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CONTENTS

A DSGE Model for the Slovenian Economy: Model Estimates and Application*

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ABSTRACT: *The paper presents the estimation of a dynamic stochastic general equilibrium (DSGE) model for the Slovenian economy and its applications. The model, which is built in the tradition of New Keynesian models, closely follows the structure of the model developed by Adolfson et al. (2007) and Masten (2010). We estimate the model using a Bayesian method on quarterly Slovenian macroeconomic data covering the period 1995-2014. Beyond evaluating the properties of the estimated model, we discuss the role of various shocks in explaining macroeconomic fluctuations in the Slovenian economy to illustrate the model's potential in structural business cycle analysis.*

Key words: *DSGE models, Bayesian methods, business cycle*

JEL classification: C11, E32

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INTORDUCTION

New-Keynesian dynamic stochastic general equilibrium (DSGE) models have recently become a standard tool for macroeconomic analysis. The key feature of this class of models is that they are derived from the microeconomic foundations meaning that they assume optimizing agents which usually form rational expectations and maximize their objective functions subject to their respective constraints in the presence of imperfect competition and nominal rigidities.[2] In recent years there have been many theoretical and empirical contributions developing and estimating DSGE models. The most influential papers in this area include Clarida et al. (1999, 2001), Beningo & Beningo (2003), Galí & Monacelli (2005), Christiano et al. (2005), Smets & Wouters (2003, 2007), Adolfson et al. (2007) and many others.

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[2] For further information on the New-Keynesian models, see Galí (2008) and Woodford (2003).

Although the literature on the estimation of DSGE models and the subsequent use of these models to study macroeconomic fluctuations in various countries has rapidly expanded in recent years, no attempt has as yet been made to estimate a New-Keynesian DSGE model for Slovenia, at least to the best of our knowledge.[2.1] This paper therefore seeks to fill this gap by presenting an estimated DSGE model for the Slovenian economy.

The model that we use was inspired in the work of Adolfson et al. (2007) and Masten (2010). Masten (2010) extended the baseline model of Adolfson et al. (2007) in two directions, namely by (i) adapting the model to the small open economy case within the euro area and (ii) enriching the fiscal block of the model. We use a Bayesian approach to estimate key model parameters on 15 time series for Slovenia: GDP, consumption, investment, exports, imports, government consumption, real effective exchange rate, real wage, employment, GDP deflator, CPI price index, short-run interest rate, and three foreign variables (that is output, inflation and interest rate), which refer to the first 12 euro area countries.

With this paper we want to contribute to the large literature on estimated DSGE models by applying the Bayesian method to the estimation of the DSGE model for the Slovenian economy and therefore presenting evidence for an additional country on the estimates of the structural parameters, and by identifying the shocks responsible for the recent recession and the key sources of macroeconomic fluctuations in Slovenia.

After the estimation, we first present our estimates of the structural parameters. We then perform several checks of the model's empirical performance. Specifically, we evaluate how well the model fits the data. To do so, we compare the actual data with the one-sided predicted values from the model. Next, we calculate statistics of the data generated by the estimated model and compare them with those based on the actual data. Finally, we look at the smoothed estimates of the shock innovation paths to check whether they look stationary. In the last part of the paper, we apply the estimated DSGE model to analyse the contribution of the structural shocks on business cycle fluctuations in the Slovenian economy. We proceed here in three steps. First, using traditional impulse response analysis, we look at the partial effects of the most important shocks included in the model on key

[2.1] Despite their wide use, DSGE models have also certain drawbacks. The most problematic issues which are currently much discussed in the literature are mainly concerned with: (i) unrealistic assumptions (e.g. Ricardian equivalence, rational expectations hypothesis, infinitely-lived households, ...), (ii) unconvincing method of estimation (which is a combination of calibration and Bayesian estimation), (iii) questionable assumption about the structural parameters that are assumed to be invariant to policy changes, (iv) issue related with the use of revised or real-time data when estimating the model, and (v) poor performance during the recent crisis. For more detailed discussion of these issues, see Romer (2016), Blanchard (2016) and the other contributions (see Blanchard (2017) for an extensive list of references). Despite these shortcomings, we decided to use a DSGE framework as we believe that it is flexible enough to be used for our purposes, while other models are more limited in terms of their ability to fully address the research questions under study.

macroeconomic variables. Second, to assess how much of the volatility of the observed variables can be explained by the shocks included in the model, we also produce variance decomposition analysis. Finally, we compute historical decompositions of GDP growth and its main components in terms of various structural shocks of the model to examine the importance of respective shocks in explaining the observed macroeconomic dynamics over the sample period, with particular attention to the recent recessionary periods.

Previewing the results, we find that investment-specific technology shocks mostly accounted for a significant portion of the drop in output growth from 2008 onwards. This result accords with a drop in foreign and domestic orders followed by a decline in investment (mostly at the beginning of the crisis) and the large amount of losses of the corporate sector that accumulated on balance sheets of the banks in the form of non-performing bad loans, further contributing to a contraction of lending activity, which in turn reduced investment and impeded economic activity. Furthermore, consumption preference and export mark-up shocks were another sources that contributed negatively to GDP growth, most likely reflecting the reduction in households' income (in combination with the precautionary saving) and the fall in exports due to the deterioration of external competitiveness, as wages increased faster than productivity before the crisis years, respectively. The results also suggest that fiscal shocks had a stimulating impact during the first stage of the crisis. However, starting from 2010 there was a turnaround in fiscal policy due to austerity measures adopted to consolidate public finances. The slowdown in GDP growth was also accompanied by permanent (unit-root) technology shocks that could be considered as associated with the lack of productivity-enhancing and other structural reforms in the run-up to the crisis. By contrast, the historical decomposition suggests that transitory (stationary) technology shocks were stimulative for GDP growth from 2013 onwards, which may be interpreted as resulting from a temporary greater tendency of the corporate sector to take restructuring measures in response to the crisis to enhance its technology and production efficiency. Finally, our results show that the recovery phase after 2013 is explained in our model mainly by consumption preference shocks, which could be explained by the increased consumer confidence, resolution of banking system problems, as well as by the improvement in the labour market situation.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 presents the estimation methodology and discusses the calibration of the model, the choice of priors and presents the data used in the estimation. Section 4 contains the estimation results and evaluation, which are followed by an analysis of the impulse responses of the various structural shocks and their contribution to the developments in the Slovenian economy in Section 5. Section 6 concludes with a summary of the main findings.

2 THE MODEL

As mentioned in the introduction, to describe the Slovenian economy we use a DSGE model presented in Adolfson et al. (2007) and Masten (2010), which is an extended ver-

sion of basic closed-economy new-Keynesian models, including the benchmark models of Christiano et al. (2005), Altig et al. (2011), and Smets & Wouters (2003, 2007). The model economy consists of households, domestic goods producing firms, importing consumption and importing investment firms, exporting firms, a government which conducts fiscal policy, and an exogenous foreign economy. As it is common in the DSGE literature, the model incorporates several real and nominal rigidities, such as habit persistence in consumption, variable capacity utilization of capital and investment adjustment costs, as well as the price and wage stickiness. The stochastic dynamics of the model is driven by sixteen exogenous structural shocks. The shocks considered are: permanent (unit-root) technology, transitory (stationary) technology, investment-specific technology, markup shocks (domestic, imported consumption, imported investment and export markup shocks), consumption preference and labour supply shocks, asymmetric technology, risk premium, foreign VAR shocks (foreign output, inflation and interest rate shocks) and fiscal shocks (rate of transfers to households and government spending shocks). One feature of the model worth noting is that it includes a stochastic unit-root technology shock, which implies a common trend in the real variables of the model. Consequently, the model can be estimated with raw data without any pre-filtering. In the following we summarize the main features of the model. To this end we follow quite closely the mode of presentation from Section 2 of Adolfson et al. (2014).[3]

2.1. Supply side of the economy

2.1.1. Domestic firms

The domestic firms use labour together with capital to produce intermediate goods Y_i, which are sold to the final good producer. The production function of the final good firm is of the Dixit-Stiglitz form:

$$Y_t^d = \left[\int_0^1 \left(Y_{i,t}^d \right)^{\frac{1}{\lambda_t^d}} di \right]^{\lambda_t^d}, \quad \lambda_t^d \geq 1, \tag{1}$$

where $\lambda_{d,t}$ is a stochastic process determining the time-varying markup in the domestic goods market. The final good producers operate in a perfectly competitive environment, taking the prices of the intermediate goods $P_{i,t}^d$ and final goods P_t^d as given. The production function for each intermediate good firm i which operates under monopolistic competition is of the Cobb-Douglas type:

$$Y_{i,t} = z_t^{1-\alpha} \epsilon_t K_{i,t}^{\alpha} H_{i,t}^{1-\alpha} - z_t \phi, \tag{2}$$

where $H_{i,t}$ denotes homogeneous labour input hired by firm i, and $K_{i,t}$ is the amount of capital services used by firm i, which can differ from capital stock since the model assumes

[3] The detailed description of the model (including the first order conditions) is available in Adolfson et al. (2007).

a variable capital utilization rate. Furthermore, z_t is a permanent (unit-root) technology shock, whereas ϵ_t is a transitory (stationary) technology shock. The term $z_t\phi$ indicates fixed costs, which grow with the technology rate. Fixed costs are set in such a way that profits are zero in steady state. Cost minimization yields the following nominal marginal cost function for intermediate firm i:

$$MC_t^d = \left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)^{\alpha}\left(R_t^k\right)^{\alpha} W_t^{1-\alpha}\frac{1}{z_t^{1-\alpha}}\frac{1}{\epsilon_t}, \tag{3}$$

where R_t^k is the gross nominal rental rate per unit of capital, R_t is the gross nominal interest rate, and W_t is the nominal wage rate per unit of aggregate, homogeneous labour $H_{i,t}$. Besides solving the cost minimization problem, intermediate good firms have to decide on price for their output. The model assumes the Calvo type staggered-price setting. This means that at each period, each firm faces a random probability $(1-\xi_d)$ that it can reoptimize its price. The reoptimized price is denoted $P_t^{d,opt}$. With probability ξ_d a firm is not allowed to set its prices optimally, and its price is then set according to the following indexation rule (Smets & Wouters, 2003):

$$P_{t+1}^d = \left(\pi_t^d\right)^{\kappa_d} P_t^d,$$

where $\pi_t^d = P_t^d/P_{t-1}^d$ is the (gross) inflation rate and κ_d is an indexation parameter. The optimization problem of a firm setting a new price in period t is the following:

$$\max_{P_t^{d,opt}} \mathbb{E}_t \sum_{s=0}^{\infty} \left(\beta\xi_d\right)^s \upsilon_{t+s} \left[\begin{array}{c} \left(\pi_t^d\pi_{t+1}^d...\pi_{t+s-1}^d\right)^{\kappa_d} P_t^{d,opt} Y_{i,t+s}^d \\ -MC_{i,t+s}^d\left(Y_{i,t+s}^d + z_{t+s}\phi\right) \end{array}\right], \tag{4}$$

where $\left(\beta\xi_d\right)^s \upsilon_{t+s}$ denotes the stochastic discount factor, which is used to make profits conditional upon utility. β is the discount factor, and υ_t denotes the marginal utility of households' nominal income in period $t+s$, which is exogenous to the intermediate firms.

2.1.2. Importing and exporting firms

The importing sector consists of two types of firms: firms which import consumption goods and firms which import investment goods. There is a continuum of importing firms, indexed by $i \in (0,1)$. These firms buy a homogeneous good in the world market at price P_t^* and transform it into a differentiated consumption $C_{i,t}^m$ or investment good $I_{i,t}^m$. In addition, there is also a continuum $i \in (0,1)$ of exporting firms that buy a homogeneous good on the domestic market and transform it into a differentiated exported good which is sold on the foreign market. The marginal cost of importing and exporting firms are P_t^* and P_t, respectively. The aggregate import consumption, import investment and export good is a composite of a continuum of i differentiated imported consumption, imported investment and exported goods, each supplied by a different firm, which follows the CES function:

$$C_t^m = \left[\int_0^1 \left(C_{i,t}^m\right)^{\frac{1}{\lambda_t^{m,c}}} di\right]^{\lambda_t^{m,c}}, \quad I_t^m = \left[\int_0^1 \left(I_{i,t}^m\right)^{\frac{1}{\lambda_t^{m,i}}} di\right]^{\lambda_t^{m,i}},$$

$$X_t = \left[\int_0^1 (X_{i,t})^{\frac{1}{\lambda_t^x}} di\right]^{\lambda_t^x}, \tag{5}$$

where $1 \leq \lambda_t^j < \infty$ for $j = \{mc, mi, x\}$ is the time-varying flexible-price mark-up in the import consumption (mc), import investment (mi) and export (x) sector. The model assumes monopolistic competition among importers and exporters and Calvo-type staggered price setting. The price setting problems are completely analogous to that of the domestic firms in Equation (4). From the optimization problems four specific Phillips curves, determining inflation in the domestic, import consumption, import investment and export sectors, can be derived.

2.2. Demand side of the economy

2.2.1. Households

In the model economy there is also a continuum of households $j \in (0, 1)$, which attain utility from consumption and leisure. The households decide on their current level of consumption and their domestic and foreign bond holdings. They also choose the level of capital services provided to the firms, their level of investment and their capital utilization rate. The households can increase their capital stock by investing in additional physical capital, taking one period to come in action, or by directly increasing the utilization rate of the capital at hand. The j^{th} household's utility function is:

$$\mathbb{E}_0^j \sum_{t=0}^{\infty} \beta^t \left[\zeta_t^c \ln\left(C_{j,t} - bC_{j,t-1}\right) - \zeta_t^h A_L \frac{(h_{j,t})^{1+\sigma_L}}{1+\sigma_L}\right], \tag{6}$$

where $C_{j,t}$ and $h_{j,t}$ denotes levels of real consumption and labour supply of household j, respectively. A_L is a constant representing the weight that the worker attaches to disutility of work. The model also allows for habit formation in consumption by including $bC_{j,t-1}$. ζ_t^c and ζ_t^h are preference shocks, consumption preference shock and labour supply shock, respectively. The aggregate consumption C_t is a CES index of domestic C_t^d and imported C_t^m consumption goods:

$$C_t = \left[(1-\omega_c)^{1/\eta_c} \left(C_t^d\right)^{(\eta_c-1)/\eta_c} + \omega_c^{1/\eta_c} \left(C_t^m\right)^{(\eta_c-1)/\eta_c}\right]^{\eta_c/(\eta_c-1)}, \tag{7}$$

where ω_c is the share of imported consumption goods in total consumption, and η_c is the elasticity of substitution between domestic and imported consumption goods. The corresponding consumer price index is given by:

$$P_t^c = \left[(1-\omega_c)^{1/\eta_c} \left(P_t^d\right)^{1-\eta_c} + \omega_c^{1/\eta_c} \left(P_t^{m,c}\right)^{1-\eta_c}\right]^{1/(1-\eta_c)}. \tag{8}$$

The model also assumes that households can purchase investment goods in order to increase their capital stock. The law of motion of capital is given by:

$$\bar{K}_{t+1} = (1-\delta)\bar{K}_t + \Upsilon_t F\left(I_t, I_{t-1}\right) + \Delta_t, \tag{9}$$

where $\bar{K}_t$ is a physical capital stock, δ is the depreciation rate of capital stock, $F\left(I_t, I_{t-1}\right)$ is a function that transforms investment into capital. Following Christiano et al. (2005), $F\left(I_t, I_{t-1}\right)$ is of the following form:

$$F\left(I_t, I_{t-1}\right) = \left[1 - \tilde{S}\left(I_t, I_{t-1}\right)\right] I_t, \tag{10}$$

where $\tilde{S}$ determines the investment adjustment costs through the estimated parameter $\tilde{S}''$. Υ_t denotes the investment-specific technology shock and Δ_t represents either newly bought capital if it is positive or sold capital if it is negative. The investment (I_t) is a bundle between domestic and imported investment goods (I_t^d and I_t^m, respectively):

$$I_t = \left[(1-\omega_i)^{1/\eta_i}\left(I_t^d\right)^{(\eta_i-1)/\eta_i} + \omega_i^{1/\eta_i}\left(I_t^m\right)^{(\eta_i-1)/\eta_i}\right]^{\eta_i/(\eta_i-1)}, \tag{11}$$

where ω_i denotes the share of imported investment goods in total investment, and η_i is elasticity of substitution between domestic and imported investment goods. It is worth noting that domestically produced consumption and investment goods have the same price P_t^d. The aggregate investment price index is therefore given by:

$$P_t^i = \left[(1-\omega_i)\left(P_t^d\right)^{1-\eta_i} + \omega_i\left(P_t^{m,i}\right)^{1-\eta_i}\right]^{1/(1-\eta_i)}. \tag{12}$$

Furthermore, the model assumes that each household is a monopolistic supplier of differentiated labour service, which implies that they can determine their own wage. Each household sells its labour $h_{j,t}$ to a firm which transforms it into a homogeneous input good H_t according to the following production function:

$$H_t = \left[\int_0^1 \left(h_{j,t}\right)^{\frac{1}{\lambda_w}} dj\right]^{\lambda_w}, \ \lambda_w \geq 1, \tag{13}$$

where λ_w is the wage markup. The demand function for each differentiated labour service is given by:

$$h_{j,t} = \left[\frac{W_{j,t}}{W_t}\right]^{\frac{\lambda_w}{1-\lambda_w}} H_t. \tag{14}$$

Following Erceg et al. (2000) and Christiano et al. (2005), the households are subject to the Calvo wage rigidities, which means that in every period each household faces a random probability $1-\xi_w$ that it can change its nominal wage. If a household is allowed to re-optimize its wage, it will set its wage to W_t^{opt} taking into account the probability ξ_w that the wage will not be re-optimized in the future. The households that cannot re-optimize set their wages according to the following indexation rule:

$$W_{j,t+1} = \left(\pi_t^c\right)^{\kappa_w} \mu_{z,t+1} W_{j,t}, \tag{15}$$

where κ_w is an indexation parameter, π_t^c is the inflation rate measured by the consumer price index, and $\mu_{z,t} = z_t / z_{t-1}$ is the growth rate of the unit-root technology shock. The

household j that can re-optimize solves the following optimization problem:

$$\max_{W_{j,t}^{opt}} \mathbb{E}_t \sum_{s=0}^{\infty} (\beta\xi_w)^s \left\{ \begin{array}{c} -\zeta_{t+s}^h A_L \frac{(h_{j,t+s})^{1+\sigma_L}}{1+\sigma_L} \\ +v_{t+s} \left(1-\tau^y+\tau_{t+s}^{tr}\right) \left(\pi_t^c \dots \pi_{t+s-1}^c\right)^{\kappa_w} \\ \times \left(\mu_{z,t+1} \dots \mu_{z,t+s}\right) W_{j,t}^{opt} h_{j,t+s} \end{array} \right\}, \tag{16}$$

where τ^y is a labour income tax and τ_t^{tr} is a time-varying rate of social transfers to households defined in more detail in Subsection 2.4.

