formation may be also described by the previous inflation volatility and persistent trend shifts or time-varying uncertainty about trend inflation. Henzel (2013) stated that professional forecasters' inflation expectations follow a simple trend learning model and concluded that agents adapt their estimate of inflation trends when systematic forecast errors occur, and systematically alter the learning scheme when trend uncertainty changes. This result implies the use of an historical learning scheme in shaping consumer inflation expectations. Our study focuses on short-term consumer inflation expectations updates (month-to-month); hence, we include inflation variability (one-year moving standard deviation) as one of the potential drivers of consumer inflation expectations.

The literature on inflation expectations has assumed that private agents follow learning patterns in forming their expectations. These patterns may be represented by a simple autoregressive process, the constant gain of learning (Orphanides & Williams 2005, Milani 2007), or the sticky information learning method (Mankiw et.al. 2003, Carroll 2003). Malmendier & Nagel (2015) argued for the learning from experience concept which combines the sticky information method with constant gain of learning. This concept assumes that the formation of consumers' expectations is highly affected by their historical experiences. The weight on the previous expectations follows the reversal exponential function with the largest weight put on most recent inflation expectation experience. In our model, we incorporate the learning component and use a memory-based inflation expectation factor to capture the medium-term memory reversal of inflation expectation. The variable is defined as the reversal exponential moving average of historical 36-month inflation expectations of consumers[5].

Studies examining determinants of euro area inflation expectations include two analyses performed by Ciccarelli and Garcia (2009, 2017). The studies expanded the list of potential drivers of inflation expectations by factors from the monetary and financial sector, real sphere, prices of specific groups, and confidence indices. Based on the previous discussion, both theoretical and empirical, and by referring to Ciccarelli and Garcia (2009, 2017), we aggregate the list of the potential determinants used in our study into the three groups (Table 1).

Table 1. List of potential drivers of consumer inflation expectations

Macrofactors	Financial-related factors	Economic favourable cognition
Industrial production Oil prices Food prices House prices Nominal wages	Money market interest rates Nominal effective exchange rate Key policy rate	Consumer confidence indicator Short-term volatility of historical inflation rate Medium-term memory reversal of inflation expectations (also called as: sensitivity of expectations to realised inflation)

2.1. Spatial dimension of consumers' inflation expectations

One key feature that distinguishes our research from Ciccarelli and Garcia (2009, 2017) and other authors is our inclusion of the spatial dimension of inflation expectations. In what follows, we postulate that consumers, when shaping their inflation expectations, consider two dimensions, namely, domestic and foreign; thus, the domestic consumer inflation expectations are affected by the behaviour of selected domestic factors (Table 1) and the same factors from the foreign economies.

The widely-cited, seminal paper by Baltagi and Li (2004) illustrated the spatial element in demand for cigarettes that has its cross-border dimension due to the optimising behaviour of consumers that observe price differences across regions. Examples of this cross-border (i.e. local) consumer optimising behaviour have been investigated and confirmed in many empirical studies. In a similar fashion, we hypothesise that consumers, when crossing the borders of their countries to purchase goods in locations with comparatively lower prices, recall (consciously or not) the price dynamic in these regions when forming their inflation expectations. In other words, the dynamics of prices in their predominant place of purchase (i.e. foreign prices) affects their decision regarding the inflation forecast.[6]

Notably, factors other than the local effects might have an influence on consumers' inflation expectations. Existence of formal or informal links consciously or non-consciously binding consumers to a network might introduce a global spill-over element into the formation of consumers' expectations. A common example of such a network includes trade networks (LeSage, 2014) reflecting the increasing role of global value chains in today's world economy. At first sight, the independent decision of a domestic consumer regarding future inflation is likely shaped by expectations of other members in the network through formal (business relationships) or informal (media) channels shaped by the expectations of their closest neighbours in the network and so forth.

In specifying the closest economic neighbours, we posit that following the Tobbler's Law of geography is the most obvious approach and we capture the concept by use of geographical distance between the member states. The geographical distance is also likely to reflect the local spatial interactions. On the other hand, the sole use of geographical distance is insufficient, in our

[5] We acknowledge the necessity for inclusion of a long-term memory component. However, because we do not want to shorten our sample significantly and must settle for the longest available 'remembering component'-36 month exponential moving average.

[6] Notably, in a small and open economy with only tradable sector in presence the domestic and foreign prices should converge and their price trajectories and should shadow each other very closely. Our study differs from this common assumption in two ways. Firstly, we focus on a very short-term horizon (one-year ahead) where the convergence in prices of tradables might not be complete. Secondly, in the presence of non-tradable goods, the behaviour of prices does not need to be fully synchronized due to different factors, most notably, the Balassa-Samuelson effect.

opinion. Our choice of closest neighbour definition builds upon the economic distance weights among the member states, that is, in the open economy, a channel or channels transmitting domestic consumer inflation expectations to its neighbours.

Several channels may affect expectations: globalisation developments (in line with the concept that everything is affected by everything), economy synchronisation (in line with the concept that similar is closer to similar than the different one), and imported prices.

Matheson & Stavrev (2013) confirmed that in the US, during the post-crisis period, the traditional Philips curve explained the US inflation surprisingly well and posited that the inflation stability may depend on better anchored inflation expectations, a flatter Philips curve, and an increasing role of imported inflation. A broad body of literature has investigated the influence of imported inflation on domestic inflation. The most recent conclusions are presented in ECB Economic Bulletin (2017), where the domestic and global drivers of domestic inflation are considered, that is, imported prices are also the main external driver of domestic inflation expectations. How does the imported inflation affect domestic inflation expectations is explained by two concepts based on global value chains (ECB Economic Bulletin 2017) and trade partners. In our model, we focus on the main global trade partners and assume that imported inflation is transmitted to consumers through the prices of global trade partners.

To summarise, we employ two concepts to capture local and global spill-over effects in consumers' inflation expectations. The first measures the foreign dimension by the geographical distance among economies (local). The second is a model that incorporates the main global trade partner economies as neighbours of the domestic economy (global).

2.2. Two approaches to capture the spatial dimension of inflation expectations of consumers

How to measure the impact of possible domestic and foreign determinants of inflation expectations may depend on the type of expectations data used. The first approach in our study analyses the drivers of the inflation expectations of consumers' updates (on the month-to month basis) $\Delta\pi^{e}_{t+12}$. In this approach, the spatial component in consumer inflation expectations captures the cross country co-movements of inflation expectations affected by the spatial component of the HICP rate.

The inflation expectations of consumers in our study are one-year ahead and survey-based. Use this type of expectations measure may cause potential bias. First, the survey measures may miss the recent changes in inflation expectations, especially when frequently purchased goods and services are over-weighted in expectations formation (Łyziak & Paloviita 2017). Second, the expectations in our study are quantified with the use of the probabilistic method, in which the scaling factor is the national HICP rate. Even if we assume the oil prices, food prices, house prices, and nominal wages, rather than HICP rate, the potential bias may be noticeable. The external food prices, oil prices, and foreign goods define the import prices which, through the exchange rate, affect the domestic headline HICP rate, domestic energy, and food prices (ECB Economic Bulletin, 2017). The literature has demonstrated that the inflation in EU may be perceived as s global phenomenon, and the domestic inflation is highly affected by the global factors. Ciccarelli & Mojon (2010) investigated 22 OECD countries in from 1960–2008 and showed that approximately 70% of the variation of domestic headline inflation has a common factor. The results indicating the large effect of global factors on domestic headline inflation have been confirmed by Ferroni & Majon (2016), for the same group of countries but from 1993–2016 and for a sample of 223 countries by Parker (2018). Additionally, Parker (2018) proved that the global component in inflation is mainly driven by energy and food prices. Borio & Filardo (2007), Auer et al. (2017) and Guaerierri et. al. (2010) confirmed that inflation co-moves across countries also through global value chains. Notably, Kearns (2016) proved that global inflation does not improve the survey-based forecasts of domestic inflation, and this result may indicate that responders already internally incorporate this global inflation into their forecasts.

If we assume that inflation co-moves across countries through global value chains or import prices' channels and quantify the inflation expectations of consumers with the HICP scaling factor, our results may reflect a spatial component of HICP inflation that translates into spatially dependent consumers expectations' hypothesised to be anchored to the past inflation rate. To control for this channel, we follow the alternative approach to capture the 'pure' spatial component of inflation expectations. In this alternative approach, we model change in consumers' inflation expectations net of change in inflation rate, hence, $\Delta\pi^{e}_{t+12} - \Delta\pi_t$, which is similar to procedure implemented by Levin et al. (2004) and Ehrmann (2015).

3. Model specification

We start modelling the determinants of consumer inflation expectations updates by standard fixed panel estimator without spatial dimension. The dependent variable is expressed as monthly change in consumers' inflation expectations; hence, capturing the process of updating the consumers' expectations with respect to change in underlying economic conditions. We are predominantly interested in the effect of a *new* set of information that forces consumers to change their perception of future inflation. The dependent variables are, similarly, expressed in differences that incorporate newly available information.

The baseline specification is as follows:

$$\Delta\pi^{e}_{it} = \alpha + \boldsymbol{\beta}\mathbf{X}_{\mathbf{it\text{-}k}} + u_i + \tau_t + \varepsilon_{it} \qquad [1]$$

where $\Delta\pi^{e}_{it}$ *denotes monthly change in consumer inflation expectations,* $\boldsymbol{X}_{\boldsymbol{it\text{-}k}}$ *is the matrix of the explanatory variables, and vector* $\boldsymbol{\beta}$ *includes the parameters of the explanatory variables.*

Equation [1] is estimated by a standard fixed effect panel estimator with country-specific u_i and time-specific τ_t effects. Independent variables in $\boldsymbol{X}_{\boldsymbol{it\text{-}k}}$ enter the equation with different time lags, $k = 0,1,2$, choice of which is driven by economic considerations based on results from the empirical studies discussed in Section 3.

Notably, the simple OLS estimator is biased in the presence of spatial autocorrelation in the residuals. For this reason, we transform the model in [1] to control for spatial dependence. Because we hypothesise that the selected individual explanatory variables might also spatially affect our dependent variable, we report estimates for static SDM, which is our preferred model. In this manner, we follow the recommendations from LeSage and Pace (2009), who argued that SDM is superior in a wide number of applied studies.

The SDM with a spatially lagged dependent variable and spatially lagged independent variables was introduced by Anselin (1988). It produces unbiased coefficient estimates if the true data-generation process is a spatial lag or spatial error model and does not impose prior restrictions on the magnitude of potential spatial spill-over effects (Atella et al., 2014). In contrast with other spatial regression specifications, these spill-over effects can be global or local and different for selected explanatory variables (Elhorst 2009). As asserted by LeSage and Pace (2009), the final choice of preferred model should be driven by the research question. Because we are interested in estimating unconstrained direct, indirect, and total covariates' effects, we posit that the SDM is a more attractive point of departure in this application. Furthermore, as misspecification of the conditional mean (i.e. ignoring spatial dependence in the dependent variable and/or in the covariates) may lead to severely biased estimates, the SDM is the best choice for at least two reasons. First, the SDM allows us to obtain unbiased estimates even if the true data generating process is an SAR or a SEM. Second, the inclusion of the spatially lagged regressors could serve as a control for the omitted variables, that is, if they are first-order spatially correlated with the included regressors (LeSage and Pace, 2009).