2.3. Monetary policy

The monetary policy is modelled in a highly simplified way. It is assumed that the domestic interest rate (R_t) depends on the exogenously given foreign interest rate (R_t^*) adjusted for the risk premium on foreign bonds ($\Phi\left(a_t, \tilde{\phi}_t\right)$):[4]

$$R_t = R_t^* \Phi\left(a_t, \tilde{\phi}_t\right), \tag{17}$$

where the risk premium, which is defined through the following function:

$$\Phi\left(a_t, \tilde{\phi}_t\right) = e^{-\tilde{\phi}_a (a_t - \bar{a}) + \tilde{\phi}_t}, \tag{18}$$

depends on the aggregate net foreign asset position of the domestic economy (a_t) and exogenous risk premium shocks ($\tilde{\phi}_t$).[5] The inclusion of risk premium is necessary to ensure a well-defined steady state in the model (Schmitt-Grohé & Uribe, 2003).

[4] In Adolfson et al. (2007), the interest rate is determined according to a simple rule (expressed in log-linear form):

$$\hat{R}_t = \rho_R \hat{R}_{t-1} + (1-\rho_R)\left(\hat{\bar{\pi}}_t^c + r_\pi\left(\hat{\pi}_{t-1}^c - \hat{\bar{\pi}}_t^c\right) + r_y \hat{y}_{t-1} + r_x \hat{x}_{t-1}\right) + r_{\Delta\pi} \Delta\hat{\pi}_t^c + r_{\Delta y} \Delta\hat{y}_t + \varepsilon_{R,t},$$

where $\hat{R}_t$ is the short-rate interest rate, $\hat{\pi}_t^c$ the CPI inflation rate, $\hat{\bar{\pi}}_t^c$ a time-varying inflation target, $\hat{y}_t$ the output gap, $\hat{x}_t$ denotes the real exchange rate, and $\varepsilon_{R,t}$ is an interest rate shock.

[5] Besides joining the European Monetary Union (EMU) in 2007, Slovenia went through different monetary regimes since its independence in 1991: money based stabilization policy (1991-1995), price and real exchange rate stability dual targeting policy (1996-2001), and exchange rate based stabilization policy and accession to ERM 2 exchange rate mechanism and EMU (2001-2007) (Caprirolo & Lavrač, 2003). Because these would be very difficult to implement in the model, we are not modelling any break in the conduct of monetary policy when estimating the model. Rather, we follow an uncomplicated way of monetary policy inclusion into the model structure. That is, we keep only a modified UIP condition (17) on the monetary side without specifying any particular form of monetary rule for the period before 2007, when Slovenia run an independent monetary policy. Of course, for the years before 2007 (or at least 2004Q3, when Slovenia entered the ERM 2), an additional term, $-\Delta S_{t+1}$, capturing the nominal exchange rate fluctuations, must be added on the right-hand side of Equation (17). In addition, the terms of trade channel would be affected by the nominal exchange rate. In such a setting the endogenously determined nominal exchange rate may reduce or amplify the impact of structural shocks, depending on their nature. Based on the findings presented in Cúrdia et al. (2012), applying a more adequate approach to modelling monetary policy may also improve the fit of the model. We initially included exchange rate as an additional variable into the model, but due to model solvability problems (i.e., more variables than equations) we again restricted with the simple version, as described above. In other words, in order to guarantee solvability of the model, an explicit monetary policy rule must be incorporated into the model structure. Despite

2.4. Fiscal policy

The government in this economy collects taxes, issues debt and uses revenues for government consumption, transfers to households and interest on outstanding debt. The resulting government budget constraint can be expressed as:

$$B_{t+1} + T_t = R_{t-1}B_t + TR_t + P_t^d G_t \Leftrightarrow B_{t+1} = B_t + DEF_t, \tag{19}$$

where B_t denotes the public debt and DEF_t is the government deficit, which is defined as the difference between the government expenditures GEX_t and total tax revenues T_t:

$$DEF_t = GEX_t - T_t. \tag{20}$$

The government tax revenues consist of taxes on private consumption, as well as on labour income and capital income:

$$\begin{aligned} T_t = {} & \tau^c P_t^c C_t + \tau^y W_t H_t \\ & + \tau^k \left[(R_{t-1} - 1) B_t + R_t^k K_t + \left(R_{t-1}^* \Phi \left(a_{t-1}, \tilde{\phi}_{t-1} \right) - 1 \right) B_t^* + \Pi_t \right], \end{aligned} \tag{21}$$

with τ^c, τ^y and τ^k being the tax rates on private consumption, labour income and capital income, respectively, which are assumed to be fixed. In the above expression, Π_t are total profits, which are equal to the sum of profits earned by domestic, importing and exporting firms, Π_t^d, Π_t^m and Π_t^x, respectively:

$$\Pi_t = \Pi_t^d + \Pi_t^m + \Pi_t^x, \tag{22}$$

where:

$$\begin{aligned} \Pi_t^d = {} & P_t^d \left(C_t^d + I_t^d + G_t \right) + P_t^d \left(C_t^x + I_t^x \right) \\ & - MC_t^d \left(C_t^d + I_t^d + G_t + C_t^x + I_t^x \right) - MC_t^d z_t \phi \end{aligned} \tag{23}$$

$$\Pi_t^m = P_t^{m,c} C_t^m + P_t^{m,i} I_t^m - P_t^* \left(C_t^m + I_t^m \right) \tag{24}$$

and:

$$\Pi_t^x = P_t^x \left(C_t^x + I_t^x \right) - P_t^d \left(C_t^x + I_t^x \right). \tag{25}$$

these simplifications, the model in such a structure fits the data, including the short-term nominal interest rates, reasonably well. It is also worth noting that similar approach neglecting existence of diverse monetary policies and flexible exchange rates prior to the EMU-start was used in the literature (see, for example, Adolfson et al. (2007), Almeida (2009), Smets & Wouters (2003), Marcellino & Rychalovska (2014) among others). The authors estimated their models under implicit assumption that, even before the establishment of the currency area there was a common monetary policy in the European Union. Finally, as a robustness check we re-estimated our model using the data for the period 2004Q3 onwards, when Slovenia entered the ERM 2. Our analysis reveals that in this case parameter estimates do not substantially vary from the estimates reported in Tables 3 and 4 in the main text. But what is more important, we find that our main results reported in the paper (e.g., those of the historical decompositions) persist. We choose not to report this robustness check in the paper to save space, but it is available upon request from the author.

Furthermore, the government expenditures are given by:

$$GEX_t = TR_t + P_t^d G_t + (R_{t-1} - 1) B_t, \tag{26}$$

where TR_t denotes transfers to households, G_t is government consumption of goods and services and $(R_{t-1} - 1) B_t$ stands for public debt interest payments. We assume that transfers to households are indexed to wages W_t and hours worked H_t with an exogenously given rate of transfers τ_t^{tr} according to the following expression (D'Auria et al., 2009):

$$TR_t = \tau_t^{tr} W_t H_t. \tag{27}$$

For the rate of transfers to households it is simply assumed that follow an AR(1) process (in deviations from its steady state):

$$\hat{\tau}_t^{tr} = \rho_{\tau^{tr}} \hat{\tau}_{t-1}^{tr} + \varepsilon_{\tau^{tr},t}. \tag{28}$$

Finally, government consumption follows the log-linear rule of the following form:[6]

$$\hat{g}_t = \rho_g \hat{g}_{t-1} - \phi_\pi \hat{\pi}_t^c - \phi_y \hat{y}_t - \phi_b \hat{b}_t - \phi_d \widetilde{def}_t + \varepsilon_{g,t}. \tag{29}$$

In this equation, $\hat{g}_t$ is the percentage deviation of real government consumption (stationarized with the unit-root technology level, z_t) from its steady state level, $\hat{\pi}_t^c$ is the CPI inflation, $\hat{y}_t$ reflects the output gap, $\hat{b}_t$ is the public debt and $\widetilde{def}_t$ denotes the government deficit which is expressed as a difference from its steady state, that is, $\widetilde{def}_t = def_t - def$. $\varepsilon_{g,t}$ defines the exogenous shock aimed at capturing discretionary changes in government consumption. ϕ_π, ϕ_y, ϕ_b and ϕ_d denote the feedback coefficients towards inflation, output gap, public debt and government deficit deviations, respectively. ρ_g reflects the degree of government consumption smoothing.

2.5. Market equilibrium

In equilibrium all markets clear. The market clearing condition for the domestic goods market is given by:

$$C_t^d + I_t^d + G_t + C_t^x + I_t^x \leq z_t^{1-\alpha} \epsilon_t K_t^\alpha H_t^{1-\alpha} - z_t \phi - a(u_t) \bar{K}_t, \tag{30}$$

where C_t^x and I_t^x are the foreign demand for export goods which follow CES aggregates with elasticity η_f. Furthermore, the net foreign assets' market clears when domestic investment in foreign bonds (denoted by B_t^*) equals the net position of exporting/importing firms:

$$B_t^* = P_t^x (C_t^x + I_t^x) - P_t^* (C_t^m + I_t^m) + R_{t-1}^* \Phi\left(a_t, \tilde{\phi}_t\right) B_t^*. \tag{31}$$

[6] Our specification for the fiscal rule is similar to those used by Erceg & Lindé (2013), with the only exception that they do not include the inflation rate.

2.6. Foreign economy

Since the domestic economy is a small open economy, we assume that the foreign economy is exogenous. In particular, foreign output ($\hat{y}_t^*$), foreign inflation ($\hat{\pi}_t^*$) and foreign interest rate ($\hat{R}_t^*$) are exogenously modelled as an identified VAR model with two lags:[7]

$$\Phi_0 X_t^* = \Phi_1 X_{t-1}^* + \Phi_2 X_{t-2}^* + S_{x^*}\varepsilon_{x^*,t}, \tag{32}$$

where $X_t^* \equiv \left(\hat{\pi}_t^*, \hat{y}_t^*, \hat{R}_t^*\right)'$, $\varepsilon_{x^*,t} \sim \mathcal{N}(0, I_{x^*})$, S_{x^*} is a diagonal matrix with standard deviations and $\Phi_0^{-1} S_{x^*}\varepsilon_{x^*,t} \sim \mathcal{N}(0, \Sigma_{x^*})$.

2.7. Structural shocks

In total, the dynamics of the model is driven by 16 exogenous shock processes that are assumed to be characterized in log-linearized form by the univariate representation:

$$\hat{\xi}_t = \rho_\xi \hat{\xi}_{t-1} + \varepsilon_{\xi,t}, \quad \varepsilon_{\xi,t} \overset{iid}{\sim} N\left(0, \sigma_\xi^2\right), \tag{33}$$

where $\xi_t = \left\{\mu_{z,t}, \epsilon_t, \lambda_t^j, \zeta_t^c, \zeta_t^h, \Upsilon_t, \tilde{\phi}_t, \tilde{z}_t^*, \tau_t^{tr}, \varepsilon_{g,t}\right\}$ for $j = \{d, mc, mi, x\}$. $\varepsilon_{g,t}$ is assumed to be a white noise process (that is, $\rho_{\varepsilon_g} = 0$). There are also three foreign shocks (that is, foreign output, foreign inflation and foreign interest rate shock) provided by the exogenous (pre-estimated) foreign VAR model.

3 MODEL SOLUTION AND ESTIMATION

In this section, we present how the DSGE model is solved and estimated.

[7] The foreign VAR model is estimated for the first 12 Euro area countries over the period 1995Q1-2014Q4 and includes the following variables: output (GDP at market prices, chain linked volumes (2005), million units of national currency); GDP deflator (GDP at market prices, price index (implicit deflator), 2005=100, national currency); interest rate (12-month money market interest rate in percent). To make the observed data consistent with the model's concepts, we adjusted the data before entering the VAR model. Specifically, we used HP-detrended log of GDP (we set the smoothing parameter to 1600, which is typically used with quarterly data), the demeaned first difference of the log of GDP deflator and the demeaned interest rate which is divided by 400. All data series are seasonally adjusted and adjusted by working days. The lag order of the VAR model was chosen using the Hannan-Quinn information criterion, which suggests an optimal lag order of two periods (Lütkepohl & Krätzig, 2004). We also removed variables with lowest t-ratios until all remaining variables had t-ratios greater than 2, which is often used in applied work. The estimated foreign VAR model is, therefore, given by:

$$\begin{aligned}
\hat{\pi}_t^* &= 0.028\hat{y}_{t-1}^* + 0.121\hat{\pi}_{t-1}^* + 0.279\hat{\pi}_{t-2}^* + \varepsilon_{\pi^*,t} \\
\hat{y}_t^* &= 1.667\hat{y}_{t-1}^* - 0.698\hat{y}_{t-2}^* + \varepsilon_{y^*,t} \\
\hat{R}_t^* &= 1.190\hat{R}_{t-1}^* + 0.321\hat{y}_{t-1}^* - 0.306\hat{y}_{t-2}^* - 0.271\hat{R}_{t-2}^* + \varepsilon_{R^*,t}.
\end{aligned}$$

.

3.1. Model solution

The model presented in the previous section consists of a set of optimality conditions and laws of motion of the shock processes. Since the model comprises the unit-root technology shock that induces a stochastic trend in the levels of the real variables, the first step prior to model solution is rendering the model stationary. To this end all real variables are divided with the trend level of technology z_t. The resulting stationary variables are then denoted by lower-case letters, that is, $x_t = \frac{X_t}{z_t}$ for a generic variable x_t. We then proceed with the log-linearisation[8] to the model's equations of the transformed model around the deterministic steady state[9], where the variables are expressed as logarithmic deviations from their steady state values, that is, $\hat{x}_t = \frac{x_t - x}{x} \approx \ln x_t - \ln x$, where x denotes the steady state value of a generic variable x_t. Once the model has been stationarized and log-linearized, it can be written in the following compact form:

$$\mathbb{E}_t \left\{ \alpha_0 \Gamma_{t-1} + \alpha_1 \Gamma_t + \alpha_2 \Gamma_{t+1} + \beta_2 \Psi_{t+1} + \beta_1 \Psi_t \right\} = 0, \tag{34}$$

where Γ_t is a vector of endogenous variables, Ψ_t is a vector of exogenous variables, and α_0, α_1, α_2, β_1 and β_1 are coefficient matrices. It is assumed that Ψ_t evolves according to:

$$\Psi_t = \rho \Psi_{t-1} + \varepsilon_t \quad \varepsilon_t \sim N\left(0, \Sigma\right). \tag{35}$$

We use Dynare 4.4.3[10] to solve the model. The solution of the model takes the form:[11]

$$\Gamma_t = A \Gamma_{t-1} + B \Psi_t. \tag{36}$$

3.2. Data and measurement equations

For estimation purposes the solved model can be written in the following state-space form (Hamilton, 1994):

$$\xi_{t+1} = F \xi_t + \upsilon_{t+1} \tag{37}$$

and:

$$\tilde{Y}_t = A' x_t + H' \xi_t + \omega_t. \tag{38}$$

[8] However, it is important to notice that dynamics in the log-linearized model is only approximation of the true non-linear dynamics. Therefore, studying the log-linearized models is only valid for small deviations from the model's steady state. For a complete list of the log-linearized equations of the model, see Appendix A.

[9] We compute the non-stochastic steady state of the model following the procedure described in Adolfson et al. (2007). It is important to note that the steady state also depends on estimated parameters. For this reason, when estimating the model, it is of great importance to take into account parameter dependence by using model-local variables. For further discussion, see Pfeifer (2014a), Remark 4 (Parameter dependence and the use of model-local variables).

[10] Dynare is a software package for solving and estimating DSGE models. For more information regarding Dynare refer to the official Dynare web page `http://www.dynare.org` and see Mancini Griffoli (2011), as well as Adjemin, Bastani, Karamé, Juillard, Maih, Mihoubi, Perendia, Pfeifer, Ratto & Villemot (2014).

[11] Dynare uses solution algorithms proposed by Klein (2000) and Sims (2002). For a detailed look at what exactly is going on behind the scenes of Dynare's computations, the interested reader is referred to Villemot (2011).