Consequently, domestic changes in consumers' expectation are also assumed to be driven by changes in the fundamentals of a country's closest neighbours, given their economic distance. The estimated model is of the following form:

$$\Delta\pi^{e}_{it} = \alpha + \rho\mathbf{W}_{\mathbf{ij}}.\Delta\pi^{e}_{it} + \boldsymbol{\theta}\mathbf{W}_{\mathbf{ij}}\mathbf{X}_{\mathbf{it\text{-}k}} + \boldsymbol{\beta}\mathbf{X}_{\mathbf{it\text{-}k}} + u_i + \tau_t + \varepsilon_{it} \qquad [2]$$

*where $\Delta\pi_{it}^{e}$ denotes the monthly change in consumer inflation expectations, $\boldsymbol{X_{it}}$ is the matrix of the explanatory variables vector **$\boldsymbol{\beta}$ and** includes the parameters of the explanatory variables, matrix $\boldsymbol{W_{ij}}$ denotes the spatial weights matrix constructed as the weighted contiguity matrix based on the geographical and economical distance specified in Section 3, scalar ρ is the coefficient associated with spatial lag of dependent variable, and vector $\boldsymbol{\theta}$ includes parameters of the explanatory variables associated spatial lags of explanatory variables.*

The computation of the effects of changes in explanatory variable **X** on the dependent variable in the SDM are more complicated than in the simple OLS setting. As shown in LeSage and Pace (2014), the partial derivation of $\Delta\pi_{it}^{e}$ with respect to a change in the *r-th* element of **X** is expressed as follows:

$$\partial\Delta\pi^{e}/\partial x_{r} = (\mathbf{I_n} - \rho\mathbf{W})^{-1}(\mathbf{I_n}\beta_{r} + \mathbf{W}\theta_{r}) \quad [3]$$

The partial derivatives form a matrix, rather than the single number observed in the OLS setting, because a change in the single observation x_{irt} can influence all the observations of the vector $\Delta\pi^{e}{}_{jt}$. The direct response (own region) is captured by their own partial derivative $\partial\Delta\pi_{i}^{e}/\partial x_{ir}$, and indirect effect (spillover) is captured by cross-partial derivative $\partial\Delta\pi_{j}^{e}/\partial x_{ir}$, where $i \neq j$. The direct effects are located on the main diagonal of the matrix in [3] and indirect effects are stored as off-diagonal elements of matrix in [3]. In Section 5, we report the average diagonal element of matrix [3] and label it ADE (average direct effect), the average row-sum of off-diagonal elements for indirect effects (AIE) and sum of ADE and AIE provides the total average effect of change in x_{r} on the dependent variable (ATE).

Alternatively, we test for the spatial component in the inflation expectations' net of change in the underlying inflation rate, as argued in Section 3.2, by the following specification:

$$\Delta\pi_{it}^{e} - \Delta\pi_{it} = \alpha + \rho\mathbf{W_{ij}}.(\Delta\pi_{it}^{e} - \Delta\pi_{it}) + \boldsymbol{\theta}\mathbf{W_{ij}}\mathbf{X_{it\text{-}k}} + \boldsymbol{\beta}\mathbf{X_{it\text{-}k}} + u_{i} + \tau_{t} + \varepsilon_{it} \quad [4]$$

The elements of $\mathbf{W}$ on the diagonal are set to zero to exclude self-neighbours, and the matrix is row-normalised. For estimation purposes, we use XSMLE Stata command by Belotti, Hughes and Mortari (2013) that fits fixed and random effects spatial models for balanced panel data by maximum likelihood estimator.

4. Data and variables description

One-year consumer inflation expectations are aggregate and based on the EC Business & Consumer Survey. According to the survey, the group of consumers comprise (1) managers and professionals; (2) technicians and associate professionals; (3) clerical and support workers, services, and sales workers; (4) skilled agricultural forestry and fishery workers, and craft and related trade workers; (5) plant and machine operators, assemblers, and elementary occupations (*The Joint Harmonised* ... 2017, p. 40). In the survey, the question referring to the inflation expectations is as follows, 'In comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months? They will... (1) increase more rapidly, (2) increase at the same rate, (3) increase at a slower rate, (4) stay about the same, (5) fall, (6) don't know (*The Joint Harmonised* ... 2017, p. 37).' The aggregate responders' answers were quantified with the Carlson-Parkin (1975) method expanded by Batchelor & Orr (1988) and subjectified by Łyziak (2003, 2010), and Łyziak & Stanisławska (2006). The method is briefly described in Appendix 8.

Table 2. Data Sources and Description

Data	Description	Source	Type	Transformation	Time lag
Global trade partners	Share of the EU trade partners on total import, average from 2005-2016	Eurostat database	Annual data	-	-
Consumer inflation expectations	Quantified with the Carlson & Parkin (1975) and Bachelor & Orr (1988) method with HICP as a scaling factor	EC Business and Consumer Survey	Monthly data	-	-
		Macrofactors			
Oil prices	Crude oil prices: West Texas Intermediate (WTI) - Cushing, Oklahoma, dollars per barrel, monthly	Federal Reserve Economic Database, FRED	Monthly data	Seasonally adjusted	1 month
Nominal wage	Labour cost index by NACE Rev. 2 activity	Eurostat database	Quarterly	Seasonally adjusted, cubic spline interpolation	2 months
Food prices	HICP (2015 = 100) - monthly data (index), food	Eurostat database	Monthly,	Seasonally adjusted	2 months
House prices	Nominal house price indices (analytical use price indicators)	OECD database	Quarterly	Seasonally adjusted, cubic spline interpolation	2 months
Industrial index	Volume index of production, mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply	Eurostat database	Monthly	Seasonally adjusted	1 month
EA membership	EA membership (1 = member)	-	Dummy	-	1 month
		Financial-related factors			
Money market interest rates	Money market interest rate, EURIBOR for EA member states	Eurostat database	Monthly	-	1 month
Nominal effective exchange rate	BIS nominal effective exchange rate, broad indices	BIS database	Monthly	-	1 month
Key rate	-	Trading Economics, central banks	Monthly		1 month
		Economic favourable cognition			
Consumer confidence indicator	Survey-based, calculated as ‘the arithmetic average of the balances (in percentage points) of the answers to the questions on the financial situation of households, the general economic situation, unemployment expectations (with inverted sign) and savings, all over the next 12 months.’ (*The Joint Harmonised* ... 2017).	EC Consumer and Business Survey	Monthly	-	1 month
Short-term inflation volatility	Moving standard deviation of month-on-month inflation rates (last 12 months)	Eurostat database	Monthly	-	1 month
Medium-term memory reversal of inflation expectations	Exponential moving average (EMA) of historical inflation expectations of consumers (last 36 months, the largest weight assigned to the most recent historical expectation)	EC Consumer and Business Survey	Monthly		1 month

The consumers are surveyed between the 1st and 14th of each month and aggregate expectations are published two working days before the end of each month. Most of the economic factors are also published at the end of the month or even in the next following month, that is, consumers do not have the most recent data on the state of the economy (i.e., contemporaneous data). Due to this situation, our model incorporates the lagged variables[7]. In this study, we divide the factors into three groups: (1) those that affect the consumers through standard information channels, including industrial production, oil prices, money market interest rates, nominal effective exchange rates, and key policy rates; (2) those updates that may affect the consumers by their own experience and information channels, including food prices, house prices, nominal wages; and (3) those that depend only on the consumers' individual experiences and perceptions. The lags for the first group of factors is assumed to be 1 month (Łyziak, 2006), and the lag for the second group of factors is assumed to be 2 months (Łyziak & Fuhrer, 2017). The 2-month lag was chosen given the maximum effect in impulse response functions from simple VAR models. As the third group of factors depend only on the personal experiences and beliefs of consumers, the imputed lag is set to 1 month.

We use balanced panel dataset on monthly frequency for 22 EU (EU22) member states for the period 2005m5–2016m12, given the data availability. We create two separate spatial matrices; one utilising the concept of geographical distance and the other relying on the economic distance concept derived from the underlying trade linkages among the EU22 member states. The data for geographical distances have the advantage of being exogenous and are likely to be highly correlated with the trade–link channel, because that is what trade gravity models commonly suppose. The data for trade-based weights matrices are calculated using the annual averages of the import shares' values in the period 2005–2016. Although using this data might be associated with a potential endogeneity issue, our preferred specification based on the zero/ones matrices should alleviate this concern because the trade linkages are assumed to be highly persistent, especially among the top trading partners. As a further robustness check, we estimate models [1] to [4] with import-based shares for year 2004.

Firstly, we specify matrix $\mathbf{W^1}$, which is based on the squared inverse geographical distance between the centroids of countries as follows:

$$w_{ij}^1 = \begin{cases} 0 & if\ i = j\ or\ \ d_{ij} < \overline{d_\iota} \\ 1 & d_{ij} \geq \overline{d_\iota} \end{cases} \qquad [5]$$

where d_{ij} is the squared inverse of distance between the centroid of country i and j, and $\overline{d_I}$ is a row-specific cut-off value for sixth closest neighbour of a country i. The choice of the six closest neighbours is motivated by characteristics of the EU22 geographical network to ensure no islands are present in the matrix.

The construction of the second matrix $\mathbf{W^2}$ is based on trade linkages among member states and specified as follows:

$$w_{ij}^2 = \begin{cases} 0 & if\ i = j\ or\ \ w_{ij} < \overline{w_\iota} \\ 1 & w_{ij} \geq \overline{w_\iota} \end{cases} \qquad [6]$$

where w_{ij} is the share of imports from country j on the total import to country i , and $\overline{w_I}$ is the row-specific cut-off value for the twelfth most important trading partner of a country i on the import side. The choice of the 12 closest neighbours is motivated by as characteristics of the EU22 trade network to ensure no islands are present in the matrix.

Alternatively, we relax the condition specifying the fixed number of closest neighbours in the matrix $\mathbf{W^2}$ (i.e. 12 trading partners) but impose a minimum threshold of $\overline{w}$=1.57%, which corresponds to the minimum import share and allows all countries to serve at least once as the closest neighbour. The matrix $\mathbf{W^3}$ is therefore specified as follows:

[7] As part of the robustness check, we introduce different lags for the selected real and financial sector indicators. Results are discussed in the robustness section.

$$w_{ij}^3 = \begin{cases} 0 & if\ i = j\ or\ \ w_{ij} < \bar{w} \\ 1 & w_{ij} \geq \bar{w} \end{cases} \quad [7]$$

where w_{ij} is share of imports from country j on total imports to country i, and $\bar{w}$ is the cut-off value equal to 1.57% for share of imports from country j on total imports to country i.

As part of the robustness checks, we use matrices $\mathbf{W^1}$-$\mathbf{W^3}$ with concrete weights, rather than the binary specification. Additionally, by acknowledging the special position of Germany in the EU22 trade network, we exclude Germany from the sample and re-estimate models [2] and [3] with updated matrices $\mathbf{W^1}$-$\mathbf{W^3}$. Our final results are robust to different matrix specifications, and this result is in line with the argument advocated in LeSage and Pace (2014).

Table 3. Summary Statistics

Variable	Description	# obs.	Mean	Std.	Min	Max
Expect	Consumer expectations (%)	3080	2.30	2.45	-1.64	17.58
EA	Euro area membership (1=member)	3080	0.60	0.49	0.00	1.00
Wage	Compensation of employees (index)	3080	94.96	13.37	41.12	138.10
Industry	Industrial production (index)	3080	103.80	11.37	67.20	141.90
Oil	Fuel prices (index)	3080	98.56	15.66	57.41	136.26
Food	Food prices (index)	3080	91.54	9.33	58.15	106.72
IR key	Central bank key IR (%)	3080	2.00	2.08	-0.50	14.50
IR mm	Money market IR (%)	3080	2.27	2.51	-0.56	21.25
NEER	NEER (index)	3080	100.71	5.50	77.22	133.06
Confidence	Consumer confidence indicator (index)	3080	-16.74	18.92	-83.80	28.00
Stdev	Standard deviation of inflation over previous 12 months	3080	0.74	0.65	0.08	4.49
EMA	Exponential moving average of expectations , 3 years	3080	2.73	2.23	-0.83	14.85

The summary statistics are provided in Table 3. We observe that consumers' expectations are on average closely anchored to the 2% level; however, relatively high dispersion in the data is present with the minimum reaching well below zero and the maximum almost approaching 20%. This result is predominantly due to inclusion of catching-up economies, such as Romania, Latvia, Lithuania, or Hungary. A similar pattern is observed in other control variables related to real or nominal economic conditions, such as the index of nominal wages, industrial production, food and fuel prices, or key and money market interest rates. The average value of the consumer confidence indicator achieves a negative number reflecting the larger weights of the crisis period observations in the entire sample with a minimum value associated with the economic recession in Greece.

The specifications in [1] to [3] aim to model monthly changes in consumer inflation expectations by a set of economic determinants. Our goal is to investigate what is the impetus for the decision of consumers to update their inflation expectations; thus, the potential explanatory variables included in matrix **X** will be expressed as first differences of underlying determinants after their logarithmic transformation. Results from the panel unit root tests performed on the first differences of log-transformed variables, if relevant, are presented in Appendix 2. All three standardly used panel unit root tests (Im-Pesaran-Shin, Dickey Fuller, Phillips-Perron) reject the null hypothesis of the unit root in all panels. Due to the potential concerns related to underlying cross-sectional dependence, we perform a test proposed by Pesaran (2007) robust to cross-sectional dependence. In both specifications, with and without trend, the t-statistic rejects the null hypothesis of a unit root and confirms stationarity of our panel.

5. Estimation results

The inclusion of the spatial dimension into the model specifications is motivated by empirical narrative in Section 3.1 and is further supported by results of residual cross-section dependence tests (Appendix 2b). Table 4 presents the FE and SDM models' estimation results with binary weights matrices. The last column is abbreviated as W2 (without Germany) and presents the results of the robustness check excluding Germany because this country is the central key node in trade network potentially introducing a high degree of centrality into our estimates. Table 5 presents the average direct (ADE), indirect (AIE), and total (ATE) effects of the models specified in [1]–[3].

The updates in consumers' inflation expectations are highly heterogeneous across countries as well as subjective due to the consumers' individual characteristics; thus, our model can explain only a relatively small portion of the total variation. Notably, the spatial component of change in consumers' inflation expectations is significant in each model specification (with different weight matrices), and this result confirms our primary hypothesis of the spatial dimension of expectation formation (Table 4). [8]

In general (Table 4), a lagged change in nominal wages is observed to have the most pronounced effect on change in the inflation expectations of consumers and is accompanied by the significant effects of change in domestic food prices. Behaviour of oil prices does not transmit into domestic inflation expectations, but after controlling for the spatial dimension of exogenous variables (SD), the indirect channel of transmission dominates. Changes in consumers' expectations respond to real domestic economic activity in the expected, positive direction (industrial production). The effect of external environment is in the first stage confirmed by the highly statistically significant coefficient associated with domestic currency appreciation (NEER) that is translated into the prices of imported goods (decrease), ultimately lowering the inflation expectations of consumers.

The positive and statistically significant impact of monetary policy decisions (key policy rate) suggests that in the very short-term, consumers may interpret an increase in policy rate as a sign of potential overheating in the domestic economy, thus adjusting their expectations in the positive direction.[9] Alternatively, increases in the nominal policy rate might reflect an increase in past inflation rates to which the inflation expectations of consumers adhere to. In this context, the EA membership per se does not significantly alter the formation of consumers' inflation expectations. Variability in short-term money market rates does not tend to affect the creation of consumers' expectations in any model specification, and this result suggests that change in financial conditions might not result in changes in consumers' perception of real economic conditions represented by inflation expectations.

The results for average direct and indirect marginal effects of the chosen economic favourable cognition factors indicate several important results. Firstly, inflation expectations of consumers are significantly affected by their domestic short-term inflation volatility and domestic medium-term memory reversal of inflation expectations. This result implies that the remembering component is an important part of forming inflation expectations in the EU and may be the impetus behind heterogeneity in consumer inflation expectations among the EU member states. The negative average marginal direct effect of EMA may be in line with the medium- and long-term anchoring of domestic consumers expectations' towards a pre-determined level of a medium- to long-term inflation rate, as targeted by domestic monetary policy.

[8] As discussed in previous section, there exists a theoretical and empirical connection between geographical distance and amount of trade, as postulated by trade gravity models. In our specification, although we observe an overlap between the geographical–distance-based matrix and trade partners-based weights matrix, the trade-based weights matrix continues to carry additional information value.

[9] This observation strongly resembles a widely-known price paradox in the VAR models of monetary transmission mechanism, where a change in key policy rate is followed by an immediate increase in domestic prices. Nine to twelve months is usually required to transmit a change in monetary policy conditions into real economy; hence, the drop in inflation rates.

Table 4 Estimation Results with Binary Weights Matrices

		SDM					SDM			
	FE	W1	W2	W3	W2 (w/o Germany)		W1	W2	W3	W2 (w/o Germany)
d.ln(Wage)	7.934**	7.108***	7.015***	7.120***	7.012***	W.d.ln(Wage)	0.074	-0.604	-1.362	0.775
	(3.452)	(1.591)	(1.574)	(1.574)	(1.616)		(3.429)	(6.087)	(6.038)	(5.907)
d.ln(Oil)	1.594***	-0.524	-0.584	-0.511	-0.452	W.d.ln(Oil)	1.460**	1.278*	1.302*	1.150
	(0.376)	(0.538)	(0.557)	(0.555)	(0.582)		(0.628)	(0.683)	(0.671)	(0.707)
EA	0.041*	0.045	0.037	0.035	0.036	W.EA	-0.177	-0.201	-0.232	-0.186
	(0.020)	(0.040)	(0.042)	(0.042)	(0.043)		(0.113)	(0.311)	(0.306)	(0.293)
d.ln(Indust)	1.438***	1.025***	1.012***	1.013***	1.074***	W.d.ln(Indust)	0.535	0.358	0.230	0.442
	(0.329)	(0.344)	(0.343)	(0.342)	(0.351)		(0.702)	(0.913)	(0.864)	(0.918)
d.ln(Food)	2.830	3.311***	2.949**	2.673**	2.924**	W.d.ln(Food)	-3.399	-3.031	-2.380	-3.332
	(2.345)	(1.243)	(1.235)	(1.23)	(1.265)		(2.456)	(3.052)	(2.999)	(3.152)
d.(IR key)	0.125	0.090**	0.090**	0.090**	0.086*	W.d.(IR key)	-0.117	-0.105	0.002	-0.121
	(0.038)	(0.045)	(0.045)	(0.045)	(0.046)		(0.089)	(0.114)	(0.102)	(0.118)
d.(IR mm)	0.002	-0.006	-0.007	-0.006	-0.007	W.d.(IR mm)	0.005	-0.041	-0.026	-0.044
	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)		(0.038)	(0.049)	(0.047)	(0.048)
d.ln(NEER)	-1.172	-2.473**	-2.756***	-3.071***	-2.704**	W.d.ln(NEER)	1.831	2.204	3.033*	2.032
	(1.001)	(1.008)	(1.03)	(1.03)	(1.052)		(1.531)	(1.737)	(1.776)	(1.794)
d.(Stdev)	0.209*	0.196***	0.165**	0.160**	0.167**	W.d.(Stdev)	-0.095	-0.097	0.018	-0.142
	(0.101)	(0.071)	(0.071)	(0.071)	(0.073)		(0.127)	(0.165)	(0.157)	(0.166)
d.(Confid)	0.004	0.000	-0.001	-0.001	-0.001	W.d.(Confid)	0.020***	0.024***	0.020***	0.026***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)		(0.005)	(0.007)	(0.007)	(0.007)
d.(EMA)	-0.176	-0.212**	-0.262***	-0.275***	-0.250**	W.d.(EMA)	0.565**	0.824**	0.646**	0.864**
	(0.138)	(0.101)	(0.099)	(0.099)	(0.102)		(0.242)	(0.345)	(0.323)	(0.341)
Constant	-0.005					Spatial coefficient (rho)	0.367***	0.545***	0.540***	0.520***
	(0.024)						(0.022)	(0.027)	(0.026)	(0.027)
Seasonal effects	YES	YES	YES	YES	YES					
Time effects (annual)	YES	YES	YES	YES	YES					
N	3080	3058	3058	3058	2919					
R2	0.081	0.089	0.093	0.092	0.096					
R2 within	0.081	0.097	0.097	0.095	0.100					
R2 between	0.495	0.131	0.290	0.292	0.304					

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

Table 5 Direct, Indirect and Total Average Marginal Effects – Binary Matrices

		W1	W2	W3	W2 (w/o Germany)
d.ln(Wage)	ADE	7.255***	7.149***	7.216***	7.210***
		(1.644)	(1.653)	(1.655)	(1.69)
	AIE	3.948	6.497	4.977	8.649
		(5.174)	(12.97)	(12.81)	(12.04)
	ATE	11.20*	13.650	12.190	15.860
		(5.991)	(13.7)	(13.54)	(12.79)
d.ln(Oil)	ADE	-0.433	-0.530	-0.451	-0.402
		(0.517)	(0.543)	(0.54)	(0.566)
	AIE	1.918***	2.049**	2.186**	1.872*
		(0.717)	(0.996)	(0.972)	(0.999)
	ATE	1.485**	1.520	1.734*	1.470
		(0.634)	(0.925)	(0.905)	(0.914)
EA	ADE	1.077	1.050	1.045	1.116
		(0.346)	(0.343)	(0.342)	(0.352)
	AIE	-0.246	-0.384	-0.449	-0.341
		(0.178)	(0.695)	(0.682)	(0.628)
	ATE	-0.212	-0.356	-0.426	-0.313
		(0.196)	(0.728)	(0.718)	(0.66)
d.ln(Indust)	ADE	3.210***	2.924***	2.674***	2.879***
		(1.239)	(1.229)	(1.225)	(1.259)
	AIE	1.310	1.808	1.534	1.916
		(0.993)	(1.8)	(1.696)	(1.737)
	ATE	2.387**	2.858	2.578	3.032*
		(1.107)	(1.875)	(1.772)	(1.816)
d.ln(Food)	ADE	3.210***	2.924**	2.674**	2.879**
		(1.239)	(1.229)	(1.225)	(1.259)
	AIE	-3.129	-2.773	-1.734	-3.448
		(3.736)	(6.528)	(6.398)	(6.493)
	ATE	0.081	0.151	0.940	-0.569
		(3.959)	(6.658)	(6.545)	(6.634)
d.(IR key)	ADE	0.084*	0.087*	0.093**	0.082*
		(0.045)	(0.045)	(0.046)	(0.046)
	AIE	-0.117	-0.100	0.123	-0.135
		(0.138)	(0.245)	(0.218)	(0.245)
	ATE	-0.033	-0.013	0.217	-0.053
		(0.152)	(0.255)	(0.229)	(0.257)
d.(IR mm)	ADE	-0.004	-0.009	-0.007	-0.009
		(0.02)	(0.02)	(0.02)	(0.02)
	AIE	0.006	-0.090	-0.058	-0.092
		(0.06)	(0.106)	(0.101)	(0.099)
	ATE	0.002	-0.099	-0.065	-0.101
		(0.067)	(0.113)	(0.108)	(0.106)
d.ln(NEER)	ADE	-2.455**	-2.766***	-3.038***	-2.719**
		(1.013)	(1.041)	(1.04)	(1.063)
	AIE	1.379	1.454	2.877	1.239
		(2.044)	(3.147)	(3.204)	(3.133)
	ATE	-1.076	-1.312	-0.161	-1.480
		(2.173)	(3.225)	(3.269)	(3.22)
d.(Stdev)	ADE	0.194***	0.165**	0.167**	0.164**
		(0.066)	(0.067)	(0.067)	(0.069)
	AIE	-0.034	-0.006	0.229	-0.103
		(0.184)	(0.332)	(0.318)	(0.321)
	ATE	0.160	0.158	0.396	0.060
		(0.195)	(0.338)	(0.324)	(0.328)
d.(Confid)	ADE	0.001	0.000	0.000	0.001
		(0.003)	(0.003)	(0.003)	(0.003)
	AIE	0.030***	0.050***	0.043***	0.052***
		(0.008)	(0.016)	(0.015)	(0.015)
	ATE	0.031***	0.051***	0.043***	0.052***
		(0.009)	(0.016)	(0.015)	(0.015)
d.(EMA)	ADE	-0.177*	-0.222**	-0.246**	-0.209**
		(0.104)	(0.101)	(0.101)	(0.104)
	AIE	0.734**	1.435**	1.044	1.480**
		(0.371)	(0.725)	(0.671)	(0.686)
	ATE	0.557	1.212	0.797	1.271*
		(0.419)	(0.759)	(0.704)	(0.722)

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

To be distinguished from the remembering component, the more contemporaneous economically favourable cognition factor, that is, the consumer confidence indicator, has a significant average marginal effect, but globally. The positive and statistically significant effect of the medium-term memory indicator points to transmission of increase (decrease) in the *foreign* inflation expectations trend into domestic expectations. All the results highlight the existence of domestic remembering component that are rather spatial, compared with the domestic component of the contemporaneous conviction of the state of the economy in forming inflation expectations.