The first equation is called the state equation, whereas the second is called the observation (measurement) equation. The symbols appearing in (37) and (38) have the following meaning: $\tilde{Y}_t$ is an $(n \times 1)$ vector of observed variables at time t, ξ_t is an $(r \times 1)$ vector of unobserved variables at time t (also referred to as state vector) and x_t is a $(k \times 1)$ vector with exogenous or predetermined variables (e.g. a constant). Furthermore, F, A' and H' are matrices of dimension $(r \times r)$, $(n \times k)$ and $(n \times r)$, respectively. The $(r \times 1)$ vector υ_t and the $(n \times 1)$ vector ω_t are uncorrelated, normally distributed white noise vectors, therefore:

$$\mathbb{E}\left(\upsilon_t \upsilon_\tau'\right) = \begin{cases} Q & \text{for } \tau = t \\ 0 & \text{otherwise} \end{cases}$$

$$\mathbb{E}\left(\omega_t \omega_\tau'\right) = \begin{cases} R & \text{for } \tau = t \\ 0 & \text{otherwise,} \end{cases}$$

where Q and R are $(r \times r)$ and $(n \times n)$ matrices, respectively. The disturbances υ_t and ω_t are assumed to be uncorrelated at all lags:

$$\mathbb{E}\left(\upsilon_t, \omega_\tau'\right) = 0 \quad \text{for all } t \text{ and } \tau. \tag{39}$$

In what follows, we describe how the raw data were converted to the form used in estimation. In addition, we present the exact measurement equations that are employed to relate the observed data to the model state variables. The estimates are based on quarterly Slovenian macroeconomic data covering the period 1995Q1-2014Q4. We employ the following 14 variables as observables:[12] the GDP deflator (P_t^d), the real wage (W_t/P_t^d), consumption (C_t), investment (I_t), government consumption (G_t), the real exchange rate (x_t), the short-run interest rate (R_t), employment[13] (E_t), GDP (Y_t), exports (X_t), imports (M_t), the CPI price index (P_t^c), foreign output (for the first 12 euro area countries) (Y_t^*), the foreign GDP deflator (for the first 12 euro area countries) (P_t^*) and the foreign interest rate (12-month money market interest rate of the euro area) (R_t^*). Regarding the foreign variables, GDP for the first 12 euro area countries is used for foreign output, and the GDP deflator for the first 12 euro area countries is used for foreign inflation, while the foreign interest rate refers to the 12-month money market interest rate of the euro area. Data come from four different sources. Data on the employment and gross wages are taken from the Statistical Office of the Republic of Slovenia. The sources for domestic interest rate are the Bank of Slovenia and the Institute of Macroeconomic Analysis and Development of the Republic of Slovenia. The rest of the data are taken from Eurostat. Since the model comprises a stochastic unit root technology shock that induces a common stochastic trend in the real variables of the model, we use first differences to make these variables stationary. When estimating the model, the following variables are matched in growth rates

[12] A detailed description of the data used in the estimation together with their sources is provided in Appendix B. Additionally, the data are plotted in Appendix D.

[13] We assume that the employment variable ($\hat{E}_t$) is related to the hours worked variable ($\hat{H}_t$) by an auxiliary equation (expressed as a percentage deviation from the steady state):

$$\Delta \hat{E}_t = \frac{\beta}{1+\beta} \mathbb{E}_t \Delta \hat{E}_{t+1} + \frac{(1-\xi_e)(1-\beta\xi_e)}{(1+\beta)\xi_e} \left(\hat{H}_t - \hat{E}_t\right).$$

The Calvo parameter, ξ_e, representing the fraction of firms that in any period is able to adjust employment to its desired total labour input, is estimated.

measured as quarter-to-quarter log-differences: GDP, consumption, investment, exports, imports, government consumption, real wage, GDP deflator, CPI price index, foreign output and foreign GDP deflator. The rest of the variables are used in levels: domestic and foreign interest rate, employment and real exchange rate. The real wage is calculated as the nominal gross wage per employee deflated by the GDP deflator. All interest rates are divided by 4 to express them in quarterly rates consistent with the variables in the model. The stationary variables, x_t and E_t, are measured as follows: we take the logarithm of real exchange rate and remove a linear trend, so that it is expressed in percentage deviations from the trend, consistently with the model concepts, that is $\hat{x}_t^{data} = \frac{x_t - x}{x}$, while the employment is measured as deviation around the mean, that is $\hat{E}_t^{data} = \frac{E_t - E}{E}$. Furthermore, in order to align the data with the model-based definitions, some additional transformations are made. First, since the model assumes that all real variables are growing at the same rate as output, we match the sample growth rates of private consumption, investment, government consumption, exports, imports and real wage with the sample growth rate of real GDP by removing the remaining growth rate differentials. Second, the model assumes that in steady-state, the interest rates (that is, domestic and foreign interest rate) as well as different measures of inflation (that is, domestic, CPI and foreign inflation) are identical, that is $R = R^*$ and $\pi^d = \pi^c = \pi^*$, respectively. This assumption is clearly rejected by the data. To circumvent this issue, we demean all these time series before the model estimation and add the sample mean of domestic interest rate to the foreign interest rate and the sample mean of domestic inflation to the CPI and foreign inflation, so that the data match the model assumptions. All variables (except the nominal interest rates) are seasonally adjusted and adjusted by working days. The vector of observable variables, $\tilde{Y}_t$, is then given by:

$$\begin{aligned}\tilde{Y}_t = \Big[& \Delta \ln P_t^{d,data} \quad \Delta \ln \left(W_t / P_t^d\right)^{data} \quad \Delta \ln \tilde{C}_t^{data} \quad \Delta \ln \tilde{I}_t^{data} \quad \hat{x}_t^{data} \ldots \\ & R_t^{data} \quad \hat{E}_t^{data} \quad \Delta \ln Y_t^{data} \quad \Delta \ln \tilde{X}_t^{data} \quad \Delta \ln \tilde{M}_t^{data} \ldots \\ & \Delta \ln G_t^{data} \quad \Delta \ln P_t^{c,data} \quad \Delta \ln Y_t^{*,data} \quad \Delta \ln P_t^{*,data} \quad R_t^{*,data} \Big]',\end{aligned} \tag{40}$$

where Δ is the first difference operator. The corresponding measurement equation that matches observed data with model's variables is:

$$\tilde{Y}_t = \begin{bmatrix} \Delta \ln P_t^{d,data} \\ \Delta \ln \left(W_t/P_t^d\right)^{data} \\ \Delta \ln \tilde{C}_t^{data} \\ \Delta \ln \tilde{I}_t^{data} \\ \hat{x}_t^{data} \\ R_t^{data} \\ \hat{E}_t^{data} \\ \Delta \ln Y_t^{data} \\ \Delta \ln \tilde{X}_t^{data} \\ \Delta \ln \tilde{M}_t^{data} \\ \Delta \ln G_t^{data} \\ \Delta \ln P_t^{c,data} \\ \Delta \ln Y_t^{*,data} \\ \Delta \ln P_t^{*,data} \\ R_t^{*,data} \end{bmatrix} = \begin{bmatrix} \left(\pi^d - 1\right) \\ \ln \mu_z \\ \ln \mu_z \\ \ln \mu_z \\ 0 \\ 4R\left(R-1\right) \\ 0 \\ \ln \mu_z \\ \ln \mu_z \\ \ln \mu_z \\ \ln \mu_z \\ \left(\pi^d - 1\right) \\ \ln \mu_z \\ \left(\pi^d - 1\right) \\ 4R\left(R-1\right) \end{bmatrix} + \begin{bmatrix} \hat{\pi}_t^d \\ \Delta\hat{\tilde{w}}_t + \hat{\mu}_{z,t} \\ \Delta\hat{\tilde{c}}_t + \hat{\mu}_{z,t} \\ \Delta\hat{\tilde{i}}_t + \hat{\mu}_{z,t} \\ \hat{x}_t \\ 4R\hat{R}_t \\ \hat{E}_t \\ \Delta\hat{y}_t + \hat{\mu}_{z,t} \\ \Delta\hat{\tilde{x}}_t + \hat{\mu}_{z,t} \\ \Delta\hat{\tilde{m}}_t + \hat{\mu}_{z,t} \\ \Delta\hat{g}_t + \hat{\mu}_{z,t} \\ \hat{\pi}_t^c \\ \Delta\hat{y}_t^* + \Delta\hat{\tilde{z}}_t^* + \hat{\mu}_{z,t} \\ \hat{\pi}_t^* \\ 4R\hat{R}_t^* \end{bmatrix} + \begin{bmatrix} \varepsilon_{\pi^d,t}^{me} \\ \varepsilon_{\tilde{w},t}^{me} \\ \varepsilon_{\tilde{c},t}^{me} \\ \varepsilon_{\tilde{i},t}^{me} \\ \varepsilon_{x,t}^{me} \\ \varepsilon_{R,t}^{me} \\ \varepsilon_{E,t}^{me} \\ \varepsilon_{y,t}^{me} \\ \varepsilon_{\tilde{x},t}^{me} \\ \varepsilon_{\tilde{m},t}^{me} \\ \varepsilon_{g,t}^{me} \\ \varepsilon_{\pi^c,t}^{me} \\ \varepsilon_{y^*,t}^{me} \\ \varepsilon_{\pi^*,t}^{me} \\ \varepsilon_{R^*,t}^{me} \end{bmatrix}, \quad (41)$$

where $\varepsilon_{i,t}^{me}$ denotes the measurement error for the respective variable. The standard deviation of specific measurement error is calibrated at 10% of the standard deviation of the corresponding observed domestic variables, while the measurement errors for the foreign variables are set to 0, as in Adolfson et al. (2007).

3.3. Estimation methodology

Structural parameters of the model are either calibrated or estimated. The values for the parameters that are calibrated (and thus kept fixed throughout the estimation) are chosen in accordance with the practice in the literature calibrating small open-economy models. Their values are discussed in Subsection 3.4. All remaining parameters are estimated with a Bayesian estimation method, which has become a standard econometric technique for estimating DSGE models.[14] In the following, we briefly describe the main features of the method. The key idea of the Bayesian estimation method[15] is that it combines the prior belief of the parameters with empirical data to form the posterior distributions of the parameters. The posterior distributions are obtained by using the Bayes theorem:

$$p\left(\theta|\tilde{Y}_t\right) = \frac{p\left(\tilde{Y}_t|\theta\right)p\left(\theta\right)}{p\left(\tilde{Y}_t\right)}, \quad (42)$$

[14] All estimates are performed using Dynare version 4.4.3 in Matlab R2012b.

[15] A detailed explanation of the estimation method can be found in An & Schorfheide (2007), Adolfson et al. (2007), Canova (2007), Fernández-Villaverde (2010) and Smets & Wouters (2003, 2007) among many others. The reader is also referred to Dynare Manual for additional explanation of the estimation method.

where θ is a vector of the parameters to estimate, $p\left(\theta|\tilde{Y}_t\right)$ is the density of the parameters conditional on data (the posterior), $p\left(\tilde{Y}_t|\theta\right)$ is the density of the data conditional on the parameters (the likelihood), $p(\theta)$ is the unconditional density of the parameters (the prior) and $p\left(\tilde{Y}_t\right)$ is the marginal density of the data.[16] Given that the marginal density of the data is a constant term or equal for any parameter, equation (42) can be rewritten as:

$$p\left(\theta|\tilde{Y}_t\right) \propto p\left(\tilde{Y}_t|\theta\right) p(\theta) \equiv \mathcal{K}\left(\theta|\tilde{Y}_t\right), \tag{43}$$

where $\mathcal{K}\left(\theta|\tilde{Y}_t\right)$ is the posterior kernel. Taking logs of (43), we get:

$$\ln \mathcal{K}\left(\theta|\tilde{Y}_t\right) = \ln p\left(\tilde{Y}_t|\theta\right) + \ln p(\theta) = \ln \mathcal{L}\left(\tilde{Y}_t|\theta\right) + \ln p(\theta). \tag{44}$$

Before the estimation can begin, we need to specify the priors for the parameters to be estimated and evaluate the likelihood function of the observed data. The choice of priors is discussed in Subsection 3.5. The likelihood function of the observed data is evaluated by generating forecasts from the state-space system, (37) and (38), with the use of the Kalman filter. Conceptually, the Kalman filter consists of calculating the sequence $\left\{\xi_{t+1|t}\right\}_{t=1}^{T}$ and $\left\{\Sigma_{t+1|t}^{\xi}\right\}_{t=1}^{T}$, where $\xi_{t+1|t}$ denotes the optimal forecast of ξ_{t+1} based on observation of $\mathbf{y}_t \equiv \left(\tilde{Y}_t', \tilde{Y}_{t-1}', \tilde{Y}_{t-2}', \ldots, \tilde{Y}_1', x_t', x_{t-1}', x_{t-2}', \ldots, x_1'\right)'$ and $\Sigma_{t+1|t}^{\xi}$ denotes the mean squared error of this forecast. The algorithm works forward in time and is conducted as follows:[17] For $t = 1$, the algorithm needs to be provided with initial values for a one-step ahead forecast of time t states, $\xi_{t|t-1}$, and respective forecast error variance-covariance matrix, $\Sigma_{t|t-1}^{\xi}$. Based on this a one-step ahead forecast of time t data, $\tilde{Y}_{t|t-1}$ and respective variance-covariance matrix, $\Sigma_{t|t-1}^{\tilde{Y}}$ are computed. The algorithm then updates the forecasts of time t states, $\xi_{t|t}$, and a respective variance-covariance matrix, $\Sigma_{t|t}^{\xi}$. The final step is to compute a one-step ahead forecast of time $t+1$ states, $\xi_{t+1|t}$, and respective variance-covariance matrix, $\Sigma_{t+1|t}^{\xi}$. These steps are iterated for $t = 2, 3, 4, \ldots, T$. The log-likelihood function (based on the data up to time t) can be written as follows (Hamilton, 1994):

$$\begin{aligned} &\sum_{t=1}^{T} \ln \mathcal{L}\left(\tilde{Y}_t|x_t, \mathbf{y}_{t-1}, F, A', H', Q, R\right) \\ &= -\sum_{t=1}^{T} \left[\begin{array}{c} \frac{n}{2}\log 2\pi + \frac{1}{2}\log|\Sigma_{t|t-1}^{\tilde{Y}}| \\ +\frac{1}{2}\sum_{t=1}^{T}\left(\tilde{Y}_t - \tilde{Y}_{t|t-1}\right)'\left(\Sigma_{t|t-1}^{\tilde{Y}}\right)^{-1}\left(\tilde{Y}_t - \tilde{Y}_{t|t-1}\right) \end{array} \right]. \end{aligned} \tag{45}$$

[16] It is defined as:

$$p\left(\tilde{Y}_t\right) = \int_{\Theta} p\left(\theta, \tilde{Y}_t\right) \mathrm{d}\theta,$$

where $p\left(\theta, \tilde{Y}_t\right)$ denotes the joint density of the parameters and the data.

[17] The presentation here follows Hamilton (1994).

Finally, the posterior distribution is obtained in two steps: first, by maximizing the log posterior density with respect to θ, the posterior mode θ^m and an approximate covariance matrix, based on the inverse Hessian matrix evaluated at the posterior mode, $\Sigma_{\theta^m} = H\left(\theta^m|\tilde{Y}\right)^{-1}$, is obtained and second, the posterior distribution is simulated by using the Monte-Carlo Markov-Chain (MCMC) sampling method, specifically the Metropolis-Hastings (MH) algorithm. The idea behind this algorithm is the following (Mancini Griffoli, 2013): first, the algorithm chooses a starting point (posterior mode), then it draws a candidate value θ^* from an arbitrary candidate (or jumping) distribution:

$$J\left(\theta^*|\theta_{i-1}\right) \sim N\left(\theta_{i-1}, c\Sigma_{\theta^m}\right), \tag{46}$$

where θ_{i-1} is the last accepted draw, Σ_{θ^m} denotes the inverse of the Hessian computed at the posterior mode, and c is the scale factor, which is chosen to ensure an appropriate acceptance rate. In the next step, the algorithm computes the acceptance ratio:

$$\alpha = \min\left[\frac{\mathcal{K}\left(\theta^*|\tilde{Y}_t\right)}{\mathcal{K}\left(\theta_{i-1}|\tilde{Y}_t\right)}, 1\right]. \tag{47}$$

The algorithm then accepts or discards the proposal θ^* according to the following rule:

$$\theta_i = \begin{cases} \theta^* & \text{with probability } \alpha \\ \theta_{i-1} & \text{otherwise} \end{cases}.$$

If the parameter value is accepted, the mean of the distribution is updated with the new draw θ_i. These algorithm steps are repeated many times to simulate the posterior distribution.

3.4. Calibrated parameters

In this section, we present the calibrated parameters of the model.[18] Their values are taken mainly from Adolfson et al. (2007) unless otherwise stated. The discount factor, β, is fixed to 0.993, implying a steady-state interest rate of 11%,[19] which matches the average interest rate in the sample period. The share of capital in production, α, is calibrated to 0.30. The depreciation rate of capital, δ, is set to 0.013. We calibrate the capital utilization cost parameter, σ_a, to 10^6. The elasticity of substitution between domestic and foreign goods, η_c, is calibrated to 5. Labour disutility constant, A_L, is calibrated to 7.5. As in Christiano, Eichenbaum and Evans (2005), we set the labour supply elasticity, σ_L, to 1, and the wage mark-up, λ_w, to 1.05. The steady state mark-ups are calibrated at: 1.222 in the domestic goods market (λ^d), 1.633 in the imported consumption goods market ($\lambda_{m,c}$) and 1.275 in the imported investment goods market ($\lambda^{m,i}$). The steady state foreign terms of trade, γ^f, is calibrated to 1. The rest of the parameters, as well as the steady state relationships, are

[18] It is important to note that a time period is taken to be a quarter.

[19] This follows from the first order condition of the households' bond holdings, $R = \frac{\pi\mu_z - \tau^k\beta}{(1-\tau^k)\beta}$.

calibrated using the averages of Slovenian data for the period 1995Q1-2014Q4. The shares of imports in consumption and investment, ω_c and ω_i, are set to 0.67 and 0.40, respectively. The steady state rate of transfers to households, τ^{tr}, is calibrated to 0.50. The ratios of government expenditures ($\frac{gex}{y}$), taxes ($\frac{t}{y}$), government consumption ($\frac{g}{y}$), and debt services ($\frac{r}{y}$) in GDP are 0.37, 0.36, 0.19, and 0.02, respectively. Further, the share of government consumption, social transfers and debt services in total government expenditures, $\frac{g}{gex}$, $\frac{tr}{gex}$ and $\frac{r}{gex}$, are set to 0.51, 0.44 and 0.05, respectively. The target value of debt-to-GDP ratio, b_y^*, is assumed to be 240% in the steady state, which is consistent with the reference value of public debt established by the Maastricht Treaty, which equals 60% of yearly output. The steady state quarterly gross inflation rate, π^d, is equal to 1.01. Finally, the average effective tax rates on consumption, labour income and capital income, τ^c, τ^y and τ^k, amount to 0.17, 0.48 and 0.22, respectively. An overview of the calibrated parameters is found in Table 1, while Table 2 provides an overview of the steady state relationships.