The results for the average marginal direct effects (Table 5) point to the significant impact of domestic factors (wages, industrial production, food prices, key rate, exchange rate and short-term inflation volatility, and medium-term memory reversal of inflation expectations) on consumer inflation expectations. The outcome for the first six factors broadly confirms the results of the literature described in Section 2. The indirect effects capture the effect of external factors on domestic consumer inflation expectations. These effects are significant in the case of oil prices and the consumer confidence indicator in the SDM specification that directly controls for spatial dimension of independent variables (Table 5). One notable finding shows the significant influence of the external consumer confidence indicator on domestic expectations, while this is not observed for the domestic confidence indicator.

5.1. Inflation-adjusted consumers' inflation expectations

Consumers' inflation expectations are expected to be anchored to the perceived inflation rate, by definition. The changes in inflation expectations thus also potentially reflect, to an extent, the behaviour of past inflation rates. The specification in [4] therefore investigates updates in consumers' inflation expectations net of potential involvement of inflation rate channel.[10]

This approach produces several notable findings (Table 6). Firstly, the highly statistically significant spatial coefficient present in all cases confirms that an update in consumers' inflation expectations tends to spill-over across proximal countries through trade (or geographical) linkages, even after ruling out the possible inflation rate channel. Secondly, after controlling for change in inflation rates the subjective cognitive factors are observed to be the primary drivers of expectations with a particular role played by the medium-term anchor (EMA variable) and change in inflation rates volatility (Stdev variable). In the matrices based on the binary specification of connections, only the domestic component of the subjective factors dominates the formation of inflation expectations. By contrast, the strength of connection captured by import trade shares or geographical distance tends to be crucial for the transmission of shocks from these cognitive factors across most proximal neighbours.

Foreign factors likely related to a phase of business cycle affect the formation of inflation expectations through the nominal wage link (in some specifications through food prices), but only once the appropriate time lag of at least 5 months is introduced. Additionally, the influence of foreign environment is captured by the nominal money market interest rate, whose positive sign is likely to reflect the short-term increase in inflation rate in periods of economic boom.

More importantly, changes in *foreign* rather than domestic key policy rates affect the formation of inflation expectations in the expected manner (a negative relationship) after considering the strength of the trade connection (Appendix 8 and 9) and not its sole existence. With a prominent position occupied by Germany in our network, the results are likely to be driven by the unique role played by Germany, as the key trade-based node, and the ECB, as the dominant central bank in our sample. The results may indirectly confirm the existence of the spill-over effects of the ECB's monetary policy in neighbouring countries (e.g. Horvath and Voslarova, 2017), even into subjective consumer expectations.

[10] The procedure used to derive inflation expectations (Appendix 11) uses one survey question that inherently anchors subjective future inflation rate to the previous inflation rate („In comparison with the past 12 months, how do you expect that consumer prices...') even though the information regarding the realized („true') inflation rate is not explicitly provided.

Table 6 Estimation Results with Binary Weights Matrices for Inflation-Adjusted Expectations

		SDM					SDM			
	FE	W1	W2	W3	W2 (w/o Germany)		W1	W2	W3	W2 (w/o Germany)
d.ln(L5.Wage)*	1.504	1.400	1.133	1.179	1.136	W.d.ln(L5.Wage)*	3.258***	11.50***	11.35***	11.11***
	(0.893)	(1.085)	(1.079)	(1.081)	(1.109)		(2.325)	(4.142)	(4.133)	(4.009)
d.ln(Oil)	0.169	0.287	0.228	0.276	0.165	W.d.ln(Oil)	-0.058	0.094	0.013	0.151
	(0.184)	(0.366)	(0.382)	(0.381)	(0.400)		(0.427)	(0.468)	(0.461)	(0.486)
EA	0.045**	0.042	0.040	0.038	0.040	W.EA	-0.040	-0.122	-0.156	-0.117
	(0.017)	(0.027)	(0.029)	(0.029)	(0.029)		(0.077)	(0.214)	(0.210)	(0.202)
d.ln(Indust)	0.234	0.264	0.298	0.305	0.314	W.d.ln(Indust)	-0.451	-0.465	-0.203	-0.585
	(0.350)	(0.235)	(0.236)	(0.236)	(0.242)		(0.475)	(0.630)	(0.595)	(0.634)
d.ln(Food)	-0.619	-0.732	-0.544	-0.658	-0.506	W.d.ln(Food)	1.925	1.770	2.025	2.083
	(1.581)	(0.849)	(0.850)	(0.847)	(0.872)		(1.694)	(2.140)	(2.116)	(2.208)
d.(IR key)	-0.015	-0.003	0.020	0.021	0.018	W.d.(IR key)	-0.048	-0.124	-0.123*	-0.119
	(0.043)	(0.031)	(0.031)	(0.031)	(0.032)		(0.061)	(0.081)	(0.072)	(0.085)
d.(IR mm)	0.009	0.005	0.001	-0.001	0.001	W.d.(IR mm)	0.056**	0.064*	0.053	0.061*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)		(0.026)	(0.034)	(0.032)	(0.033)
d.ln(NEER)	-0.560	-0.901	-0.924	-1.020	-0.959	W.d.ln(NEER)	1.352	1.240	1.451	1.183
	(0.6)	(0.684)	(0.704)	(0.705)	(0.72)		(1.040)	(1.187)	(1.217)	(1.229)
d.(Stdev)	0.261***	0.233***	0.215***	0.221***	0.216***	W.d.(Stdev)	0.091	0.056	0.039	0.055
	(0.091)	(0.048)	(0.049)	(0.049)	(0.05)		(0.086)	(0.111)	(0.106)	(0.111)
d.(Confid)	0.003	0.003*	0.003*	0.003*	0.003*	W.d.(Confid)	0.004	0.004	0.005	0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)		(0.004)	(0.005)	(0.005)	(0.005)
d.(EMA)	-0.571***	-0.583***	-0.570***	-0.565***	-0.570***	W.d.(EMA)	-0.216	-0.110	-0.087	-0.102
	(0.132)	(0.070)	(0.069)	(0.069)	(0.071)		(0.170)	(0.243)	(0.226)	(0.239)
Constant	-0.111***					Spatial coefficient (rho)	0.197***	0.334***	0.325***	0.307***
	(0.017)						(0.028)	(0.038)	(0.037)	(0.038)
Seasonal effects	YES	YES	YES	YES	YES					
Time effects (annual)	YES	YES	YES	YES	YES					
N	2992	2992	2992	2856						
R2	0.069	0.075	0.074	0.075						
R2_within	0.073	0.078	0.078	0.079						
R2_between	0.024	0.006	0.006	0.007						

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

Table 7 Direct, Indirect and Total Average Marginal Effects for Inflation-adjusted Expectations – Binary Matrices

		W1	W2	W3	W2 (w/o Germany)
*d.ln(L5.Wage)**	ADE	1.490	1.406	1.452	1.385
		(1.084)	(1.084)	(1.087)	(1.112)
	AIE	4.282***	17.45***	17.11***	16.28***
		(2.732)	(5.900)	(5.865)	(5.531)
	ATE	5.772*	18.86***	18.56***	17.66***
		(3.171)	(6.256)	(6.221)	(5.896)
d.ln(Oil)	ADE	0.286	0.231	0.277	0.169
		(0.356)	(0.375)	(0.374)	(0.392)
	AIE	0.005	0.258	0.157	0.296
		(0.438)	(0.534)	(0.522)	(0.546)
	ATE	0.291	0.489	0.434	0.465
		(0.339)	(0.432)	(0.421)	(0.433)
EA	ADE	0.042	0.038	0.035	0.038
		(0.026)	(0.029)	(0.03)	(0.03)
	AIE	-0.042	-0.163	-0.210	-0.151
		(0.097)	(0.331)	(0.321)	(0.303)
	ATE	0.000	-0.125	-0.175	-0.113
		(0.106)	(0.346)	(0.338)	(0.317)
d.ln(Indust)	ADE	0.241	0.280	0.293	0.293
		(0.233)	(0.233)	(0.233)	(0.24)
	AIE	-0.515	-0.592	-0.202	-0.749
		(0.548)	(0.88)	(0.82)	(0.861)
	ATE	-0.274	-0.312	0.092	-0.457
		(0.598)	(0.904)	(0.845)	(0.887)
d.ln(Food)	ADE	-0.634	-0.465	-0.574	-0.421
		(0.839)	(0.841)	(0.839)	(0.863)
	AIE	2.238	2.447	2.755	2.847
		(2.096)	(3.202)	(3.143)	(3.219)
	ATE	1.604	1.982	2.181	2.427
		(2.143)	(3.198)	(3.145)	(3.217)
d.(IR key)	ADE	-0.005	0.017	0.018	0.015
		(0.031)	(0.031)	(0.031)	(0.032)
	AIE	-0.053	-0.162	-0.161	-0.151
		(0.077)	(0.12)	(0.105)	(0.122)
	ATE	-0.057	-0.145	-0.142	-0.136
		(0.083)	(0.123)	(0.108)	(0.126)
d.(IR mm)	ADE	0.007	0.003	0.001	0.003
		(0.013)	(0.013)	(0.013)	(0.013)
	AIE	0.070**	0.096*	0.078	0.090*
		(0.032)	(0.05)	(0.048)	(0.047)
	ATE	0.078**	0.099*	0.079	0.093*
		(0.036)	(0.053)	(0.051)	(0.051)
d.ln(NEER)	ADE	-0.894	-0.934	-1.025	-0.972
		(0.688)	(0.711)	(0.712)	(0.727)
	AIE	1.420	1.353	1.618	1.249
		(1.155)	(1.541)	(1.568)	(1.555)
	ATE	0.526	0.419	0.593	0.277
		(1.167)	(1.512)	(1.527)	(1.53)
d.(Stdev)	ADE	0.237***	0.218***	0.224***	0.219***
		(0.045)	(0.046)	(0.046)	(0.047)
	AIE	0.167	0.191	0.164	0.177
		(0.103)	(0.157)	(0.15)	(0.152)
	ATE	0.404***	0.409***	0.388***	0.397***
		(0.104)	(0.154)	(0.148)	(0.15)
d.(Confid)	ADE	0.003	0.003*	0.003*	0.003*
		(0.002)	(0.002)	(0.002)	(0.002)
	AIE	0.006	0.008	0.009	0.008
		(0.004)	(0.007)	(0.007)	(0.007)
	ATE	0.009*	0.012	0.012*	0.011
		(0.005)	(0.007)	(0.007)	(0.007)
d.(EMA)	ADE	-0.594***	-0.578***	-0.573***	-0.577***
		(0.070)	(0.069)	(0.069)	(0.07)
	AIE	-0.402	-0.450	-0.400	-0.402
		(0.205)	(0.349)	(0.321)	(0.334)
	ATE	-0.996***	-1.028***	-0.973***	-0.978***
		(0.229)	(0.363)	(0.334)	(0.349)

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1–W3 stands for estimates with weight matrices as specified in [5]–[7]. All variables, except wage, enter estimates with lags as specified in Table 5. Nominal wages (wage) enter specification with 5 months lag.

5.2. Robustness checks results

The previously discussed results are—in general—robust to the weights matrix specification, either based on geographical distance weights or global trade partners. The trade-based binary matrices are also stable due to relatively high persistence in terms of the top trading partner specification. Model specifications with matrices for import share in 2004 deliver outcomes almost indistinguishable from the baseline results. Secondly, excluding Germany does not significantly alter our findings in most of the cases and suggests that results are not driven by a specific position of Germany in the trade network of EU countries but the unique network characteristics of the EU22.[11] We also report the results from the estimations by using spatial weights without binary transformation (Appendix 3-5). Although the effect of some coefficients is more pronounced in this setting, the relevance of indicators, as captured by statistical significance, remains broadly unaffected.

House prices belong to the widely discussed determinant of financial cycle and, consequently, might be a significant driver of consumers' behaviour. Our findings strongly confirm the hypothesis that consumers' perception is influenced by the nominal (financial) side of the economy, and more precisely, the real estate sector. Once included into model specifications (Tables 6 and 7), their effect completely overshadows the effect of other domestic real factors, except food prices. This observation holds for domestically-induced changes in inflation expectations and transmission of changes in house price from the real estate sector of the most proximal economic neighbours. This result may tentatively support the argument in favour of including the financial side of an economy into the central banks' inflation forecasts. Secondly, if inflation expectations are the key driver to influence current inflation levels (forward-looking NKPC), consumers' included, sufficient space exists for discussion on the role of the central bank in influencing prices on the financial side of an economy.

Reducing the sample to 16 countries also highlights the role of NEER that gains on statistical significance in estimates for consumers' inflation expectations adjusted for changes in inflation rates. In this reduced sample, changes in the value of the domestic currency and currencies of neighbouring countries are transmitted into domestic consumers' expectations in an economically justified manner, as discussed in the main results section (positive for ADE, negative of AIE). This robustness check therefore highlights the role of nominal exchange rate depreciation (appreciation) in forming the inflation expectations through the inflation rate and 'pure' updates channel.

In most of the cases, our findings are not sensitive towards choice of lags, but some exceptions are notable. In the case of oil prices, the contemporaneous change in oil prices (lag=0) shows a significant impact on consumers' inflation expectations in the domestic and foreign dimensions, which is opposite to our benchmark results for ADE in Table 5. Secondly, the ADE of nominal exchange rate variable loses its significance in contemporaneous setting and the indirect (positive) effect becomes dominant. These observations further strengthen the necessity to acknowledge the presence of the spatial effects of selected determinants on the formation of consumers' inflation expectations based on the highly heterogeneous ability of consumers to collect, understand, and interpret information from different sources, time, and space. In a case where inflation expectations are adjusted for inflation rates, the small order of time lags for nominal wage and food prices produces a negative coefficient (i.e. higher wages lead to lower inflation expectations). A more delayed response of inflation expectations to changes in real economic conditions (5–6 months) links domestic inflation expectations to the upwards (or downwards) phase of a business cycle in a positive manner, as expected.

LeSage and Pace (2009) argue that regional scientists tend to assume that spill over effects are global by nature at the expense of more simple neighbour (local) effects modelled by the SLX and SDEM models. Notably, in many empirical specifications the global nature of spill-over effects might be called into question. To address this concern, we estimate the SLX and SDEM models as specified in LeSage (2014) to confirm the importance of local spill over effects in formation of inflation expectations.

[11] By analysing the trade-based network in the EU22, the key central nodes include more countries than just Germany. The most interconnected nodes belong to Belgium, Germany, Spain, Italy, the Netherlands, the United Kindgom, and France.

The results available in the Appendix 7 confirm the highly significant role of the spatial dimension of inflation expectations (lambda and rho coefficients).

Apparently, the individual domestic effects of wage, industrial production, NEER, and inflation volatility remain robust to the choice of model. Notably, after controlling for possible global inflation, the food prices, key interest rate and, medium-term memory component gain on significance. The presence of the local (neighbour) effect is confirmed by the oil prices, consumer confidence indicator, and medium-term memory component. Interestingly, the statistically significant coefficient associated with the industrial production index in the SLX model loses its significance after controlling for the spatial nature of inflation expectations (SDEM, SDM). This finding may emphasise the importance of transmitting consumers' expectations through trade and production channels, a phenomenon relevant for highly interconnected European economy.

5.3. Summary and policy implications

The first approach in our study analyses the updates of inflation expectations of consumers anchored to realised previous inflation rates. The results obtained by spatial models indicate a global spatial component in consumers' inflation expectations that is assumed to be transmitted through the trade channel. Key determinants affecting inflation expectations include real and financial economic variables and a set of subjective cognitive indicators with a prominent role played by a medium-term inflation reversal indicator. The network-transmitted information regarding expected inflation can be traced to changes in oil prices and consumer confidence indicators.

The second approach addresses the presence of potential spatial dependence stemming from changes in underlying, spatially dependent, inflation rates and control for this element. This approach should intentionally capture the 'pure' spatial component in forming the expectations and omit possible distortions. Our findings confirm the presence of an inherent spatial component in consumers' inflation expectations, as hypothesised. The consumer confidence indicator and medium-term memory reversal of inflation expectations are notable as the domestic drivers. Conversely, the significant impact of the lagged international business cycle captured by nominal wages behaviour and changes in the monetary policy of important trade neighbours tend to spill-over into the domestic consumers' inflation expectations.

The discussed findings assert important implications for the conduct of monetary policy. In small open economies, the existence of a spatial component in consumers' inflation expectations may disrupt monetary policy transmission mechanism and distort signals from domestic central bank. Additionally, the existence of the spatial component in consumers' inflation expectations may be a sign of good news for the execution of common monetary policy in the euro zone. The more interlinked consumer expectations may facilitate the path to better business cycle synchronisation and strengthen the process of EA convergence, improving the conditions for efficient and effective monetary policy conduct.

Monetary authorities, when managing short-term inflation expectations, should also pay sufficient attention not only to the domestically driven real economy and financial-related factors but also their foreign counterparts, including the consumers' economic favourable cognition. Additionally, the need to implement transparent monetary policy which uses a broad range of information policy instruments including set of information from relevant neighbour economies may become even more pronounced. On the positive side, the negative reaction of consumers' inflation expectations to increase in past inflation rates may signal presence of counter-cyclical behaviour, thus rewarding the domestic monetary policy of EU countries for successfully anchoring consumers' inflation expectations towards medium-term inflation objective which, in turn, should ease the burden of future monetary policy conduct.

Conclusions

In this study, we examined the impact of potential domestic and external factors on one-year-ahead inflation expectations of consumers in the EU22 from 2005–2016. Thus, we reflect the current discussion on international channels of inflation transmission in the new Keynesian Phillips curve setting.

In our study we confirm the existence of a spatial component of the inflation expectations of consumers. This finding indicates that inflation expectations co-move across countries through trade channels and are driven by the domestic and foreign factors from the macro- and financial spheres, as well as cognitive factors. After controlling for the possible presence of a spatial component in inflation rates, which the inflation expectations are anchored to, the cognitive factors are shown to play a special role in forming the inflation expectations, that is, on top of the present spatial dependence in 'pure' updates of consumers' inflation expectations. Thus, we underscore that not only the inflation rates but also the inflation expectations of consumers with their certain cognitive features have started showing signs of being an international phenomenon.

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Appendix 1 Pair-Wise Correlation Coefficients

	Expect	EA	Wage	Oil	Industry	Food	IR key	IR mm	NEER	Stdev	Confid.	EMA	House*
Expect (change)	1.00												
EA (dummy)	0.02	1.00											
Wage (growth rate)	0.07	-0.28	1.00										
Oil (growth rate)	0.13	-0.03	0.01	1.00									
Industry (growth rate	0.11	-0.03	0.03	0.14	1.00								
Food (growth rate)	0.06	-0.10	0.18	0.10	0.02	1.00							
IR key (change)	0.09	0.03	0.01	0.09	0.08	0.05	1.00						
IR mm (change)	0.03	0.01	0.04	0.03	0.02	0.04	0.19	1.00					
NEER (growth rate)	-0.03	0.02	0.01	-0.03	0.02	0.02	0.02	-0.02	1.00				
Stdev. (change)	-0.07	-0.32	0.05	0.11	0.00	0.01	-0.12	-0.12	0.04	1.00			
Confidence (change)	0.04	0.01	-0.03	0.03	0.08	-0.08	0.03	-0.04	0.06	0.04	1.00		
EMA (change)	0.02	0.10	0.22	0.12	-0.01	0.32	0.18	0.13	0.02	0.04	-0.13	1.00	
House (change)*	0.30	-0.08	0.32	0.09	0.17	0.09	0.21	0.03	-0.02	-0.15	0.09	0.20	1.00

Note: * Correlation coefficients between house prices and other variables are based on a restricted subsample excluding Bulgaria, Cyprus, Czechia, Hungary, Romania, and Slovenia. Growth rates are calculated as the first difference of the logarithm of a particular variable. Changes are calculated as the first differences of a particular variable. The EA dummy equals 1 for EA member states.

Appendix 2a Panel Unit Root Tests

		d.Expect	d.ln(Wage)	d.ln(Ind)	d.ln(Oil)	d.ln(Food)	d.IR key	d.IR mm	d.ln(NEER)	d.Stdev	d.Confid	d. EMA
Im-Pesaran-Shin	N	3036	3036	3036	3036	3036	3036	3036	3036	3036	3036	3036
	# groups	22	22	22	22	22	22	22	22	22	22	22
	Avg # periods	139	139	139	139	139	139	139	139	139	139	139
	p value	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Dickey – Fuller	N	3058	3058	3058	3058	3058	3058	3058	3058	3058	3058	3058
	# groups	22	22	22	22	22	22	22	22	22	22	22
	Avg # periods	139	139	139	139	139	139	139	139	139	139	139
	Inverse chi-squared, p-value	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	Inverse normal, p-value	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	Inverse logit, p-value	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	Mod. inv. chi-squared,	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Philips – Perron	N	3058	3058	3058	3058	3058	3058	3058	3058	3058	3058	3058
	# groups	22	22	22	22	22	22	22	22	22	22	22
	Avg # periods	139	139	139	139	139	139	139	139	139	139	139
	Inverse chi-squared, p-value	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	Inverse normal, p-value	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	Inverse logit, p-value	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	Mod. inv. chi-squared,	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Pesaran (2007)	N	3058	3058	3058	3058	3058	3058	3058	3058	3058	3058	3058
	# groups	22	22	22	22	22	22	22	22	22	22	22
	t-stats (CIPS)	-5.40***	-3.08***	-5.81***	-6.06***	-5.87***	-4.76***	-2.51***	-5.82***	-5.21***	-6.19***	-2.79***
	t-stats (CIPS, with trend)	-5.54***	-3.21***	-6.12***	-6.32***	-6.08***	-4.82***	-2.49***	-5.97***	-5.25***	-6.42***	-2.81***

Note: H0 - All panels contain unit roots, H1 - At least one panel is stationary. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level.