Table 1: *Calibrated parameters of the model*

Parameter	Description	Calibrated value
β	Households' discount factor	0.993
α	Capital share in production	0.30
η_c	Substitution elasticity between C_t^d and C_t^m	5
σ_a	Capital utilization cost parameter	10^6
A_L	Labour disutility constant	0.3776
σ_L	Labour supply elasticity	1
δ	Depreciation rate of physical capital	0.013
λ_w	Wage mark-up	1.05
λ^d	Mark-up in the domestic goods market	1.168
$\lambda^{m,c}$	Mark-up in the imported consumption goods market	1.619
$\lambda^{m,i}$	Mark-up in the imported investment goods market	1.226
ω_i	Share of imports in investment	0.40
ω_c	Share of imports in consumption	0.67
τ_c	Consumption tax rate	0.114
τ_y	Labour income tax rate	0.48
τ_k	Capital tax rate	0.22
τ^{tr}	Rate of transfers to households	0.50

3.5. Prior distributions of the estimated parameters

Before the Bayesian estimation method starts, the prior distributions of the estimated parameters need to be specified. As the name suggests, prior distribution describes the available information about the parameters prior to observing the data used in the estimation. The observed data is then used to update the prior, through the Bayes theorem, to the posterior distribution of the model's parameters. In specifying the prior distributions we mainly

Table 2: *Steady state relationships*

Parameter	Description	Value
π^d	Steady state quarterly gross inflation rate	1.01
$\frac{gex}{y}$	Share of government expenditures in GDP	0.37
$\frac{t}{y}$	Share of taxes in GDP	0.36
$\frac{g}{y}$	Share of government consumption in GDP	0.19
$\frac{g}{gex}$	Share of government consumption in government expenditures	0.51
$\frac{r}{y}$	Share of debt services in GDP	0.02
$\frac{r}{gex}$	Share of debt services in government expenditures	0.05
$\frac{tr}{gex}$	Share of social transfers in government expenditures	0.44
b_y^*	Target value of debt-to-GDP ratio	2.4

rely on choices from Adolfson et al. (2007).

Throughout the analysis we use four main distributions: beta distribution, inverse gamma distribution, normal distribution and gamma distribution. For the parameters bounded between 0 and 1 we choose beta distribution. Parameters belonging to this group are nominal stickiness parameters ξ, indexation parameters κ, the habit persistence b and the persistence parameters of the shock processes ρ. We set the mean of prior distributions for the price stickiness parameters to 0.5 with standard deviation 0.2, while the mean for the indexation parameters is set to 0.4 with standard deviation 0.1. However, there are three exceptions. For the Calvo parameter for domestic firms we set the prior mean to 0.85 with a standard deviation of 0.1, while for the Calvo parameter for exporting firms we choose a prior mean equal to 0.75 with a standard deviation of 0.1. For the wage indexation parameter we impose a prior mean of 0.5 with a standard deviation of 0.2. The prior on habit persistence has a mean of 0.65 and a standard deviation of 0.2. With the exception of the shocks to the unit-root technology, stationary technology and government consumption, we set the prior means of the persistence parameters for the structural shocks equal to 0.5 with a standard deviation of 0.2. For the unit-root technology, stationary technology and government consumption shocks we choose a mean of 0.6 and a standard deviation of 0.2.

We use inverse gamma distribution to describe our priors about the parameters that are assumed to be positive. These parameters are the standard deviations of shocks and the substitution elasticities between goods, η. We set the prior mean of the substitution elasticity between domestic and foreign investment goods, η_i, equal to 0.8, while the prior mean of the substitution elasticity among goods in the foreign economy, η_f, is set to 1.5. Continuing with the standard deviations of shocks[20], we set the standard deviation of the stationary technology shock, σ_ϵ, to 0.007, and the standard deviation of the unit-root technology shock, σ_{μ_z}, is assumed to be 0.002, which is the value used by Altig et al. (2011).

[20] In order to decrease the degree of non-linearity when estimating the model, the mark-up shocks in the Phillips curves, as well as the investment-specific technology shock, the labour supply shock and the consumption preference shock enter into the equations in an additive way.

The size of the risk premium shock, $\sigma_{\tilde{\phi}}$, and the prior on the risk premium parameter related to net foreign assets, $\tilde{\phi}$, are set to 0.0005 and 0.045, respectively. Based on the residuals from a first-order autoregression of the series obtained when substracting the HP-trend in domestic output from the HP-trend in foreign output, we set the size of the asymmetric technology shock, $\sigma_{\tilde{z}^*}$, to 0.003. The consumption preference, labour supply and investment-specific technology shocks, σ_{ζ_c}, σ_{ζ_h} and σ_{Υ}, respectively, are assumed to have the prior mean of 0.002, which is similar to Adolfson et al. (2007). Since we have little information about the properties of these shocks, we choose very loose priors with infinite variances. Regarding the foreign shocks, there are three standard deviations of shocks which need to be specified, namely the standard deviation of the foreign output shock, foreign inflation shock and foreign interest rate shock. We fix their values at the standard deviations of residuals obtained from a pre-estimated foreign VAR model. The standard deviation for the foreign output shock, σ_{y^*}, is, therefore, set to 0.004, the foreign inflation shock, σ_{π^*}, is assumed to have a standard deviation of 0.002, while the standard deviation for the foreign interest rate shock, σ_{R^*}, is set to 0.003.

Finally, turning to the parameters of the fiscal rule, the prior on the persistence parameter (ρ_g) follows a beta distribution with a mean of 0.6 and a standard deviation of 0.2. The priors on the feedback coefficients are assumed to be gamma distributed. We set their values as follows: the prior mean of the feedback coefficient on inflation (ϕ_π) and output gap (ϕ_y) is set to 0.25 with a standard deviation of 0.15, while the prior on the feedback coefficient on public debt (ϕ_b) and government deficit (ϕ_d) is somewhat lower and has a mean equal to 0.05 and a standard deviation of 0.01. For the steady state quarterly gross growth rate, μ_z, we choose normal distribution with prior mean centred around 1.006, implying an annual growth rate of about 2.4%.

4 ESTIMATION RESULTS AND EVALUATION

In this section, we present and evaluate the estimation results.

4.1. Posterior distributions of the estimated parameters

In total we estimated 50 parameters: 17 friction parameters, 5 policy parameters and 28 shock processes parameters. The posterior mode and an approximate covariance matrix, based on the inverse Hessian matrix evaluated at the mode, have been computed by using a standard numerical optimisation routine, namely Christopher Sims' optimizer csminwel, on the log posterior density. After having optimized the log posterior density, the draws from the posterior distribution have been obtained by simulating two parallel Markov chains of 300,000 draws of the Metropolis-Hastings algorithm, ignoring the first 50% of draws as burn-in. The average acceptance rate is roughly 32% across the two Metropolis-Hastings blocks used.

After the estimation, we performed several diagnostic tests to assess the quality of the estimated model. More precisely, we (i) looked at the quality of the posterior kernel optimization, (ii) assessed the convergence of the Markov chains by using both the univariate convergence diagnostics proposed by Brooks & Gelman (1998) as well as the multivariate convergence diagnostics, and (iii) compared the plots of the prior and posterior distributions. This latter diagnostic can be found in Appendix C. To have sensible estimates, the patterns of the prior and posterior distributions should be reasonably distinct. If the posterior looks like the prior, either the prior is a very accurate reflection of the information in the data or, more usually, the parameter under consideration is only weakly identified and the data does not provide much information to update the prior (Canova, 2007). On the other hand, if the prior and posterior distribution are far away from each other, this typically indicates that there is a disagreement between the information provided by the data and the prior knowledge about the true parameter value. In addition, the posterior distribution should be approximately normal in shape, which is in line with the asymptotic properties of Bayesian estimation, and the mode should be in the center of the posterior distribution.

As seen in these plots, the most of the estimated parameters are well identified as their posterior distribution is reasonably different from the prior distribution. Moreover, for the majority of the parameters, the variance of the posterior is lower compared to the prior distribution, indicating that data are quite informative. The mode check plots (not presented here) indicate that the optimization procedure was able to precisely find a robust maximum for the posterior kernel. Finally, both univariate and multivariate convergence graphs (also not presented here) confirm that the parameters are generally characterized by good convergence.[21]

The estimation results are summarized in Table 3, which provides prior distributions, posterior estimations and 90% confidence intervals of the estimated parameters. Let us now briefly discuss the estimation results. Beginning with the Calvo price stickiness parameters, we find that the domestic price stickiness parameter ξ_d is estimated at 0.90, which implies the average duration of prices of about 10 quarters.[22] The values for the other sectors ($\xi_{m,c}$, $\xi_{m,i}$ and ξ_x) are estimated as follows: the estimated price stickiness parameter for the imported consumption, $\xi_{m,c}$, is equal to 0.71, suggesting that prices remain on average unchanged for 3 quarters. Furthermore, the posterior mean of the price stickiness parameter for the imported investment, $\xi_{m,i}$, is estimated at 0.52. The average duration of prices in this sector is therefore 2 quarters. The export price stickiness parameter, ξ_x, in turn, is estimated at 0.87, corresponding to an average price duration of 7 quarters. The posterior mean of the Calvo wage stickiness parameter, ξ_w, is nearly 0.56. This value implies that wages are reset as frequent as twice a year. Considering next the indexation parameters, we find that the posterior mean of the degree of wage indexation, κ_w, is estimated at 0.60, while the remaining indexation parameters (κ_d, $\kappa_{m,c}$, $\kappa_{m,i}$, κ_x) are estimated at a lower value. The posterior mean of the habit persistence parameter in consumption, b, is

[21] Due to space limitations these graphs are not presented here, but they are available from the author upon request.

[22] Average duration of prices comes from $\frac{1}{1-\xi_d}$.

estimated at 0.94. Furthermore, our estimates suggest the substitution elasticity between domestic and foreign investment goods, η_i, of around 0.29, while the posterior mean for the substitution elasticity among goods in the foreign economy, η_f, is estimated at 1.37. The investment adjustment cost parameter, $\tilde{S}''$, is estimated to be equal to 8.65. The posterior mean of the risk premium parameter related to net foreign assets, $\tilde{\phi}_a$, is 0.03.

Regarding the parameters in the fiscal policy rule, we find that the feedback coefficient of government consumption to inflation, ϕ_π, is estimated at 0.22, the estimated feedback coefficient of output gap, ϕ_y, is 0.08, while the estimated feedback coefficients of public debt and government deficit, ϕ_b and ϕ_d, are equal to 0.06 and 0.05, respectively. It is worth noting that the latter two parameters are driven by a prior. This can be explained by the fact that we do not use the data on public debt and government deficit in the estimation. The persistence parameter in the fiscal rule, ρ_g, is estimated to be 0.50, which indicates a moderate degree of persistence in government consumption.

Finally, we consider the parameters associated with the persistence and volatility of shock processes (see Table 4). We find that the autoregressive parameters are estimated to lie between 0.22 for the consumption preference shock and 0.96 for the unit-root technology shock. In general, the level of persistence of stochastic processes is not very high, indicating that the model contains a sufficiently persistent endogenous propagation mechanism. Turning to the estimated standard deviations of shocks, we find that the most volatile are the imported investment mark-up shocks and the investment-specific technology shock, with standard deviations of 0.3345 and 0.0309, respectively, while the least volatile is the unit-root technology shock with a standard deviation equal to 0.0013.

Table 3: *Prior and posterior distribution of structural parameters*

		Prior distribution			Posterior distribution				
Description	Parameter	Type	Mean	Std. Dev./Df	Mode	Std. Dev.	Mean	5 %	95 %
Friction parameters									
Calvo wages	ξ_w	Beta	0.500	0.200	0.5775	0.0881	0.5568	0.4173	0.6918
Calvo domestic prices	ξ_d	Beta	0.850	0.100	0.9044	0.0206	0.9018	0.8639	0.9365
Calvo import consumption prices	$\xi_{m,c}$	Beta	0.500	0.200	0.7569	0.0957	0.7051	0.5352	0.8673
Calvo import investment prices	$\xi_{m,i}$	Beta	0.500	0.200	0.6293	0.1099	0.5195	0.2910	0.7509
Calvo export prices	ξ_x	Beta	0.750	0.100	0.8954	0.0439	0.8655	0.7689	0.9702
Calvo employment	ξ_e	Beta	0.500	0.200	0.8112	0.0319	0.8232	0.7762	0.8757
Indexation wages	κ_w	Beta	0.500	0.200	0.5927	0.1770	0.6016	0.3491	0.8291
Indexation domestic prices	κ_d	Beta	0.400	0.100	0.2013	0.0643	0.2181	0.1064	0.3172
Indexation import consumption prices	$\kappa_{m,c}$	Beta	0.400	0.100	0.3379	0.1110	0.3510	0.1951	0.5056
Indexation import investment prices	$\kappa_{m,i}$	Beta	0.400	0.100	0.3250	0.0957	0.3349	0.1814	0.4848
Indexation export prices	κ_x	Beta	0.400	0.100	0.3293	0.0996	0.3309	0.1786	0.4764
Investment adjustment cost	$\tilde{S}^*$	Normal	7.694	1.500	8.6319	1.2547	8.6526	6.5778	10.6581
Habit formation	b	Beta	0.650	0.200	0.9442	0.0214	0.9413	0.9081	0.9761
Substitution elasticity investment	η_i	Inv. Gamma	0.800	inf	0.2860	0.0552	0.2925	0.2001	0.3847
Substitution elasticity foreign	η_f	Inv. Gamma	1.500	2	1.1934	0.4019	1.3696	0.6160	2.1375
Technology growth	μ_z	Beta	1.006	0.005	1.0061	0.0005	1.0061	1.0054	1.0068
Risk premium	$\tilde{\phi}_a$	Beta	0.045	0.02	0.0234	0.0103	0.0296	0.0115	0.0460
Policy parameters									
Policy rule: lagged gov. consumption	ρ_g	Beta	0.600	0.200	0.5149	0.1585	0.4987	0.3314	0.6619
Policy rule: inflation	ϕ_π	Gamma	0.25	0.15	0.1900	0.0990	0.2234	0.0623	0.3765
Policy rule: output gap	ϕ_y	Gamma	0.25	0.15	0.0649	0.0491	0.0834	0.0148	0.1451
Policy rule: public debt	ϕ_b	Gamma	0.05	0.01	0.0508	0.0160	0.0553	0.0381	0.0716
Policy rule: gov. deficit	ϕ_{def}	Gamma	0.05	0.01	0.0495	0.0101	0.0514	0.0339	0.0674

Table 4: *Prior and posterior distribution of shock processes*

		Prior distribution			Posterior distribution				
Description	Parameter	Type	Mean	Std. Dev./Df	Mode	Std. Dev.	Mean	5 %	95 %
Persistence parameters									
Unit-root technology shock	ρ_{μ_z}	Beta	0.600	0.200	0.9707	0.0167	0.9577	0.9272	0.9899
Stationary technology shock	ρ_{ϵ}	Beta	0.600	0.200	0.8697	0.1096	0.7887	0.6071	0.9613
Investment-specific technology shock	ρ_{Υ}	Beta	0.500	0.200	0.2872	0.1381	0.2775	0.0823	0.4677
Asymmetric technology shock	$\rho_{\tilde{z}^*}$	Beta	0.500	0.200	0.9872	0.0091	0.9822	0.9678	0.9971
Consumption preference shock	ρ_{ζ_c}	Beta	0.500	0.200	0.1938	0.0979	0.2228	0.0773	0.3700
Labour supply shock	ρ_{ζ_h}	Beta	0.500	0.200	0.5307	0.3261	0.5435	0.2473	0.8126
Risk premium shock	$\rho_{\tilde{\phi}}$	Beta	0.500	0.200	0.9329	0.0153	0.9317	0.9076	0.9577
Domestic mark-up shock	ρ_{λ_d}	Beta	0.500	0.200	0.4599	0.0988	0.4742	0.3051	0.6394
Import consumption mark-up shock	$\rho_{\lambda_{m,c}}$	Beta	0.500	0.200	0.4727	0.2155	0.5425	0.2412	0.8520
Import investment mark-up shock	$\rho_{\lambda_{m,i}}$	Beta	0.500	0.200	0.1670	0.1219	0.3121	0.0500	0.5801
Export mark-up shock	ρ_{λ_x}	Beta	0.500	0.200	0.2893	0.1458	0.3566	0.0859	0.6103
Rate of transfers shock	$\rho_{\tau^{tr}}$	Beta	0.500	0.200	0.6550	0.1105	0.5941	0.3635	0.8286
Standard deviations									
Unit-root technology shock	σ_{μ_z}	Inv. Gamma	0.002	inf	0.0011	0.0002	0.0013	0.0008	0.0017
Stationary technology shock	σ_{ϵ}	Inv. Gamma	0.007	inf	0.0126	0.0056	0.0210	0.0071	0.0380
Investment-specific technology shock	σ_{Υ}	Inv. Gamma	0.002	inf	0.0304	0.0040	0.0309	0.0246	0.0367
Asymmetric technology shock	$\sigma_{\tilde{z}^*}$	Inv. Gamma	0.003	inf	0.0037	0.0005	0.0038	0.0030	0.0047
Consumption preference shock	σ_{ζ_c}	Inv. Gamma	0.002	inf	0.0044	0.0006	0.0044	0.0035	0.0054
Labour supply shock	σ_{ζ_h}	Inv. Gamma	0.002	inf	0.0010	0.0005	0.0015	0.0006	0.0023
Risk premium shock	$\sigma_{\tilde{\phi}}$	Inv. Gamma	0.0005	inf	0.0030	0.0003	0.0032	0.0026	0.0036
Domestic mark-up shock	σ_{λ_d}	Inv. Gamma	0.003	inf	0.0024	0.0003	0.0024	0.0018	0.0030
Import consumption mark-up shock	$\sigma_{\lambda_{m,c}}$	Inv. Gamma	0.003	inf	0.0026	0.0004	0.0028	0.0019	0.0037
Import investment mark-up shock	$\sigma_{\lambda_{m,i}}$	Inv. Gamma	0.003	inf	0.2533	0.0756	0.3345	0.1470	0.5169

Table continued on next page

		Prior distribution			Posterior distribution				
Description	Parameter	Type	Mean	Std. Dev./Df	Mode	Std. Dev.	Mean	5 %	95 %
Export mark-up shock	σ_{λ_x}	Inv. Gamma	0.003	inf	0.0112	0.0043	0.0113	0.0044	0.0184
Government consumption shock	σ_g	Inv. Gamma	0.002	inf	0.0049	0.0006	0.0050	0.0041	0.0058
Rate of transfers shock	$\sigma_{\tau^{tr}}$	Inv. Gamma	0.002	inf	0.0018	0.0005	0.0016	0.0007	0.0023

4.2. Assessing the empirical performance of the model

After having presented and evaluated the estimation results, we now proceed with the assessment of the empirical performance of the estimated model. This is done in three directions. First, we evaluate the absolute (in-sample) fit of the model. Second, we compare the unconditional second moments in the estimated DSGE model with those based on the actual data. Finally, we look at the smoothed estimates of the innovation component of structural shocks.