Appendix 2b Residual Cross-Section Dependence Tests

	Consumers expectations			Consumers expectations adjusted for inflation rate		
Test	Statistic	d.f.	Prob.	Statistic	d.f.	Prob.
Breusch-Pagan LM	2 844.43	231	0.000	1 204.03	231	0.000
Pesaran scaled LM	121.59		0.000	45.27		0.000
Bias-corrected scaled LM	121.51		0.000	45.19		0.000
Pesaran CD	44.85		0.000	22.41		0.000

Note: H0: No cross-section dependence (correlation) in residuals

Appendix 3 Estimation Results with Weighted Matrices

		SDM					SDM			
	FE	W1	W2	W3	W2 (w/o Germany)		W1	W2	W3	W2 (w/o Germany)
d.ln(Wage)	7.934**	7.299***	7.387***	7.392***	7.572***	W.d.ln(Wage)	-2.364	-5.955	-5.869	-1.914
	(3.452)	(1.627)	(1.575)	(1.575)	(1.625)		(2.794)	(5.041)	(4.971)	(4.456)
d.ln(Oil)	1.594***	-0.241	-0.627	-0.610	-0.177	W.d.ln(Oil)	1.526***	1.800***	1.802***	1.085
	(0.376)	(0.507)	(0.54)	(0.539)	(0.569)		(0.546)	(0.63)	(0.628)	(0.676)
EA	0.041*	0.046	0.047	0.046	0.048	W.EA	-0.119*	-0.045	-0.059	-0.030
	(0.020)	(0.040)	(0.040)	(0.040)	(0.041)		(0.062)	(0.212)	(0.209)	(0.169)
d.ln(Indust)	1.438***	1.176***	1.062***	1.064***	1.158***	W.d.ln(Indust)	-0.041	-0.327	-0.307	-0.388
	(0.329)	(0.349)	(0.344)	(0.344)	(0.353)		(0.508)	(0.832)	(0.823)	(0.805)
d.ln(Food)	2.830	3.090**	2.716**	2.680**	2.762**	W.d.ln(Food)	-2.486	-2.725	-2.683	-2.284
	(2.345)	(1.258)	(1.241)	(1.241)	(1.27)		(2.079)	(2.857)	(2.84)	(2.988)
d.(IR key)	0.125***	0.089**	0.086*	0.086*	0.082*	W.d.(IR key)	-0.035	0.044	0.052	0.064
	(0.038)	(0.045)	(0.045)	(0.045)	(0.046)		(0.065)	(0.091)	(0.09)	(0.095)
d.(IR mm)	0.002	-0.002	-0.002	-0.002	-0.006	W.d.(IR mm)	0.001	0.034	0.035	-0.001
	(0.021)	(0.020)	(0.02)	(0.02)	(0.02)		(0.025)	(0.046)	(0.045)	(0.038)
d.ln(NEER)	-1.172	-2.090**	-2.915***	-2.944***	-2.607**	W.d.ln(NEER)	1.017	1.786	1.908	0.871
	(1.001)	(0.995)	(1.032)	(1.032)	(1.044)		(1.384)	(1.671)	(1.669)	(1.767)
d.(Stdev)	0.209*	0.200***	0.171**	0.171**	0.182**	W.d.(Stdev)	-0.015	0.081	0.098	-0.082
	(0.101)	(0.071)	(0.071)	(0.071)	(0.072)		(0.095)	(0.154)	(0.152)	(0.147)
d.(Confid)	0.004	0.000	-0.001	-0.001	-0.001	W.d.(Confid)	0.016***	0.015**	0.015**	0.020***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)		(0.004)	(0.006)	(0.006)	(0.006)
d.(EMA)	-0.176	-0.197*	-0.252**	-0.253**	-0.226**	W.d.(EMA)	0.394**	0.672**	0.641**	0.689**
	(0.138)	(0.102)	(0.099)	(0.099)	(0.102)		(0.156)	(0.314)	(0.309)	(0.28)
Constant	-0.005					Spatial coefficient (rho)	0.235***	0.522***	0.517***	0.467***
	(0.024)						(0.018)	(0.026)	(0.026)	(0.026)
Seasonal effects	YES	YES	YES	YES	YES					
Time effects (annual)	YES	YES	YES	YES	YES					
N	3080	3058	3058	3058	2919					
R2	0.081	0.089	0.091	0.091	0.094					
R2 within	0.081	0.095	0.093	0.093	0.097					
R2 between	0.495	0.197	0.431	0.437	0.434					

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

Appendix 4 Direct, Indirect and Total Average Marginal Effects – Weighted Matrices

		W1	W2	W3	W2 (w/o Germany)
d.ln(Wage)	ADE	7.197***	7.205***	7.213***	7.622***
		(1.648)	(1.653)	(1.653)	(1.691)
	AIE	-0.832	-4.390	-4.232	2.809
		(3.299)	(10.37)	(10.15)	(8.133)
	ATE	6.366	2.815	2.981	10.430
		(4.078)	(11.15)	(10.93)	(8.945)
d.ln(Oil)	ADE	-0.125	-0.537	-0.517	-0.117
		(0.484)	(0.527)	(0.526)	(0.552)
	AIE	1.809***	2.996***	2.999***	1.832**
		(0.551)	(0.888)	(0.878)	(0.875)
	ATE	1.684***	2.459***	2.481***	1.715**
		(0.492)	(0.859)	(0.849)	(0.795)
EA	ADE	0.038	0.046	0.045	0.049
		(0.039)	(0.042)	(0.042)	(0.043)
	AIE	-0.135*	-0.049	-0.078	-0.018
		(0.079)	(0.454)	(0.443)	(0.326)
	ATE	-0.097	-0.003	-0.034	0.031
		(0.096)	(0.477)	(0.466)	(0.349)
d.ln(Indust)	ADE	1.180***	1.061***	1.064***	1.152***
		(0.350)	(0.344)	(0.344)	(0.353)
	AIE	0.254	0.360	0.391	0.191
		(0.590)	(1.564)	(1.532)	(1.367)
	ATE	1.434**	1.421	1.455	1.343
		(0.724)	(1.643)	(1.612)	(1.453)
d.ln(Food)	ADE	3.009**	2.693**	2.657**	2.760**
		(1.249)	(1.236)	(1.236)	(1.265)
	AIE	-2.053	-2.422	-2.379	-1.614
		(2.585)	(5.713)	(5.627)	(5.459)
	ATE	0.955	0.271	0.278	1.146
		(2.852)	(5.86)	(5.777)	(5.629)
d.(IR key)	ADE	0.087*	0.091**	0.092**	0.089*
		(0.046)	(0.046)	(0.046)	(0.047)
	AIE	-0.011	0.194	0.206	0.199
		(0.084)	(0.187)	(0.183)	(0.178)
	ATE	0.077	0.285	0.298	0.288
		(0.101)	(0.199)	(0.194)	(0.191)
d.(IR mm)	ADE	-0.001	0.001	0.001	-0.005
		(0.020)	(0.020)	(0.020)	(0.020)
	AIE	0.008	0.071	0.073	-0.005
		(0.032)	(0.095)	(0.093)	(0.071)
	ATE	0.007	0.072	0.074	-0.010
		(0.042)	(0.102)	(0.1)	(0.079)
d.ln(NEER)	ADE	-2.097**	-2.948***	-2.971***	-2.679**
		(0.998)	(1.042)	(1.042)	(1.053)
	AIE	0.644	0.502	0.737	-0.658
		(1.547)	(2.917)	(2.89)	(2.797)
	ATE	-1.453	-2.446	-2.234	-3.338
		(1.734)	(3.008)	(2.981)	(2.895)
d.(Stdev)	ADE	0.202***	0.182***	0.182***	0.182***
		(0.066)	(0.067)	(0.066)	(0.068)
	AIE	0.038	0.347	0.375	0.008
		(0.114)	(0.299)	(0.294)	(0.256)
	ATE	0.241*	0.529*	0.557*	0.190
		(0.131)	(0.307)	(0.302)	(0.266)
d.(Confid)	ADE	0.001	0.000	0.000	0.001
		(0.003)	(0.003)	(0.003)	(0.003)
	AIE	0.020***	0.031**	0.030**	0.036***
		(0.005)	(0.013)	(0.013)	(0.011)
	ATE	0.021***	0.032**	0.030**	0.037***
		(0.006)	(0.014)	(0.014)	(0.012)
d.(EMA)	ADE	-0.169	-0.219**	-0.221**	-0.191*
		(0.103)	(0.101)	(0.101)	(0.104)
	AIE	0.429**	1.092*	1.022*	1.058**
		(0.191)	(0.628)	(0.613)	(0.504)
	ATE	0.260	0.873	0.800	0.867
		(0.238)	(0.664)	(0.648)	(0.544)

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

Appendix 5 Estimation Results for the Subsample Including House Prices (2005-2016, 16 countries)

		SDM			SDM	
	FE	W2	W2 (weighted)		W2	W2 (weighted)
d.ln(House)	12.33***	10.55***	10.63***	W.d.ln(House)	8.882***	5.035*
	(2.966)	(0.987)	(0.989)		(3.392)	(2.76)
d.ln(Wage)	3.949	4.482**	4.821***	W.d.ln(Wage)	-6.693	-9.313
	(2.786)	(1.77)	(1.783)		(6.568)	(6.267)
d.ln(Oil)	1.140***	0.478	0.332	W.d.ln(Oil)	-0.723	-0.280
	(0.355)	(0.573)	(0.564)		(0.705)	(0.66)
EA	0.041	0.012	0.049	W.EA	-0.448*	0.040
	(0.065)	(0.043)	(0.043)		(0.261)	(0.211)
d.ln(Indust)	0.663*	0.472	0.467	W.d.ln(Indust)	-1.136	-0.859
	(0.318)	(0.336)	(0.339)		(0.848)	(0.826)
d.ln(Food)	6.703***	4.585***	4.228**	W.d.ln(Food)	0.819	1.206
	(1.962)	(1.683)	(1.707)		(3.48)	(3.032)
d.(IR key)	0.038	-0.042	-0.048	W.d.(IR key)	0.046	0.093
	(0.053)	(0.064)	(0.064)		(0.1)	(0.097)
d.(IR mm)	0.012	-0.006	0.005	W.d.(IR mm)	0.041	0.045
	(0.03)	(0.023)	(0.023)		(0.053)	(0.042)
d.ln(NEER)	0.221	-3.413**	-3.186**	W.d.ln(NEER)	5.280**	4.765***
	(1.55)	(1.29)	(1.29)		(2.011)	(1.823)
d.(Stdev)	0.425**	0.367***	0.374***	W.d.(Stdev)	-0.070	-0.026
	(0.157)	(0.08)	(0.079)		(0.168)	(0.153)
d.(Confid)	0.006	0.004	0.004	W.d.(Confid)	0.000	-0.002
	(0.004)	(0.003)	(0.003)		(0.007)	(0.006)
d.(EMA)	-0.277**	-0.344***	-0.301***	W.d.(EMA)	0.753**	0.704**
	(0.096)	(0.113)	(0.114)		(0.348)	(0.312)
Constant	-0.077			Spatial coefficient (rho)	0.379***	0.522***
	(0.068)				(0.022)	(0.026)
Seasonal effects	YES	YES	YES			
Time effects (annual)	YES	YES	YES			
N	2016	2000	2000			
R2	0.166	0.190	0.197			
R2_within	0.166	0.201	0.201			
R2_between	0.004	0.006	0.002			

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W2 stands for estimates with the weight matrix specified in [6].

Appendix 6 Direct, Indirect and Total Average Marginal Effects for Subsample Including House Prices (2005-2016, 16 countries)

\		W2	W2 (weighted)			W2	W2 (weighted)
d.ln(House)	ADE	11.56***	11.33***	d.(IR key)	ADE	-0.037	-0.040
		(1.039)	(1.028)			(0.062)	(0.062)
	AIE	28.78***	18.62***		AIE	0.052	0.133
		(6.757)	(5.088)			(0.17)	(0.152)
	ATE	40.34***	29.95***		ATE	0.015	0.094
		(7.238)	(5.56)			(0.174)	(0.155)
d.ln(Wage)	ADE	4.179**	4.326**	d.(IR mm)	ADE	-0.004	0.007
		(1.874)	(1.884)			(0.023)	(0.024)
	AIE	-8.499	-12.800		AIE	0.073	0.085
		(12.96)	(11.3)			(0.098)	(0.074)
	ATE	-4.321	-8.471		ATE	0.069	0.092
		(13.67)	(12.02)			(0.106)	(0.084)
d.ln(Oil)	ADE	0.456	0.336	d.ln(NEER)	ADE	-3.172***	-2.967**
		(0.517)	(0.51)			(1.199)	(1.202)
	AIE	-1.013	-0.271		AIE	6.967**	5.938**
		(1.094)	(0.959)			(3.462)	(2.896)
	ATE	-0.557	0.065		ATE	3.795	2.972
		(0.972)	(0.867)			(3.489)	(2.974)
EA	ADE	-0.022	0.051	d.(Stdev)	ADE	0.377***	0.385***
		(0.053)	(0.051)			(0.08)	(0.08)
	AIE	-0.909	0.098		AIE	0.257	0.296
		(0.554)	(0.414)			(0.311)	(0.259)
	ATE	-0.931	0.149		ATE	0.634*	0.681**
		(0.591)	(0.448)			(0.327)	(0.277)
d.ln(Indust)	ADE	0.425	0.438	d.(Confid)	ADE	0.004	0.004
		(0.342)	(0.343)			(0.003)	(0.003)
	AIE	-1.687	-1.092		AIE	0.005	0.001
		(1.734)	(1.549)			(0.014)	(0.012)
	ATE	-1.262	-0.654		ATE	0.009	0.005
		(1.816)	(1.622)			(0.015)	(0.013)
d.ln(Food)	ADE	4.806***	4.446**	d.(EMA)	ADE	-0.300**	-0.258**
		(1.717)	(1.737)			(0.117)	(0.117)
	AIE	6.677	6.153		AIE	1.156	1.035*
		(6.67)	(5.292)			(0.71)	(0.59)
	ATE	11.480	10.60*		ATE	0.856	0.777
		(7.044)	(5.676)			(0.752)	(0.637)

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W2 stands for estimates with the weight matrix specified in [6].