In Figure D.1 in Appendix D we first plot the actual series used in the estimation along with filtered variables obtained by the one-sided Kalman filter for each of the fifteen observable variables. The thin red line depicts the mean estimate of the one step ahead forecast of the endogenous variables (best guess for the endogenous variables at time $t + 1$ given information up to the current observations t), derived from the Kalman filter, whereas the thick black line represents the actual data (Pfeifer, 2014b). As it can be seen from the subplots, the in-sample fit of the model is satisfactory in most of the cases since the model predictions closely follow the path of the observed historical data. However, the model is not good at capturing government consumption.

The common practice in the DSGE literature is to analyse how well the model's moments match those from the actual data. As a next step we therefore compare the second moments in the data (for the period 1995Q2-2014Q4) with those in the model (calculated at the posterior mean). The results are presented in Table 5. The first column presents the standard deviations of the selected observed variables and their counterparts implied by the estimated model. The second column reports the first order autocorrelation coefficients. The last two columns show correlations with GDP growth rates and domestic inflation, respectively. Several results are worth highlighting here. First, our model is able to replicate quite well the volatilities of some observables, in particular those of the growth rate of GDP and government consumption, but generates much high volatile consumption growth rates as compared to the data. Consumption growth in the model is three times more volatile than in the data. Furthermore, we can observe that the model replicates quite closely the positive correlation of investment and government consumption growth rates with GDP growth rates. The correlation between investment and GDP growth rates is 0.67 in the model, while it is 0.77 in the data. These numbers are respectively 0.09 and 0.14 for the correlation of government consumption. On the other hand, the correlation of imports and exports seems to be underestimated by the model (0.77 in the data and 0.40 in the model for imports, 0.70 in the data and 0.41 in the model for exports), while the correlation of consumption is slightly overestimated by the model (0.42 in the data and 0.64 in the model). Furthermore, the model is quite successful in predicting the persistence of the observables, except the persistence of consumption, investment and imports that is overpredicted compared to their empirical counterparts. From the table we can also see that the model is less successful in replicating the observed correlations between the respective variables and inflation.

Finally, Figures (E.1a)-(E.1b) in Appendix E plot the estimated structural shocks of the model. The values plotted are obtained using the two-sided Kalman filter and represent the most likely values for the respective shock in a particular period, whereas the green areas provide the highest posterior density intervals (HPDI) (Pfeifer, 2014b). For the estimates to be sensible, they should be stationary around zero. As can clearly be seen from the figures, the estimates tend to fluctuate around zero over time and look clearly stationary, which gives some positive indication on the statistical validity of the estimated model.

Table 5: *Unconditional second moments in the data (1995Q2-2014Q4) and in the model*

	Standard dev.		Autocorrelation		Corr with $\Delta \ln Y_t$		Corr with $\Delta \ln P_t^d$	
	Data	Model	Data	Model	Data	Model	Data	Model
$\Delta \ln P_t^d$	0.95	0.75	0.62	0.74	0.03	-0.46	1	1
$\Delta \ln \left(W_t/P_t^d\right)$	1.09	1.17	0.49	0.59	0.74	0.46	-0.01	-0.38
$\Delta \ln \tilde{C}_t$	1.51	4.91	-0.09	0.67	0.42	0.64	0.11	-0.75
$\Delta \ln \tilde{I}_t$	7.06	8.28	-0.15	0.35	0.77	0.67	-0.13	-0.22
$\hat{E}_t$	3.17	5.13	0.99	0.99	-0.36	0.02	-0.42	0.03
$\Delta \ln Y_t$	1.18	1.43	0.49	0.47	1	1	0.03	-0.46
$\Delta \ln \tilde{X}_t$	2.80	3.13	0.45	0.50	0.70	0.41	-0.07	-0.05
$\Delta \ln \tilde{M}_t$	3.97	4.34	-0.02	0.30	0.77	0.40	-0.13	-0.05
$\Delta \ln G_t$	0.76	0.78	0.22	0.29	0.14	0.09	0.47	0.14

Notes: Standard deviations are in percent. Values implied by the model are calculated at the posterior mean estimates of the model's parameters.

5 APPLICATION: WHAT STRUCTURAL SHOCKS DRIVE THE SLOVENIAN ECONOMY?

After having verified the empirical performance of the model, we use the estimated DSGE model to analyse historical contributions of structural shocks to the business cycle developments in the Slovenian economy. In particular, we focus our attention to analyse the main driving forces behind the real GDP growth and its components during the sample period with special focus on the recent recessions. Before proceeding to such analyses, it is useful to discuss the impulse response functions and variance decompositions to understand the reaction and properties of the shocks.

5.1. Impulse response analysis

This section briefly discusses the impulse response functions of some selected variables[23] from shocks that appear to be, based on a historical decomposition of the data (discussed in more detail in Subsection 5.3), the most important in driving macroeconomic fluctuations in Slovenia. The results are reported in Figures F.1-F.9 in Appendix F, displaying impulse responses up to 20 quarters. These figures portray a Bayesian version of the impulse responses which are presented in terms of mean responses of endogenous variables (solid line) together with the 5% and 95% posterior intervals (dashed lines). Notice that all quantities are reported as log deviations from the steady state (i.e. percentage deviations).

We first focus on the impulse responses to a permanent (unit-root) technology shock that captures permanent shifts in total factor productivity (see Figure F.1). As can be seen in the figure, this shock induces all variables (except the real exchange rate and private consumption) to rise. After the initial drop, it has also a positive impact on private consumption.

Figure F.2 plots the impulse responses to a transitory (stationary) technology shock. As expected, this shock has expansionary effects on the economy. When such a shock hits the economy, marginal cost of domestic firms decreases, which reduces domestic inflation and increases domestic output. Since the increase of output outperforms the decrease in inflation, government consumption is decreased by the government. One noticeable observation is that the model predicts negative response for employment. The reason for this is that the model includes various rigidities that restrict the increase in aggregate demand, which further induces a fall in employment as firms have become more productive.

Next, we present the impulse response functions to an investment-specific technology shock (also referred to as a shock to the marginal efficiency of investment), which affects the transformation of investment into physical capital (see Figure F.3). A positive realiza-

[23] Although the model includes 81 endogenous variables, we restrict our attention to key variables only. These variables include the GDP and its main components, domestic inflation, CPI inflation, real wages, employment and real exchange rate.

tion of this shock is associated with an increase in investment. This induces an increase in aggregate demand and output in the economy. Interestingly, domestic inflation slightly decreases after this shock, while private consumption increases. Further, if we look at the impulse responses of government consumption, we can see that the government reduces its consumption to dampen demand. The expansion in the economy drives up imports, while exports suffer from higher prices caused by increasing domestic marginal costs.

Figure F.4 refers to the case when the economy is hit by a consumption preference shock. This shock causes an increase in consumption, investment and output. To meet the higher demand, firms increase capital utilisation and employment. Firms therefore face rising marginal costs, and they respond by increasing prices. Higher domestic prices drive up CPI inflation. This, in turn, induces the government to decrease its consumption to counter the expansion in the economy.

Next, we present the impulse responses to a negative labour supply shock (i.e., an increase in the disutility of working, ζ_t^h). The impulse responses are presented in Figure F.5. This shock leads to a decline in hours worked and to an increase in the real wage. This increase in the real wage leads to an increase in marginal cost and inflation. Through the usual aggregate demand effects, the result is a recession in the economy.

In the following, we discuss the impulse responses to four mark-up shocks. Figure F.6 depicts the impulse responses to a domestic mark-up shock. As a consequence of this shock, domestic inflation increases. Higher domestic prices lead to a decrease in demand of domestic consumption and investment goods. Consumption demand is also shifted towards imported goods that are cheaper than domestic production. Volumes of imports therefore increase. As a consequence, lower domestic production has a negative impact on both hours worked and wages. Higher domestic prices also negatively affect the competitiveness of exports. All these factors cause a decrease in the GDP growth rate. Government consumption, which follows a fiscal rule, decreases on impact in response to the increase in inflation.

Figures F.7 and F.8 contains the impulse response functions to an imported consumption and investment shock, respectively. After the imported consumption shock, the prices of imported consumption goods increase. This leads households to buy fewer of these goods. The increase in imported consumption inflation also drives up CPI inflation. Because imported consumption goods are now more expensive relative to the domestic ones, expenditure switching towards domestic goods works to expand the economy. As domestic firms see marginal costs go up, they increase their prices and domestic inflation increases. This has a negative effect on exports. Nevertheless, output increases because of increased domestic demand. The government therefore reduces demand in the economy by decreasing its consumption.

Figure F.8 shows impulse response functions to an imported investment mark-up shock. Following this shock, the prices of imported investment goods rise up. As a consequence, the resulting relative price effects induce investment to fall whereas consumption increases.

Decrease in demand for imported investment goods causes a reduction in imports. Domestic inflation rises up. Due to higher domestic prices, export decreases. Because of reduced exports, production in the economy falls and thus output decreases. To stimulate the economy, the government increases its consumption.

Finally, in Figure F.9 we present the dynamics of the economy following an export mark-up shock. After this shock prices of exported goods rise up. This leads to a fall in exports and consequently domestic firms produce less output. Lower production forces firms to reduce demand for labour and capital services, pushing down wages and rental rate of capital. This reduces marginal costs, allowing domestic firms to reduce prices on domestic goods. The fall in domestic inflation also works to reduce CPI inflation. Consequently, this has a positive effect on domestic demand. Since the increase in domestic demand is not sufficient to off-set the fall in exports, output falls. Fiscal policy therefore responds by raising government consumption.

5.2. Variance decompositions

In this section, we use the estimated model to decompose the unconditional variances of the observable variables into the contributions of the structural shocks. Although the primary interest of this paper is to investigate the background of the GDP (and its main components) fluctuations, we also present results for some other macroeconomic aggregates. The results are presented in Table 6, where we report the unconditional variance decomposition analysis (i.e., evaluated at the infinite horizon)[24] computed at the posterior mean for selected observable variables.

To facilitate the presentation, we divide the shocks into five categories. The first contains technology shocks: the stationary ($\varepsilon_{\epsilon,t}$), unit-root ($\varepsilon_{\mu_z,t}$), investment-specific ($\varepsilon_{\Upsilon,t}$), and asymmetric technology ($\varepsilon_{\tilde{z}^*,t}$) shocks. The second category includes supply shocks: the labour supply shock ($\varepsilon_{\zeta^h,t}$) and shocks to the mark-ups of the domestic ($\varepsilon_{\lambda^d,t}$), imported consumption ($\varepsilon_{\lambda^{mc},t}$), imported investment ($\varepsilon_{\lambda^{mi},t}$), and export ($\varepsilon_{\lambda^x,t}$) goods. The third category contains the domestic demand shock: the consumption preference shock ($\varepsilon_{\zeta^c,t}$). The fourth category includes foreign shocks: the uncovered interest rate parity ($\varepsilon_{\tilde{\phi},t}$), foreign output ($\varepsilon_{y^*,t}$), foreign inflation ($\varepsilon_{\pi^*,t}$) and foreign interest rate ($\varepsilon_{R^*,t}$) shocks. Finally, we have the fiscal policy shocks: the government spending ($\varepsilon_{g,t}$) and rate of transfers to households ($\varepsilon_{\tau^{tr},t}$) shocks.

It is evident from the table that technology shocks play the most important role in fluctuation of the GDP and investment growth. Our results show that roughly 50% and 80%

[24] In general, Dynare allows for two types of variance decompositions. The first one is the variance decomposition that is obtained under stoch_simul command and is calculated at the calibrated parameter combination, e.g., at the posterior mean (at the average over the parameters), while the second one is the so-called Bayesian variance decomposition, which is the average of the variance decomposition over the parameter draws. Furthermore, Dynare distinguishes between the conditional and unconditional variance decomposition. The first one is at a particular time horizon, while the second one is at horizon infinity.

of fluctuations in GDP and investment growth rates, respectively, are due to technology shocks. In this context, the most important technology shocks are the investment-specific technology shocks. Among the 50% (80%) of fluctuations of GDP (investment) growth rates explained by technology shocks, investment-specific technology shocks account for around 38% (78%). Furthermore, we can observe that supply shocks are the main drivers of fluctuations in the domestic inflation, real wages, consumption, exports and imports. More specifically, domestic inflation is mainly driven by domestic mark-up shocks. In our case they account for 41% of the total variation. Moreover, domestic mark-up and imported consumption mark-up shocks appear to have a leading role in explaining consumption growth fluctuations. They explain about 28% of total volatility. The shocks most responsible for the variability of real wages are labour supply shocks (34%). The export mark-up shocks turn out to be the key drivers for the exports, contributing to approximately 91% of total volatility, while the imported investment mark-up shocks play the most important role in accounting for the variation in imports, explaining about 54% of total volatility in that variable. Next, our estimates suggest that demand shocks have some importance in our framework in the sense that they explain about 15% of the variance in GDP growth rates, but their contribution to the remaining variables is negligible. Finally, we can observe that foreign and fiscal shocks explain a small fraction of variability in all variables and thus do not play an important role in explaining the Slovenian business cycle.[25]

[25] The small impact of foreign shocks may be due to the simplified representation of the foreign block, which is modelled as a VAR model.

Table 6: *Variance decompositions (in %) evaluated at the infinite horizon*

Variable	Technology	Supply	Demand	Foreign	Fiscal
$\ln P_t^d$	33.70	57.01	0.27	7.34	0.10
$\Delta\left(\ln W_t/P_t^d\right)$	36.95	60.59	0.19	1.03	0.38
$\Delta \ln \tilde{C}_t$	27.52	66.27	3.45	2.59	0.07
$\Delta \ln \tilde{I}_t$	79.82	16.03	0.24	2.90	0.01
$\hat{E}_t$	60.30	32.25	4.56	2.45	0.06
$\Delta \ln Y_t$	49.60	33.26	14.84	0.98	0.62
$\Delta \ln \tilde{X}_t$	4.13	92.52	0	2.54	0
$\Delta \ln \tilde{M}_t$	41.70	55.11	0.17	2.19	0
$\Delta \ln G_t$	35.88	5.44	0.27	1.62	55.85

Notes: The unconditional variance decomposition is performed at the posterior mean estimates of the model's parameters. Shocks are aggregated as explained in the main text.

5.3. Historical decompositions

The economic developments in Slovenia in recent years have been characterized by one of the biggest decline in economic growth in the European Union. Since 2008, Slovenia has experienced a double-dip recession. After a significant decline in GDP over the 2008-2009 period, the period of short-lived recovery began, but in the last quarter of 2011 Slovenia again dropped into recession. The question that arises is, what were the main driving forces behind the decline in GDP during the recent recession? To answer this question, we calculate historical decompositions that allow us to investigate the role of shocks in explaining the movement of observable variables over the sample period. In discussing the results, we focus on four variables: GDP, private consumption, investment, import and export. All variables are in real terms. The historical decomposition of real GDP growth is provided in Figure 1, while the remaining graphs are presented in Appendix G. In all graphs the bold black line represents the estimate of the smoothed observed variables[26] (best guess for the observed variables given all observations) derived from the Kalman smoother, while the coloured bars correspond to the contribution of the respective smoothed shock to the deviation of the smoothed observable variable from its steady state (Pfeifer, 2014b). Bars above the horizontal axis represent positive shock contributions, while bars below the horizontal axis show negative contributions.

Figure 1 decomposes the growth rate of real GDP dynamics over the underlying period. Prior to the crisis, Slovenia was characterized by a very high growth rate of the GDP. During the period 1996-2005, the annual growth rate of real GDP averaged 4%. The highest growth rate of GDP was achieved in the years 2006-2008, reaching its peak in 2007, when it was 6.7%. The historical decomposition results show that while domestic mark-up

[26]The smoothed series results from the Kalman smoother. They are the best guess of the variables given the information for the whole sample. Given that they are observed, their best guess is the actual value. Hence, there should be no difference unless one assumes they are observed only with measurement error (Pfeifer, 2014b).

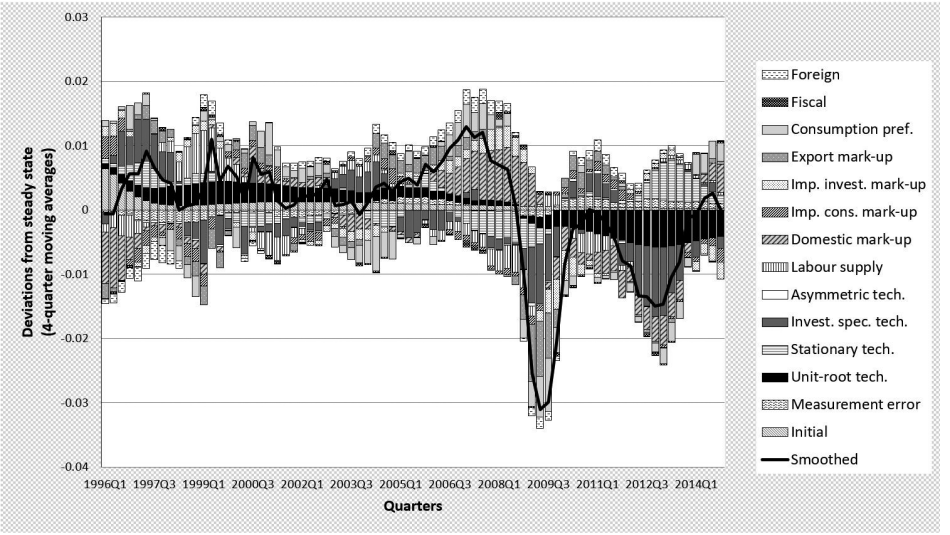
shocks had a positive effect on economic growth in this period, stationary technology and labour supply shocks had a negative one. The intuition behind this result can be explained as follows: During this period domestic, mark-up shocks appear to have contributed significantly to lower inflation, which in turn stimulated the economy. This could be contributed to the entrance of Slovenia to the EMU, since this process was characterized by the efforts aimed to achieve sufficiently low inflation to satisfy the euro adoption, as well as by the convergence of previously high Slovenian interest rates towards lower interest rates in the Euro Area. This enabled the Slovenian banks to get access to low interest rate credits from abroad, which were mainly intended for the corporate sector. The competition among banks has further induced a decrease in effective interest rates and thus reduced borrowing costs for a business. At the same time, negative transitory (stationary) technology and labour supply shocks that resulted in lower efficiencies of production and higher wages, caused an upward inflationary pressures, which affected GDP growth negatively.

Since the first quarter of 2008, the GDP growth has experienced persistent declines until reaching the bottom in the first quarter of 2009. In that quarter, the GDP declined by about 5% relative to the previous quarter. As the model's estimates suggest, this negative dynamics was mainly driven by investment-specific technology, consumption preference and export mark-up shocks. Investment-specific technology shocks to a large extent reflect a drop in foreign and domestic orders, followed by a decline in investment. This effect was further compounded by tougher access to financial resources. Consumption preference and export mark-up shocks also contributed to the slowdown in economic activity in the 2008-2009 period. It is likely that consumption preference shocks reflect the reduction in households' income (in combination with the precautionary saving) while export mark-up shocks could capture the loss of external competitiveness from an increase in wages, reflected in a series of negative labour supply shocks identified right before the crisis. The analysis also points out that fiscal and foreign shocks played a smaller but nevertheless noticeable role in driving the Slovenian business cycle. According to the model, fiscal shocks have contributed positively over the whole pre-crisis period. The positive effect was still visible in the early stages of the crisis, when loose fiscal policy mitigated the economic slowdown, although during the ongoing recession fiscal tightening (as a result of austerity measures adopted to consolidate public finances) was suppressing GDP. However, it should be noted that the impact of fiscal policy shocks was small compared to other shocks, which suggests a relatively minor significance of changes in fiscal policy for cyclical fluctuations in GDP growth. The results regarding the effects of foreign shocks show that the direction of foreign shocks has reversed its course in 2010, from having a negative effect on GDP growth during the period 2008-2010 to having a positive influence by the middle of 2010, where the latter can be attributed to improvements in the economic situation in Slovenia's main trading partners. Moreover, the historical decomposition also suggests that investment-specific technology shocks continued to be the main sources of blocking recovery in more recent years, especially in the years 2012-2013, when Slovenia fell into its second recession, in which GDP declined by about -2% (quarter-on-quarter) in real terms. This result is obviously connected to banking system problems. Namely, the Slovenian banking system has accumulated a large amount of non-performing bad loans in the last years, resulting in a credit crunch which in turn caused a cutback in

corporate investment and impeded economic activity. The model also identifies the important role of permanent (unit-root) technology shocks in explaining the movements of real GDP growth, from having a small but positive impact on GDP growth dynamics in the pre-crisis period to having negative one in recessionary periods, in particular between 2012-2013, and whose negative effects also lasted during the recovery phase. This result could be considered as associated with the lack of productivity-enhancing and other structural reforms in the run-up to the crisis. On the other hand, transitory (stationary) technology shocks have had a positive impact on economic growth, especially from 2013 onwards. This result may be interpreted as resulting from a temporary greater tendency of corporate sector to take restructuring measures in response to the crisis to enhance its production efficiency. If we compare the two recessionary periods, we can observe that in contrast to the first period (2008-2009), when investment-specific technology shocks were accompanied by consumption preference and export mark-up shocks, in the second period (2012-2013), export mark-up shocks made virtually no contribution to the downturn, pointing to a recovery in exports thanks to improving foreign demand, and more importantly, to wage moderation and productivity gains, which translated into considerable competitiveness gains and strong export performance. According to the results obtained, it can also be observed that at the end of the sample period, when the recovery officially began, consumption preference shocks were the main contributors to the pace of economic recovery, presumably due to the increased consumer confidence, resolution of banking system problems, and the improvement in the labour market situation.

Turning now to the main components of GDP, Figure G.1 in Appendix G shows the historical decomposition of consumption growth. As can be seen from the figure, the movement of consumption growth was affected by a variety of structural shocks. Consistent with the variance decomposition results, the shocks most important for explaining dynamics of consumption growth rates over the sample period were stationary technology shocks, investment-specific technology shocks, domestic mark-up shocks and imported consumption mark-up shocks. Figures G.2-G.3 (see Appendix G) plot the historical decomposition results for investment and imports, respectively. As can be seen from the figures, the investment-specific technology shocks and the imported investment mark-up shocks explained most of the variation in these two variables. Finally, Figure G.4 (see Appendix G) portrays historical decomposition of the growth rates of exports. As illustrated in the figure, almost all historical variation in exports was due to export mark-up shocks.

Figure 1: *Historical decomposition of GDP growth in terms of structural shocks*



Notes: The smoothed observed time series is plotted excluding its mean.

6 CONCLUSION

The main objective of this paper is to present and estimate an open-economy DSGE model for the Slovenian economy. The model we use closely follows that of Adolfson et al. (2007) and Masten (2010). Using a data set that extends from 1995Q1 to 2014Q4 for Slovenia, we estimate the model using Bayesian estimation techniques and compute the contribution of structural shocks to the cyclical variation of key macroeconomic variables.

After the estimation, we first describe the estimation results and perform several tests on the quality of the estimation process. Further, we evaluate the model's empirical performance. Overall, the estimation results are satisfactory. The diagnostic tests indicate that the estimation is robust in what concerns the quality of the numerical posterior kernel optimization and the convergence of the MCMC procedure. Furthermore, the majority of the parameters appear to be well identified by the data and the data fit of the model is good. The obtained estimates for the structural parameters of interest are generally in line with the literature and, in most cases, seem to make sense from an economic point of view.

In the last part of the paper, the empirical importance of various types of structural shocks in explaining macroeconomic fluctuations in the Slovenian economy is studied using impulse responses, variance and shock decompositions. Our main findings can be summarized as follows. The variance decomposition results show that the investment-specific technology shock is the major driving force of the growth rates of GDP and investment.

Moreover, domestic mark-up shocks are estimated to have a leading role in explaining consumption growth and inflation fluctuations. The labour supply shocks explain the majority of the variance of real wages. The variance of imports growth rates is explained mainly by imported investment mark-up shocks, while the exported mark-up shocks account for most of the variation in exports growth rates. The effect of consumption preference shocks on the economy is estimated to be rather limited, with the largest influence on the GDP and consumption growth rates. Finally, fiscal and foreign shocks are estimated to have a negligible effect in our framework.

Last, using historical decompositions, we estimate the individual contributions of each structural shock to the movements in GDP growth rates (and its main components) over the sample period, focusing mainly on the two recessionary periods: 2008-2009 and 2012-2013. Our results suggest that investment-specific technology shocks accounted for a significant portion of the drop in output from 2008 onwards. This result accords with a drop in foreign and domestic orders followed by a decline in investment (mostly at the beginning of the crisis), as well as with a significant tightening of credit availability, thereby reducing expenditures on investment, which produced a decrease in the aggregate demand and output. Consumption preference and export mark-up shocks were another important sources that contributed to the slowdown in economic activity, especially in the first recession (2008-2009), most likely reflecting the reduction in households' income (in combination with the precautionary saving) and the fall in exports, mainly due to the deterioration of external competitiveness as wages increased faster than productivity before the crisis years, respectively. A noticeable but smaller impact was also exerted by foreign and fiscal shocks. Furthermore, the results show that permanent (unit-root) technology shocks also contributed to the developments of GDP growth rates during the analysed period. While in the pre-crisis period these shocks had a small but positive impact on GDP growth rates, in periods of the crisis, they contributed importantly to the GDP decline. This result could be considered as associated with the lack of productivity-enhancing and other structural reforms in the run-up to the crisis. On the contrary, transitory (stationary) technology shocks had a stimulating impact, especially from 2013 onwards. This finding may capture the effect of measures adopted to improve production efficiency. The comparison between the two recessions also shows that the role of export mark-up shocks decreased in 2010, from having a significantly negative effect on GDP growth during the period 2008-2009 to making virtually no contribution to the economic downturn between 2012-2013, pointing to a recovery in exports thanks to improving foreign demand, but more importantly, to wage moderation and productivity gains, which translated into considerable competitiveness gains and strong export performance. In addition, consumption preference also importantly contributed to the surge in GDP growth in the most recent years, which could be interpreted as a consequence of the increased consumer confidence, the resolution of banking system problems and the recovery in the labour market.

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APPENDICES

A COMPLETE MODEL IN LOG-LINEARIZED FORM

This appendix presents the log-linearized equations of the model. In what follows, a variable with a hat denotes the log deviation from steady-state values ($\hat{x}_t = \frac{x_t - x}{x} \approx \ln x_t - \ln x$ for any variable x_t, where x is the steady-state level), while the overhead tilde indicates that a variable is measured as difference from its steady-state value, i.e. $\tilde{x}_t \equiv x_t - x$. Because the model comprises the unit-root technology shock, all real variables have to be scaled with the trend level of technology z_t in order to render them stationary. The resulting stationary variables are denoted by lower-case letters, that is, $x_t = \frac{X_t}{z_t}$.

Domestic Phillips curve:

$$\hat{\pi}_t^d = \frac{\beta}{1+\beta\kappa_d}\mathbb{E}_t\hat{\pi}_{t+1}^d + \frac{\kappa_d}{1+\beta\kappa_d}\hat{\pi}_{t-1}^d + \frac{(1-\xi_d)(1-\beta\xi_d)}{\xi_d(1+\beta\kappa_d)}\left(\widehat{mc}_t + \hat{\lambda}_t^d\right). \tag{48}$$

Phillips curve for the imported consumption goods:

$$\begin{aligned}\hat{\pi}_t^{m,c} = &\frac{\beta}{1+\beta\kappa_{m,c}}\mathbb{E}_t\hat{\pi}_{t+1}^{m,c} + \frac{\kappa_{m,c}}{1+\beta\kappa_{m,c}}\hat{\pi}_{t-1}^{m,c} \\ &+ \frac{(1-\xi_{m,c})(1-\beta\xi_{m,c})}{\xi_{m,c}(1+\beta\kappa_{m,c})}\left(\widehat{mc}_t^{m,c} + \hat{\lambda}_t^{m,c}\right).\end{aligned} \tag{49}$$

Real marginal cost for domestic firms:

$$\widehat{mc}_t = \alpha\hat{r}_t^k + (1-\alpha)\hat{\tilde{w}}_t - \hat{\epsilon}_t \tag{50}$$

Rental rate of capital:

$$\hat{r}_t^k = \hat{\mu}_{z,t} + \hat{\tilde{w}}_t + \hat{H}_t - \hat{k}_t \tag{51}$$

Phillips curve for the imported investment goods:

$$\begin{aligned}\hat{\pi}_t^{m,i} = &\frac{\beta}{1+\beta\kappa_{m,i}}\mathbb{E}_t\hat{\pi}_{t+1}^{m,i} + \frac{\kappa_{m,i}}{1+\beta\kappa_{m,i}}\hat{\pi}_{t-1}^{m,i} \\ &+ \frac{(1-\xi_{m,i})(1-\beta\xi_{m,i})}{\xi_{m,i}(1+\beta\kappa_{m,i})}\left(\widehat{mc}_t^{m,i} + \hat{\lambda}_t^{m,i}\right).\end{aligned} \tag{52}$$

Real marginal cost for the importing firms (consumption goods):

$$\widehat{mc}_t^{m,c} = -\widehat{mc}_t^x - \hat{\gamma}_t^{x,*} - \hat{\gamma}_t^{mc,d}. \tag{53}$$

Real marginal cost for the importing firms (investment goods):

$$\widehat{mc}_t^{m,i} = -\widehat{mc}_t^{x} - \hat{\gamma}_t^{x,*} - \hat{\gamma}_t^{mi,d}. \tag{54}$$

Phillips curve for the exporting firms:

$$\hat{\pi}_t^x = \frac{\beta}{1+\beta\kappa_x}\mathbb{E}_t\hat{\pi}_{t+1}^x + \frac{\kappa_x}{1+\beta\kappa_x}\hat{\pi}_{t-1}^x + \frac{(1-\xi_x)(1-\beta\xi_x)}{\xi_x(1+\beta\kappa_x)}\left(\widehat{mc}_t^x + \hat{\lambda}_t^x\right). \tag{55}$$

Real marginal cost for the exporting firms:

$$\widehat{mc}_t^x = \widehat{mc}_{t-1}^x + \hat{\pi}_t^d - \hat{\pi}_t^x. \tag{56}$$

Real wage equation:

$$\mathbb{E}_t\left[\begin{array}{c}\alpha_0\hat{\tilde{w}}_{t-1} + \alpha_1\hat{\tilde{w}}_t + \alpha_2\hat{\tilde{w}}_{t+1} + \alpha_3\left(\hat{\pi}_t^d - \hat{\bar{\pi}}_t^c\right) + \alpha_4\left(\hat{\pi}_{t+1}^d - \rho_{\bar{\pi}^c}\hat{\bar{\pi}}_t^c\right)\\ +\alpha_5\left(\hat{\pi}_{t-1}^c - \hat{\bar{\pi}}_t^c\right) + \alpha_6\left(\hat{\pi}_t^c - \rho_{\bar{\pi}^c}\hat{\bar{\pi}}_t^c\right)\\ +\alpha_7\hat{\psi}_{z,t} + \alpha_8\hat{H}_t + \alpha_9\hat{\zeta}_t^h + \alpha_{10}\hat{\tau}_t^b\end{array}\right] = 0, \tag{57}$$

where:

$$\begin{pmatrix}\alpha_0\\ \alpha_1\\ \alpha_2\\ \alpha_3\\ \alpha_4\\ \alpha_5\\ \alpha_6\\ \alpha_7\\ \alpha_8\\ \alpha_9\\ \alpha_{10}\end{pmatrix} = \begin{pmatrix} b_w\xi_w\\ \sigma_L\lambda_w - b_w\left(1+\beta\xi_w^2\right)\\ b_w\beta\xi_w\\ -b_w\xi_w\\ b_w\beta\xi_w\\ b_w\xi_w\kappa_w\\ -b_w\beta\xi_w\kappa_w\\ (1-\lambda_w)\\ -(1-\lambda_w)\sigma_L\\ -(1-\lambda_w)\\ (1-\lambda_w)\dfrac{\tau^b}{(1-\tau^y+\tau^b)}\end{pmatrix}$$

and:

$$b_w = \frac{[\lambda_w\sigma_L - (1-\lambda_w)]}{[(1-\beta\xi_w)(1-\xi_w)]}.$$

Euler equation for consumption:

$$\mathbb{E}_t\left[\begin{array}{c}-b\beta\hat{c}_{t+1} + \left(\mu_t^2 + b^2\beta\right)\hat{c}_t - b\mu_z\hat{c}_{t-1} + b\mu_z\left(\hat{\mu}_{z,t} - \beta\hat{\mu}_{z,t+1}\right)\\ +(\mu_z - b\beta)(\mu_z - b)\hat{\psi}_{z,t} + (\mu_z - b\beta)(\mu_z - b)\hat{\gamma}_t^{c,d}\\ -(\mu_z - b)\left(\mu_z\hat{\zeta}_t^c - b\beta\hat{\zeta}_{t+1}^c\right)\end{array}\right] = 0. \tag{58}$$

First order condition w.r.t. i_t:

$$\mathbb{E}_t\left\{\hat{P}_{k',t} + \hat{\Upsilon}_t - \mu_z^2\tilde{S}''\left[\left(\hat{i}_t - \hat{i}_{t-1}\right) - \beta\left(\hat{i}_{t+1} - \hat{i}_t\right) + \hat{\mu}_{z,t} - \beta\hat{\mu}_{z,t+1}\right]\right\} = 0. \tag{59}$$

First order condition w.r.t. b_{t+1}:

$$\mathbb{E}_t \left[\begin{array}{c} -\hat{\psi}_{z,t} + \dfrac{\pi\mu_z - \tau^k\beta}{\mu_z\pi}\left(\hat{\psi}_{z,t+1} - \hat{\mu}_{z,t+1} - \hat{\pi}^d_{t+1} + \hat{R}_t\right) \\ +\beta\dfrac{\tau^k}{\mu_z\pi}\left(\hat{\psi}_{z,t+1} - \hat{\mu}_{z,t+1} - \hat{\pi}^d_{t+1}\right) \end{array} \right] = 0. \tag{60}$$

First order condition w.r.t. $\bar{k}_{t+1}$:

$$\mathbb{E}_t \left[\begin{array}{c} \hat{\psi}_{z,t} + \hat{\mu}_{z,t+1} - \hat{\psi}_{z,t+1} - \dfrac{\beta(1-\delta)}{\mu_z}\hat{P}_{k',t+1} + \hat{P}_{k',t} \\ -\dfrac{\mu_z - \beta(1-\delta)}{\mu_z}\hat{r}^k_{t+1} \end{array} \right] = 0. \tag{61}$$

Law of motion for capital:

$$\begin{aligned} \hat{\bar{k}}_{t+1} = {} & (1-\delta)\frac{1}{\mu_z}\hat{\bar{k}}_t - (1-\delta)\frac{1}{\mu_z}\hat{\mu}_{z,t} + \left[1-(1-\delta)\frac{1}{\mu_z}\right]\hat{\Upsilon}_t \\ & + \left[1-(1-\delta)\frac{1}{\mu_z}\right]\hat{i}_t. \end{aligned} \tag{62}$$

Capacity utilization rate:

$$\hat{u}_t = \hat{k}_t - \hat{\bar{k}}_t = \frac{1}{\sigma_a}\hat{r}^k_t. \tag{63}$$