Appendix 7 Estimation Results with Binary Weights Matrices (SLX, SDEM, SDM models)

	W1			W2			W3		
	SLX	SDEM	SPD	SLX	SDEM	SPD	SLX	SDEM	SPD
d.ln(Wage)	7.410**	7.286**	7.108*	7.224**	7.014**	7.015*	7.188**	7.158**	7.120*
	(3.366)	(3.350)	(1.591)	(3.319)	(3.294)	(1.574)	(3.307)	(3.361)	(1.574)
d.ln(Oil)	-0.272	-0.384	-0.524	-0.369	-0.513	-0.584	-0.315	-0.313	-0.511
	(0.800)	(0.647)	(0.538)	(0.770)	(0.589)	(0.557)	(0.654)	(0.551)	(0.555)
EA	0.038	0.033	0.045	0.036	0.030	0.037	0.028	0.029	0.035
	(0.023)	(0.030)	(0.040)	(0.025)	(0.029)	(0.042)	(0.025)	(0.026)	(0.042)
d.ln(Indust)	1.088***	1.104***	1.025***	1.031***	1.041***	1.012***	0.995***	1.041***	1.013***
	(0.343)	(0.301)	(0.344)	(0.329)	(0.292)	(0.343)	(0.331)	(0.277)	(0.342)
d.ln(Food)	3.128	3.150	3.311***	2.510	2.853	2.949**	2.568	2.648	2.673**
	(2.418)	(2.230)	(1.243)	(2.437)	(2.197)	(1.235)	(2.408)	(2.183)	(1.23)
d.ln(IR key)	0.086	0.088	0.090**	0.077	0.087	0.090**	0.069	0.097	0.090**
	(0.059)	(0.064)	(0.045)	(0.063)	(0.066)	(0.045)	(0.064)	(0.067)	(0.045)
d.ln(IR mm)	-0.004	-0.004	-0.006	-0.005	-0.008	-0.007	-0.003	-0.007	-0.006
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.021)	(0.021)	(0.020)
d.ln(NEER)	-2.226***	-2.346***	-2.473**	-2.689***	-2.636***	-2.756***	-2.924***	-2.916***	-3.071***
	(0.777)	(0.779)	(1.008)	(0.851)	(0.911)	(1.030)	(0.775)	(0.902)	(1.030)
d.Stdev	0.201*	0.198*	0.196***	0.168	0.169	0.165**	0.170**	0.180*	0.160**
	(0.111)	(0.103)	(0.071)	(0.113)	(0.109)	(0.071)	(0.112)	(0.107)	(0.071)
d.Confid	0.001	0.001	0.000	0.000	0.001	-0.001	0.000	0.000	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
d.EMA	-0.185	-0.188	-0.212**	-0.203	-0.228	-0.262***	-0.218	-0.274*	-0.275***
	(0.148)	(0.139)	(0.101)	(0.158)	(0.151)	(0.099)	(0.157)	(0.150)	(0.099)
W.d.ln(Wage)	3.188	3.071	0.074	0.631	0.314	-0.604	0.583	0.410	-1.362
	(3.615)	(4.808)	(3.429)	(0.427)	(0.811)	(6.087)	(0.455)	(0.736)	(6.038)
W.d.ln(Oil)	1.894*	1.976*	1.460**	0.134	0.206*	1.278*	0.168**	0.212**	1.302*
	(1.040)	(1.025)	(0.628)	(0.087)	(0.108)	(0.683)	(0.078)	(0.084)	(0.671)
W.EA	-0.170	-0.243	-0.177	-0.012	-0.024	-0.201	-0.020	-0.023	-0.232
	(0.118)	(0.151)	(0.113)	(0.027)	(0.028)	(0.311)	(0.027)	(0.030)	(0.306)
W.d.ln(Indust)	1.574**	1.195	0.535	0.173**	0.103	0.358	0.194**	0.114	0.230
	(0.729)	(0.922)	(0.702)	(0.072)	(0.130)	(0.913)	(0.088)	(0.153)	(0.864)
W.d.ln(Food)	-3.158	-3.271	-3.399	-0.100	-0.442	-3.031	-0.154	-0.336	-2.380
	(2.933)	(2.967)	(2.456)	(0.230)	(0.396)	(3.052)	(0.257)	(0.293)	(2.999)
W.d.ln(IR key)	-0.114	-0.078	-0.117	-0.010	-0.008	-0.105	0.003	0.013	0.002
	(0.091)	(0.103)	(0.089)	(0.012)	(0.019)	(0.114)	(0.012)	(0.018)	(0.102)
W.d.ln(IR mm)	-0.001	0.005	0.005	-0.005	-0.006	-0.041	-0.004	-0.005	-0.026
	(0.037)	(0.047)	(0.038)	(0.005)	(0.009)	(0.049)	(0.006)	(0.010)	(0.047)
W.d.ln(NEER)	1.967	0.391	1.831	0.152	0.042	2.204	0.245	0.250	3.033*
	(2.182)	(3.182)	(1.531)	(0.217)	(0.444)	(1.737)	(0.243)	(0.447)	(1.776)
W.d.Stdev	0.013	-0.056	-0.095	-0.001	0.007	-0.097	0.015	0.029	0.018
	(0.158)	(0.197)	(0.127)	(0.012)	(0.021)	(0.165)	(0.014)	(0.023)	(0.157)
W.d.Confid	0.026***	0.025***	0.020***	0.003***	0.004**	0.024***	0.003***	0.004**	0.020***
	(0.007)	(0.009)	(0.005)	(0.001)	(0.002)	(0.007)	(0.001)	(0.002)	(0.007)
W.d.EMA	0.603**	0.611**	0.565**	0.105**	0.092	0.824**	0.071*	0.027	0.646**
	(0.229)	(0.288)	(0.242)	(0.038)	(0.064)	(0.345)	(0.036)	(0.053)	(0.323)
Constant	0.107			0.093			0.167		
	(0.091)			(0.262)			(0.243)		
Spatial coeffcient (lambda)		0.369***			0.549***			0.543***	
		(0.023)			(0.046)			(0.04)	
Spatial coefficient (rho)			0.367***			0.545***			0.540***
			(0.022)			(0.027)			(0.026)
Seasonal effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time effects (ann.)	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	3080	3058	3058	3080	3058	3058	3080	3058	3058
R2	0.097	0.085	0.089	0.100	0.092	0.093	0.100	0.092	0.092
R2_within	0.097	0.096	0.097	0.100	0.096	0.097	0.100	0.096	0.095
R2_between	0.152	0.101	0.131	0.322	0.219	0.290	0.075	0.044	0.292

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

Appendix 8 Estimation Results with Weighted Matrices for Inflation-adjusted Expectations

		SDM					SDM			
	FE	W1	W2	W3	W2 (w/o Germany)		W1	W2	W3	W2 (w/o Germany)
*d.ln(L5.Wage)**	*1.504*	*1.530*	*1.260*	*1.263*	*1.260*	*W.d.ln(L5.Wage)**	*1.794*	*10.10****	*9.922****	*7.730***
	(0.893)	*(1.099)*	*(1.080)*	*(1.080)*	*(1.113)*		*(1.890)*	*(3.450)*	*(3.401)*	*(3.032)*
d.ln(Oil)	0.169	0.292	0.275	0.281	0.222	W.d.ln(Oil)	-0.149	0.130	0.117	0.208
	(0.184)	(0.341)	(0.369)	(0.369)	(0.389)		(0.366)	(0.431)	(0.429)	(0.464)
EA	0.045**	0.047*	0.047*	0.048*	0.046	W.EA	-0.044	0.043	0.039	0.031
	(0.017)	(0.027)	(0.027)	(0.027)	(0.029)		(0.042)	(0.145)	(0.143)	(0.116)
d.ln(Indust)	0.234	0.244	0.311	0.311	0.351	W.d.ln(Indust)	-0.184	-0.082	-0.039	-0.563
	(0.350)	(0.236)	(0.236)	(0.236)	(0.242)		(0.341)	(0.571)	(0.565)	(0.550)
d.ln(Food)	-0.619	-0.905	-0.569	-0.591	-0.586	W.d.ln(Food)	2.298	0.407	0.441	1.286
	(1.581)	(0.850)	(0.852)	(0.851)	(0.872)		(1.424)	(1.995)	(1.982)	(2.081)
d.(IR key)	-0.015	-0.014	0.021	0.022	0.017	W.d.(IR key)	0.034	-0.137**	-0.138**	-0.103
	(0.043)	(0.031)	(0.031)	(0.031)	(0.032)		(0.044)	(0.063)	(0.062)	(0.067)
d.(IR mm)	0.009	0.007	0.000	0.000	0.001	W.d.(IR mm)	0.044***	0.071**	0.067**	0.059**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)		(0.017)	(0.031)	(0.030)	(0.026)
d.ln(NEER)	-0.560	-0.783	-0.918	-0.924	-0.859	W.d.ln(NEER)	0.540	1.018	1.037	0.733
	(0.600)	(0.667)	(0.703)	(0.703)	(0.712)		(0.928)	(1.141)	(1.139)	(1.206)
d.(Stdev)	0.261***	0.240***	0.223***	0.225***	0.228***	W.d.(Stdev)	0.098	0.089	0.086	0.109
	(0.091)	(0.048)	(0.049)	(0.049)	(0.050)		(0.065)	(0.106)	(0.105)	(0.100)
d.(Confid)	0.003	0.002	0.003*	0.003*	0.003	W.d.(Confid)	0.003	0.005	0.005	0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)		(0.003)	(0.004)	(0.004)	(0.004)
d.(EMA)	-0.571***	-0.555***	-0.555***	-0.554***	-0.556***	W.d.(EMA)	-0.192*	-0.256	-0.252	-0.229
	(0.132)	(0.070)	(0.069)	(0.069)	(0.071)		(0.108)	(0.220)	(0.217)	(0.196)
Constant	-0.111***					Spatial coefficient (rho)	0.092***	0.298***	0.294***	0.241***
	(0.017)						(0.021)	(0.035)	(0.035)	(0.034)
Seasonal effects	YES	YES	YES	YES	YES					
Time effects (annual)	YES	YES	YES	YES	YES					
N	3014	2992	2992	2992	2856					
R2	0.065	0.070	0.076	0.075	0.074					
R2 within	0.065	0.073	0.079	0.079	0.077					
R2 between	0.076	0.059	0.077	0.072	0.087					