Aggregate resource constraint:

$$\begin{aligned} (1-\omega_c)\left(\gamma^{c,d}\right)^{\eta_c}\frac{c}{y}\left(\hat{c}_t + \eta_c\hat{\gamma}^{c,d}_t\right) + (1-\omega_i)\left(\gamma^{i,d}\right)^{\eta_i}\frac{i}{y}\left(\hat{i}_t + \eta_i\hat{\gamma}^{i,d}_t\right) + \frac{g}{y}\hat{g}_t & \\ +\frac{y^*}{y}\left(\hat{y}^*_t - \eta_f\hat{\gamma}^{x,*}_t + \hat{\tilde{z}}^*_t\right) & \\ = \lambda^d\left[\hat{\epsilon}_t + \alpha\left(\hat{k}_t - \hat{\mu}_{z,t}\right) + (1-\alpha)\hat{H}_t\right] & \\ -\left(1-\tau^k\right)r^k\frac{\bar{k}}{y}\frac{1}{\mu_z}\left(\hat{k}_t - \hat{\bar{k}}_t\right). & \end{aligned} \tag{64}$$

Equilibrium law of motion for net foreign assets:

$$\begin{aligned} \hat{a}_t = {} & -y^*\widehat{mc}^x_t - \eta_f y^*\hat{\gamma}^{x,*}_t + y^*\hat{y}^*_t + y^*\hat{\tilde{z}}^*_t + \left(c^m + i^m\right)\hat{\gamma}^f_t \\ & -c^m\left[-\eta_c(1-\omega_c)\left(\gamma^{c,d}\right)^{-(1-\eta_c)}\hat{\gamma}^{mc,d}_t + \hat{c}_t\right] \\ & +i^m\left[-\eta_i(1-\omega_i)\left(\gamma^{i,d}\right)^{-(1-\eta_i)}\hat{\gamma}^{mi,d}_t + \hat{i}_t\right] + \frac{R}{\pi\mu_z}\hat{a}_{t-1}. \end{aligned} \tag{65}$$

CPI inflation:

$$\hat{\pi}_t^c = \left[(1-\omega_c)\left(\gamma^{d,c}\right)^{1-\eta_c}\right]\hat{\pi}_t^d + \left[(\omega_c)\left(\gamma^{mc,c}\right)^{1-\eta_c}\right]\hat{\pi}_t^{m,c}. \tag{66}$$

Investment price inflation:

$$\hat{\pi}_t^i = \left[(1-\omega_i)\left(\gamma^{d,i}\right)^{1-\eta_i}\right]\hat{\pi}_t^d + \left[(\omega_i)\left(\gamma^{mi,i}\right)^{1-\eta_i}\right]\hat{\pi}_t^{m,i}. \tag{67}$$

Gross domestic product:

$$\hat{y}_t = \lambda^d\left[\hat{\epsilon}_t + \alpha\left(\hat{k}_t - \hat{\mu}_{z,t}\right) + (1-\alpha)\hat{H}_t\right]. \tag{68}$$

Real effective exchange rate:

$$\hat{x}_t = -\omega_c\left(\gamma^{c,mc}\right)^{-(1-\eta_c)}\hat{\gamma}_t^{mc,d} - \hat{\gamma}_t^{x,*} - \widehat{mc}_t^x. \tag{69}$$

Employment equation:

$$\Delta\hat{E}_t = \frac{\beta}{1+\beta}\mathbb{E}_t\Delta\hat{E}_{t+1} + \frac{(1-\xi_e)(1-\beta\xi_e)}{(1+\beta)\xi_e}\left(\hat{H}_t - \hat{E}_t\right). \tag{70}$$

Domestic interest rate:

$$\hat{R}_t = \hat{R}_t^* + \hat{\tilde{\phi}}_t - \tilde{\phi}_a\hat{a}_t. \tag{71}$$

Government budget constraint:

$$b\hat{b}_t + t\hat{t}_t = \frac{Rb}{\pi^d\mu_z}\left(\hat{R}_{t-1} + \hat{b}_{t-1} - \hat{\pi}_t^d - \hat{\mu}_{z,t}\right) + tr\widehat{tr}_t + g\hat{g}_t. \tag{72}$$

Government expenditures:

$$\begin{aligned}\widehat{gex}_t =& \frac{tr}{gex}\widehat{tr}_t + \frac{g}{gex}\hat{g}_t + \frac{r}{gex}\frac{R}{\pi\mu_z(R-1)}\hat{R}_{t-1} + \frac{r}{gex}\frac{\hat{b}_{t-1}}{\pi\mu_z} - \frac{r}{gex}\frac{\hat{\pi}_t}{\pi\mu_z}\\ &- \frac{r}{gex}\frac{\hat{\mu}_{z,t}}{\pi\mu_z}.\end{aligned} \tag{73}$$

Transfers to households:

$$\widehat{tr}_t = \widehat{\tau}_t^{tr} + \hat{\bar{w}}_t + \hat{H}_t. \tag{74}$$

Fiscal policy rule for government consumption:

$$\hat{g}_t = \rho_g\hat{g}_{t-1} - \phi_\pi\hat{\pi}_t^c - \phi_y\hat{y}_t - \phi_b\hat{b}_t - \phi_d\widetilde{def}_t + \varepsilon_{g,t}. \tag{75}$$

Tax on consumption:

$$\hat{t}_t^a = \omega_c \left(\gamma^{c,mc}\right)^{-(1-\eta_c)} \hat{\gamma}_t^{mc,d} + \hat{c}_t. \tag{76}$$

Taxes and contributions on wages:

$$\hat{t}_t^b = \hat{\tilde{w}}_t + \hat{H}_t. \tag{77}$$

Public debt interest payments:

$$\tilde{t}_t^c = \frac{Rb}{\pi\mu_z}\hat{R}_{t-1} + \frac{(R-1)\,b}{\pi\mu_z}\hat{b}_{t-1} - \frac{(R-1)\,b}{\pi\mu_z}\hat{\pi}_t - \frac{(R-1)\,b}{\pi\mu_z}\hat{\mu}_{z,t}. \tag{78}$$

Interest on the amount of the capital services:

$$\tilde{t}_t^d = \frac{r^k k}{\mu_z}\left(\hat{r}_t^k + \hat{k}_t - \hat{\mu}_{z,t}\right). \tag{79}$$

Interest on the amount of foreign bond holdings:

$$\tilde{t}_t^e = \frac{R-1}{\pi\mu_z}\tilde{a}_{t-1}. \tag{80}$$

Profit of domestic firms:

$$\widetilde{\Pi}_t^d = y\left(\frac{\lambda^d - 1}{\lambda^d}\right)\hat{y}_t - \frac{1}{\lambda^d}(y+\phi)\left[\alpha\left(\hat{\mu}_{z,t} + \hat{H}_t - \hat{k}_t\right) + \hat{\tilde{w}}_t - \hat{\epsilon}_t\right]. \tag{81}$$

Profit of importing firms:

$$\begin{aligned}
\widetilde{\Pi}_t^m = {} & \left\{c^m\left(\gamma^{mc,d} - \frac{1}{\lambda^d}\right)\eta_c\left[-(1-\omega_c)\left(\frac{1}{\gamma^{c,mc}\gamma^{mc,d}}\right)^{1-\eta_c}\right] + \gamma^{mc,d}c^m\right\}\hat{\gamma}_t^{mc,d} \\
& + c^m\left(\gamma^{mc,d} - \frac{1}{\lambda^d}\right)\hat{c}_t \\
& + \left\{i^m\left(\gamma^{mi,d} - \frac{1}{\lambda^d}\right)\eta_i\left[-(1-\omega_i)\left(\frac{1}{\gamma^{i,mi}\gamma^{mi,d}}\right)^{1-\eta_i}\right] + \gamma^{mi,d}i^m\right\}\hat{\gamma}_t^{mi,d} \\
& + i^m\left(\gamma^{mi,d} - \frac{1}{\lambda^d}\right)\hat{i}_t \\
& + \frac{1}{\gamma^f}\left[\left(\frac{\eta^{m,c}}{\eta^{m,c}-1}\right)c^m + \left(\frac{\eta^{m,i}}{\eta^{m,i}-1}\right)i^m\right]\hat{\gamma}_t^f.
\end{aligned} \tag{82}$$

Profit of exporting firms:

$$\widetilde{\widetilde{\Pi}}_t^x = -y^* \widehat{mc}_t^x. \tag{83}$$

Total tax revenue:

$$\hat{t}_t = \frac{\tau^c t^a}{t}\hat{t}_t^a + \frac{\tau^y t^b}{t}\hat{t}_t^b + \frac{\tau^k}{t}\left(\tilde{t}_t^c + \tilde{t}_t^d + \tilde{t}_t^e + \tilde{t}_t^f\right). \tag{84}$$

Deficit:

$$\widetilde{def}_t = gex\widehat{gex}_t - t\hat{t}_t. \tag{85}$$

Debt-to-GDP ratio:

$$\hat{b}_{y,t} = \hat{b}_t - \hat{y}_t. \tag{86}$$

Deficit-to-GDP ratio:

$$\widetilde{def}_{y,t} = \frac{\widetilde{def}_t}{y} - \frac{def}{y}\hat{y}_t. \tag{87}$$

Relative prices:

$$\hat{\gamma}_t^{mc,d} = \hat{\gamma}_{t-1}^{mc,d} + \hat{\pi}_t^{m,c} - \hat{\pi}_t^d \tag{88}$$

$$\hat{\gamma}_t^{mi,d} = \hat{\gamma}_{t-1}^{mi,d} + \hat{\pi}_t^{m,i} - \hat{\pi}_t^d \tag{89}$$

$$\hat{\gamma}_t^{x,*} = \hat{\gamma}_{t-1}^{x,*} + \hat{\pi}_t^x - \hat{\pi}_t^* \tag{90}$$

$$\hat{\gamma}_t^f = \widehat{mc}_t^x + \hat{\gamma}_t^{x,*} \tag{91}$$

$$\hat{\gamma}_t^{c,d} = \omega_c \left(\gamma^{mc,c}\right)^{(1-\eta_c)} \hat{\gamma}_t^{mc,d} \tag{92}$$

$$\hat{\gamma}_t^{i,d} = \omega_i \left(\gamma^{mi,i}\right)^{(1-\eta_i)} \hat{\gamma}_t^{mi,d} \tag{93}$$

Exogenous shock processes:

$$\hat{\xi}_t = \rho_\xi \hat{\xi}_{t-1} + \varepsilon_{\xi,t}, \quad \varepsilon_{\xi,t} \overset{iid}{\sim} N\left(0, \sigma_\xi^2\right), \tag{94}$$

where $\xi_t = \left\{ \mu_{z,t}, \epsilon_t, \lambda_t^j, \zeta_t^c, \zeta_t^h, \Upsilon_t, \tilde{\phi}_t, \tilde{z}_t^*, \tau_t^{tr}, g_t \right\}$ for $j = \{d, mc, mi, x\}$.

B DATA SOURCES AND DESCRIPTION

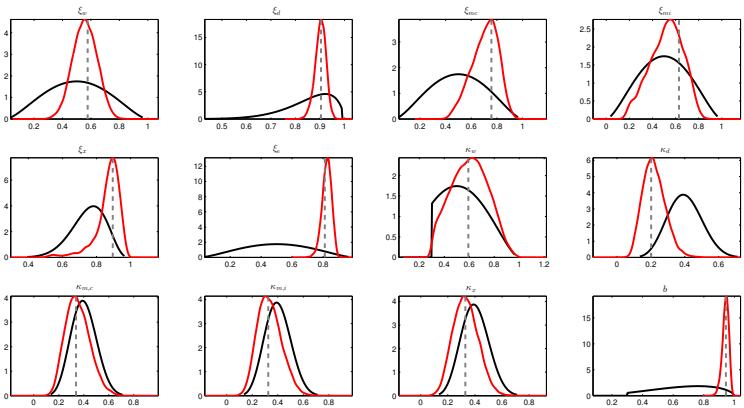
Table B.1: *List of variables used in the estimation and their sources*

Symbol	*Description*	*Country*	*Source*
Y_t	*GDP.* Gross domestic product in millions of euro, chain-linked volumes, reference year 2005, SA	SI	Eurostat
C_t	*Private consumption.* Household and NPISH final consumption expenditure in millions of euro, chain-linked volumes, reference year 2005, SA	SI	Eurostat
I_t	*Investment.* Gross fixed capital formation in millions of euro, chain-linked volumes, reference year 2005, SA	SI	Eurostat
G_t	*Government consumption.* Final consumption expenditure of general government in millions of euro, chain-linked volumes, reference year 2005, SA	SI	Eurostat
X_t	*Exports.* Exports of goods and services in millions of euro, chain-linked volumes, reference year 2005, SA	SI	Eurostat
M_t	*Imports.* Imports of goods and services in millions of euro, chain-linked volumes, reference year 2005, SA	SI	Eurostat
W_t	*Gross wages and salaries.* Gross wages and salaries (income structure of GDP), current prices, millions of euro, SA	SI	SORS
E_t	*Employment.* Employment (domestic concept), persons (in 1000), SA	SI	SORS
P_t^d	*GDP deflator.* Price index, reference year 2005, SA	SI	Eurostat
P_t^c	*CPI index.* Consumer price index, current month/average of the year 2005, not SA	SI	Eurostat/ECB
x_t	*Real exchange rate.* Real effective exchange rate, consumer price index deflator, reference year 2005, 28 trading partners	SI	Eurostat
R_t	*Domestic interest rate.* Monetary interest rate on new loans to non-financial corporations in domestic currency in percent	SI	BS/IMAD
Y_t^*	*Foreign GDP.* Gross domestic product in millions of euro, chain-linked volumes, reference year 2005, SA	EA12	Eurostat
P_t^*	*Foreign GDP deflator.* Price index, reference year 2005, SA	EA12	Eurostat
R_t^*	*Foreign interest rate.* 12-month money market interest rate in percent	EA12	Eurostat

Notes: SA: seasonally adjusted; SORS: Statistical Office of the Republic of Slovenia; IMAD: Institute of Macroeconomic Analysis and Development of the Republic of Slovenia; BS: Bank of Slovenia

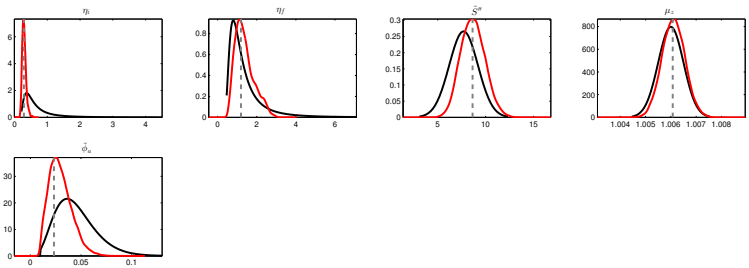
C PRIOR AND POSTERIOR DISTRIBUTIONS

Figure C.1a: *Prior and posterior distributions of the structural parameters, friction parameters*



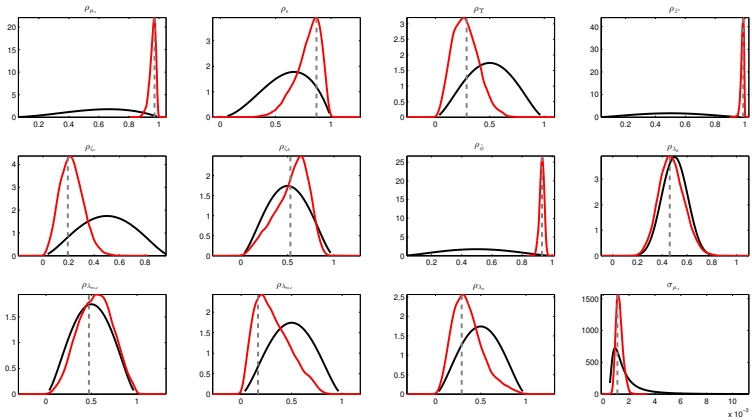
Notes: Prior (black) vs. posterior (red) distributions for the estimated structural parameters. The gray dashed vertical line is the posterior mode obtained from the posterior kernel maximization. Estimates obtained from Bayesian estimation of the DSGE model using Slovenian macroeconomic data from 1995Q1-2014Q4.

Figure C.1b: *Prior and posterior distributions of the structural parameters, friction parameters (cont.)*



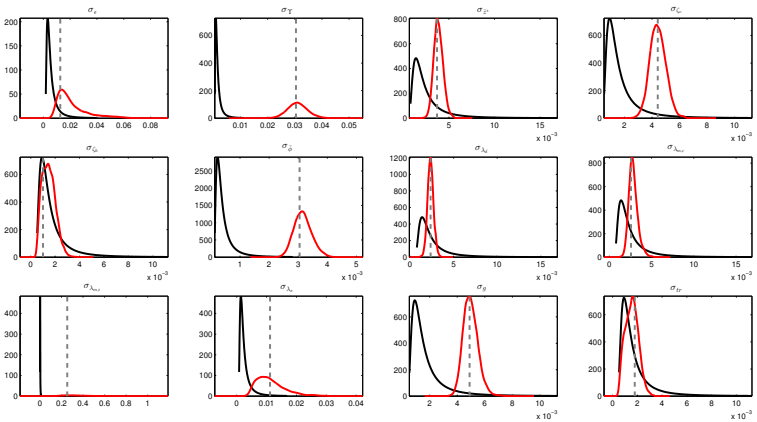
Notes: Prior (black) vs. posterior (red) distributions for the estimated structural parameters. The gray dashed vertical line is the posterior mode obtained from the posterior kernel maximization. Estimates obtained from Bayesian estimation of the DSGE model using Slovenian macroeconomic data from 1995Q1-2014Q4.

Figure C.1c: *Prior and posterior distributions of the structural parameters, shock processes parameters*



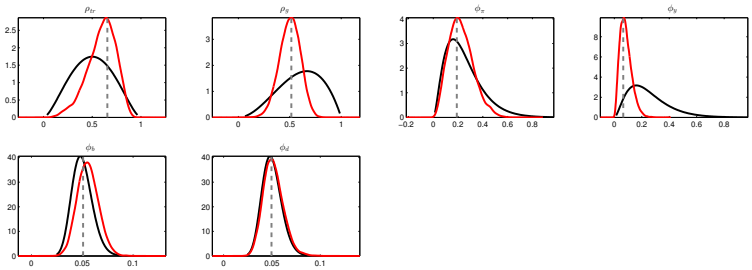
Notes: Prior (black) vs. posterior (red) distributions for the estimated structural parameters. The gray dashed vertical line is the posterior mode obtained from the posterior kernel maximization. Estimates obtained from Bayesian estimation of the DSGE model using Slovenian macroeconomic data from 1995Q1-2014Q4.