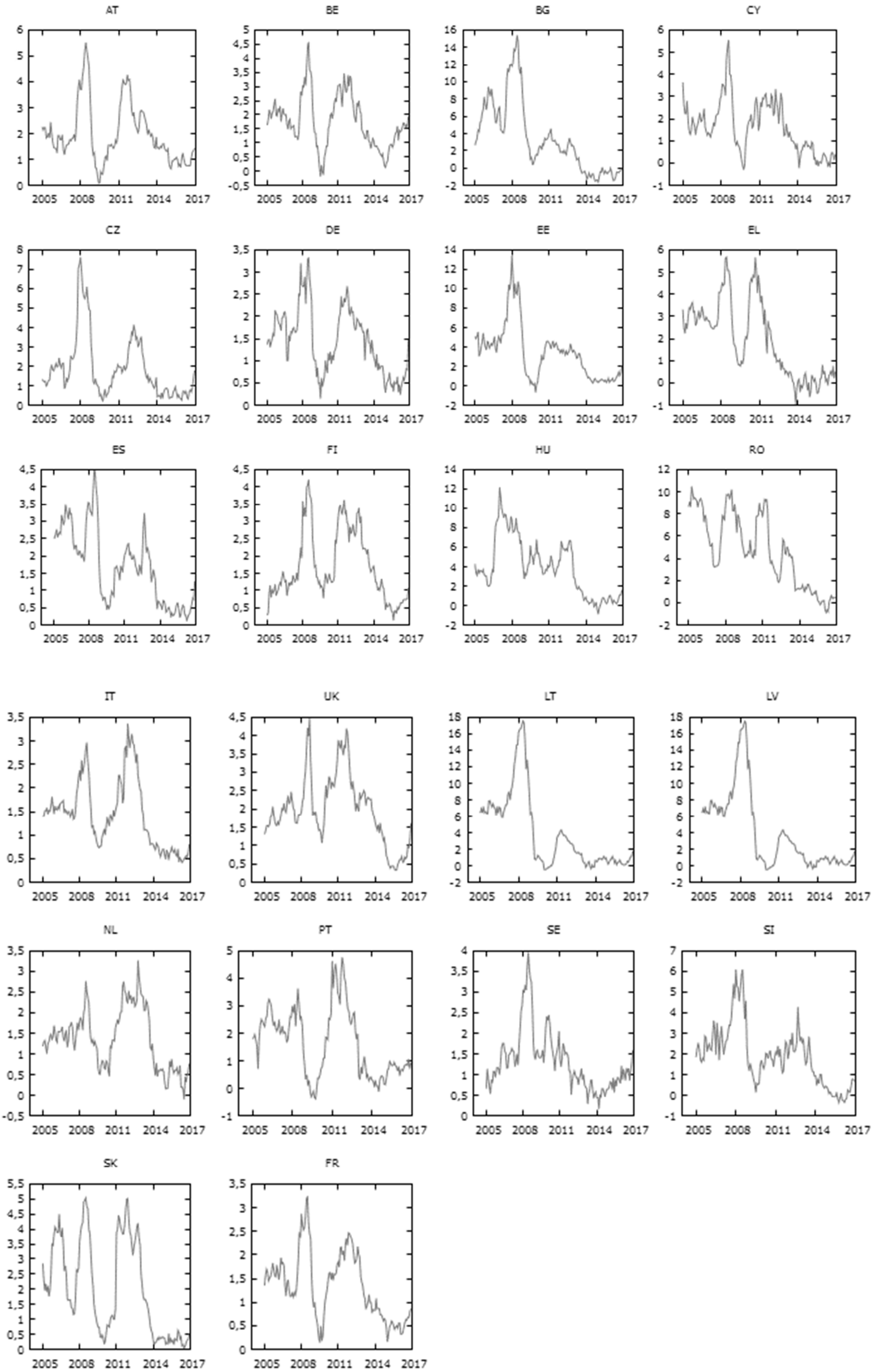
Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

Appendix 9 Estimation Results with Weighted Matrices for Inflation-adjusted Expectations

		W1	W2	W3	W2 (w/o Germany)
*d.ln(L5.Wage)**	ADE	1.556	1.516	1.516	1.436
		(1.087)	(1.086)	(1.086)	(1.113)
	AIE	2.080	14.70***	14.36***	10.39***
		(1.921)	(4.782)	(4.692)	(3.832)
	ATE	3.635*	16.21***	15.88***	11.82***
		(2.311)	(5.178)	(5.091)	(4.24)
d.ln(Oil)	ADE	0.287	0.279	0.286	0.228
		(0.333)	(0.362)	(0.362)	(0.381)
	AIE	-0.125	0.304	0.285	0.346
		(0.357)	(0.474)	(0.471)	(0.493)
	ATE	0.162	0.583	0.571	0.574
		(0.279)	(0.395)	(0.391)	(0.382)
EA	ADE	0.046*	0.050*	0.050*	0.050*
		(0.026)	(0.027)	(0.027)	(0.027)
	AIE	-0.045	0.075	0.069	0.052
		(0.045)	(0.214)	(0.209)	(0.159)
	ATE	0.001	0.125	0.119	0.099
		(0.055)	(0.224)	(0.219)	(0.169)
d.ln(Indust)	ADE	0.231	0.302	0.303	0.330
		(0.234)	(0.233)	(0.233)	(0.239)
	AIE	-0.192	-0.0271	0.0323	-0.658
		(0.351)	(0.754)	(0.741)	(0.679)
	ATE	0.039	0.275	0.336	-0.328
		(0.414)	(0.779)	(0.766)	(0.708)
d.ln(Food)	ADE	-0.803	-0.525	-0.545	-0.518
		(0.841)	(0.843)	(0.843)	(0.864)
	AIE	2.432	0.446	0.484	1.567
		(1.572)	(2.786)	(2.752)	(2.742)
	ATE	1.629	-0.079	-0.061	1.049
		(1.636)	(2.78)	(2.748)	(2.746)
d.(IR key)	ADE	-0.013	0.018	0.018	0.014
		(0.031)	(0.031)	(0.031)	(0.032)
	AIE	0.039	-0.176**	-0.176**	-0.121
		(0.049)	(0.089)	(0.087)	(0.088)
	ATE	0.026	-0.158*	-0.158*	-0.107
		(0.057)	(0.092)	(0.09)	(0.092)
d.(IR mm)	ADE	0.009	0.002	0.002	0.003
		(0.013)	(0.013)	(0.013)	(0.013)
	AIE	0.049***	0.100**	0.095**	0.078**
		(0.019)	(0.044)	(0.043)	(0.034)
	ATE	0.058**	0.103**	0.098**	0.081**
		(0.024)	(0.048)	(0.047)	(0.038)
d.ln(NEER)	ADE	-0.802	-0.932	-0.937	-0.879
		(0.673)	(0.710)	(0.710)	(0.719)
	AIE	0.503	1.023	1.048	0.667
		(0.936)	(1.425)	(1.417)	(1.410)
	ATE	-0.299	0.0916	0.111	-0.212
		(0.983)	(1.401)	(1.391)	(1.388)
d.(Stdev)	ADE	0.243***	0.228***	0.229***	0.232***
		(0.045)	(0.046)	(0.046)	(0.047)
	AIE	0.128*	0.219	0.213	0.215*
		(0.069)	(0.146)	(0.144)	(0.127)
	ATE	0.372***	0.447***	0.442***	0.446***
		(0.075)	(0.145)	(0.143)	(0.127)
d.(Confid)	ADE	0.003	0.003*	0.003*	0.003*
		(0.002)	(0.002)	(0.002)	(0.002)
	AIE	0.004	0.009	0.008	0.007
		(0.003)	(0.006)	(0.006)	(0.005)
	ATE	0.006*	0.012*	0.012*	0.010*
		(0.003)	(0.006)	(0.006)	(0.006)
d.(EMA)	ADE	-0.578***	-0.567***	-0.566***	-0.566***
		(0.069)	(0.068)	(0.068)	(0.070)
	AIE	-0.261**	-0.594**	-0.581**	-0.472*
		(0.114)	(0.301)	(0.295)	(0.249)
	ATE	-0.838***	-1.161***	-1.148***	-1.038***
		(0.138)	(0.316)	(0.310)	(0.267)

Note: *,**, and *** denote statistical significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. W1-W3 stands for estimates with weight matrices, as specified in [5]–[7].

Appendix 10 Inflation expectations of consumers in selected EU member states



Appendix 11 Carlson-Parkin method

"By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months? They will…

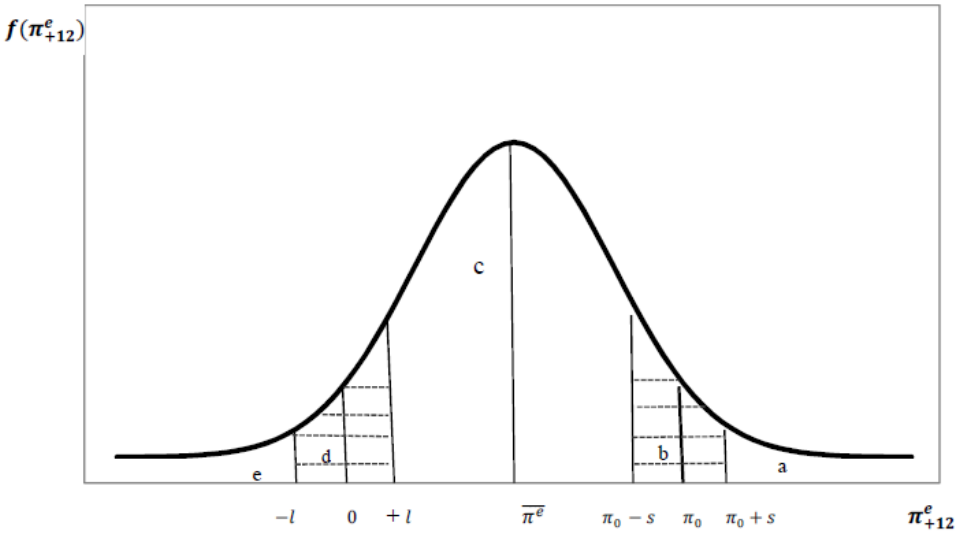
a-increase more rapidly,

b-increase at the same rate,

c- increase at a slower rate,

d-stay about the same,

e- fall" (EC Business and Consumer Survey).



$a = P(\pi_t^e > \pi_{0t} + s_t) = 1 - F_t(\pi_{0t} + s_t)$
$b = P(\pi_{0t} - s_t < \pi_t^e + < \pi_{0t} + s_t) = F_t(\pi_{0t} + s_t) - F_t(\pi_{0t} - s_t)$
$c = P(l_t < \pi_t^e < \pi_{0t} - s_t) = F_t(\pi_{0t} - s_t) - F_t(l_t)$
$d = P(-l_t < \pi_t^e < l_t) = F_t(l_t) - F_t(-l_t)$
$e = P(\pi_t^e < -l_t) = F_t(-l_t)$

The equations need to be rearranged with the use of standarisation of normal distribution:

$F_t\,(k_t) = Nz\left(\frac{k_t - \overline{\pi^e}}{\sigma_t}\right)$

$a = 1 - Nz\left(\frac{\pi_{0t} + s_t - \overline{\pi^e}}{\sigma_t}\right)$,
$b = Nz\left(\frac{\pi_{0t} + s_t - \overline{\pi^e}}{\sigma_t}\right) - Nz\left(\frac{\pi_{0t} - s_t - \overline{\pi^e}}{\sigma_t}\right)$
$c = Nz\left(\frac{\pi_{0t} - s_t - \overline{\pi^e}}{\sigma_t}\right) - Nz\left(\frac{l_t - \overline{\pi^e}}{\sigma_t}\right)$
$d = Nz\left(\frac{l_t - \overline{\pi^e}}{\sigma_t}\right) - Nz\left(\frac{-l_t - \overline{\pi^e}}{\sigma_t}\right)$
$e = Nz\left(\frac{-l_t - \overline{\pi^e}}{\sigma_t}\right)$.

The equation for quantified inflation expectations is :

$$\overline{\pi^e} = \frac{\pi_{0t} \times (C + D) - (A + B)}{C + D - (A + B)}$$

where:

$A = Nz^{-1}(1 - a)$,

$\mathrm{B} = Nz^{-1}(1 - a - b)$,

$C = Nz^{-1}(1 - a - b - c)$,

$D = Nz^{-1}(e)$. (Source: Łyziak 2003, p. 11-15; Łyziak 2010, p. 9-11, Łyziak & Stanisławska 2006, p. 10-13)

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