Figure C.1d: *Prior and posterior distributions of the structural parameters, shock processes parameters (cont.)*



Notes: Prior (black) vs. posterior (red) distributions for the estimated structural parameters. The gray dashed vertical line is the posterior mode obtained from the posterior kernel maximization. Estimates obtained from Bayesian estimation of the DSGE model using Slovenian macroeconomic data from 1995Q1-2014Q4.

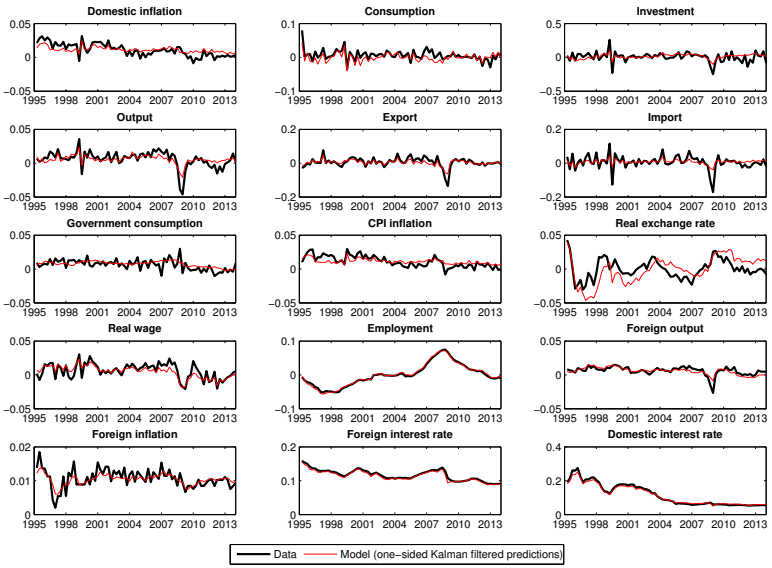
Figure C.1e: *Prior and posterior distributions of the structural parameters, policy parameters*



Notes: Prior (black) vs. posterior (red) distributions for the estimated structural parameters. The gray dashed vertical line is the posterior mode obtained from the posterior kernel maximization. Estimates obtained from Bayesian estimation of the DSGE model using Slovenian macroeconomic data from 1995Q1-2014Q4.

D DATA AND ONE-SIDED PREDICTED VALUES FROM THE MODEL

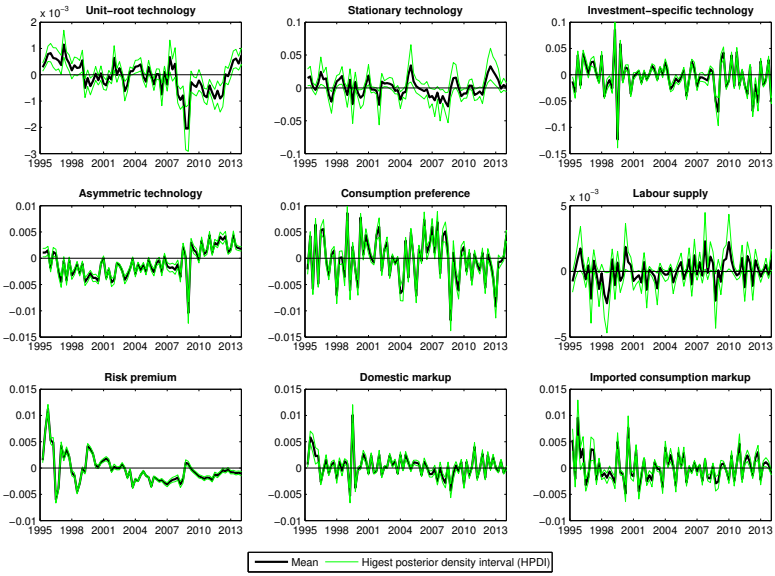
Figure D.1: *Data (thick black) and one-sided Kalman-filtered predictions (thin red)*



Notes: The plot shows deviations from steady state/trend.

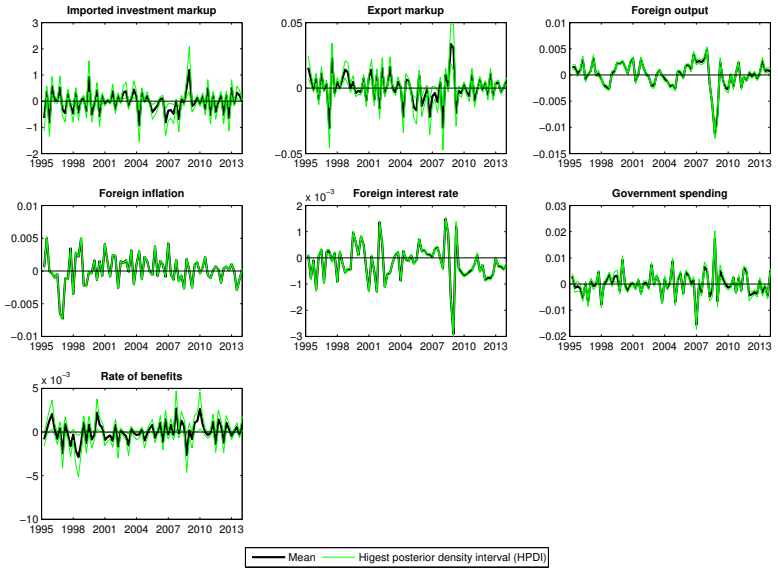
E SMOOTHED SHOCKS

Figure E.1a: *Smoothed (two-sided Kalman filtered) estimates of the structural shocks (deviations from steady state)*



Notes: The plot shows deviations from steady state.

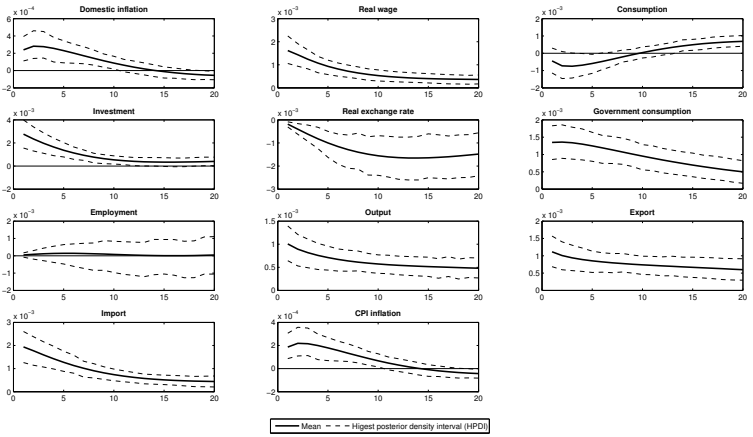
Figure E.1b: *Smoothed (two-sided Kalman filtered) estimates of the structural shocks (deviations from steady state) (cont.)*



Notes: The plot shows deviations from steady state.

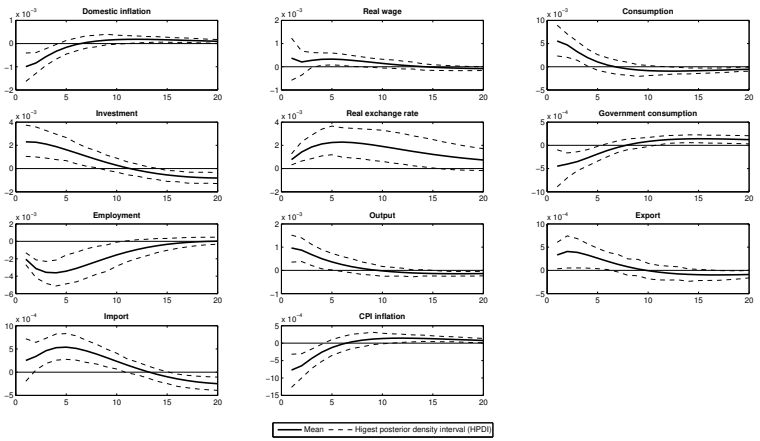
F IMPULSE RESPONSE FUNCTIONS

Figure F.1: *Impulse responses to a unit-root technology shock*



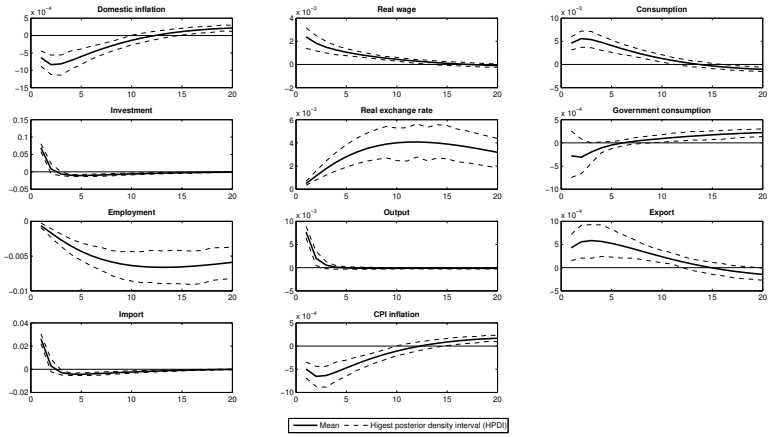
Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

Figure F.2: *Impulse responses to a stationary technology shock*



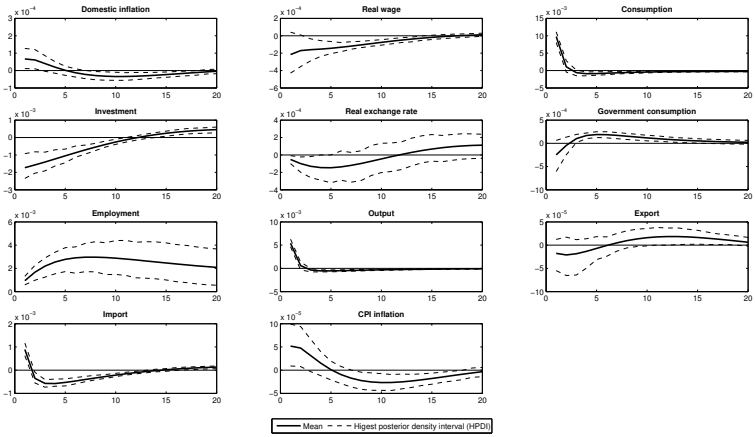
Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

Figure F.3: *Impulse responses to an investment-specific technology shock*



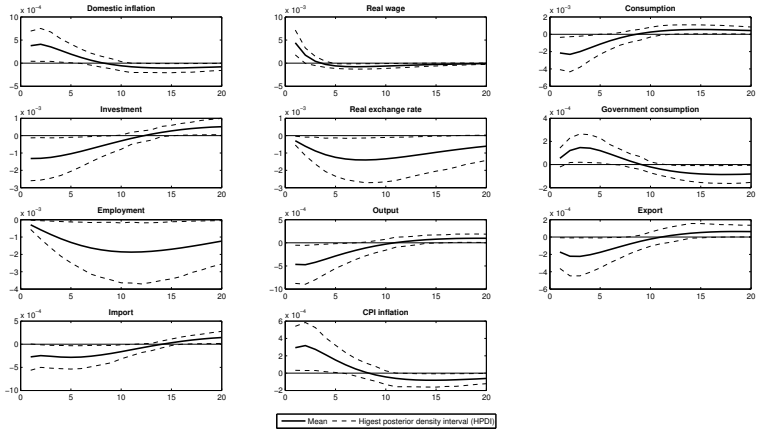
Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

Figure F.4: *Impulse responses to a consumption preference shock*



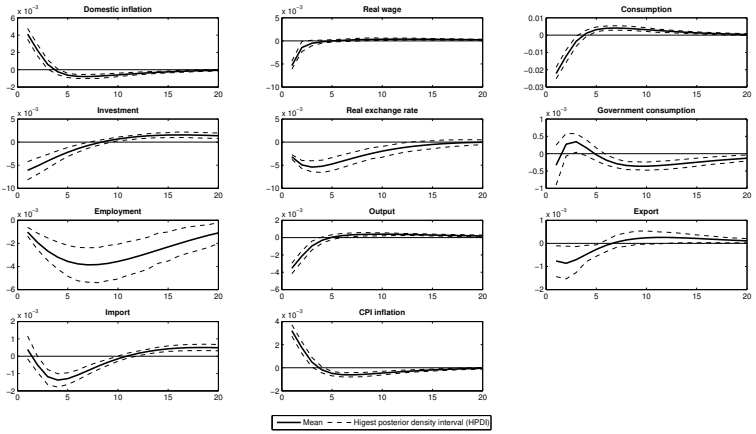
Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

Figure F.5: *Impulse responses to a labour supply shock*



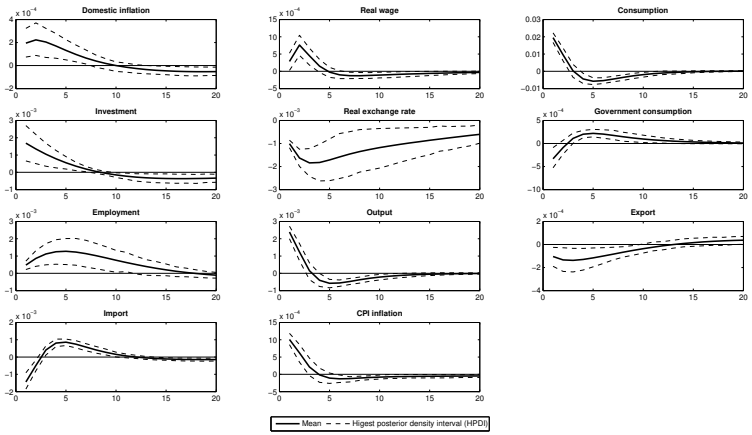
Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

Figure F.6: *Impulse responses to a domestic mark-up shock*



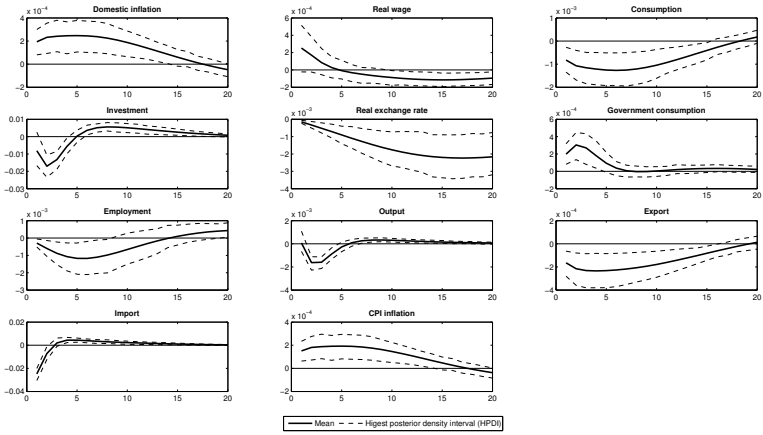
Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

Figure F.7: *Impulse responses to an imported consumption mark-up shock*



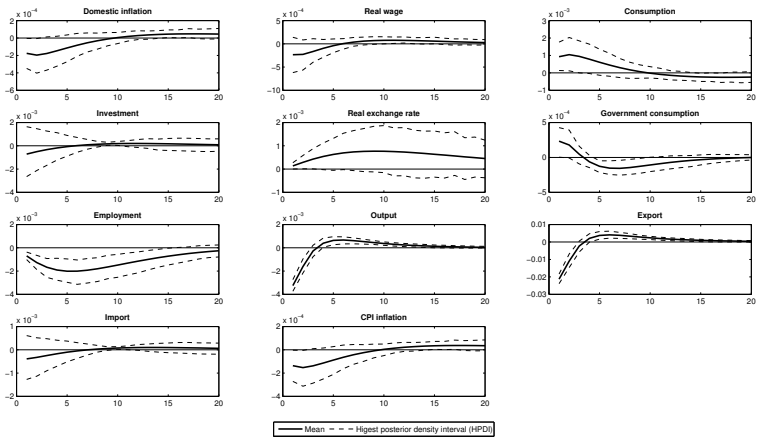
Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

Figure F.8: *Impulse responses to an imported investment mark-up shock*



Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

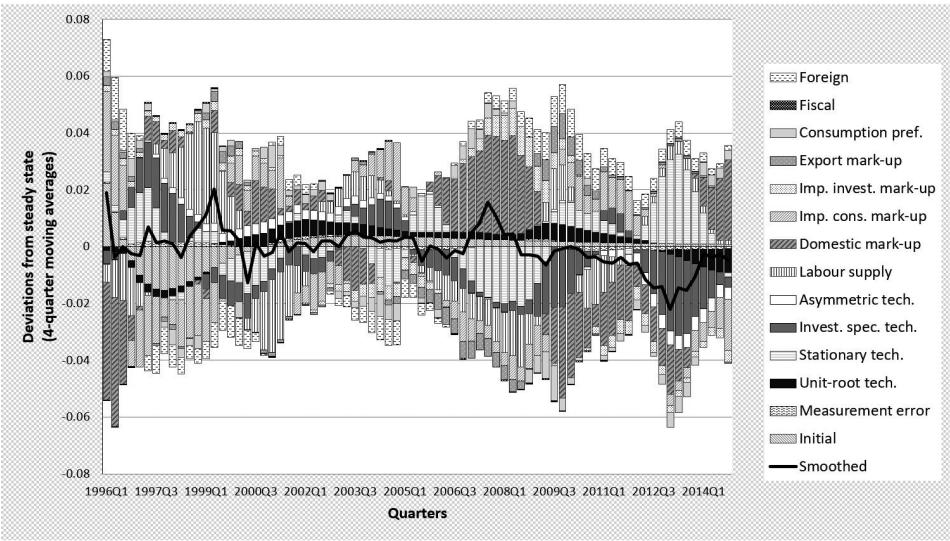
Figure F.9: *Impulse responses to an export mark-up shock*



Notes: The solid line shows the average impulse responses results over the MCMC parameter draws; the dashed lines at the 5% and 95% posterior intervals. The impulse horizon is measured in quarters.

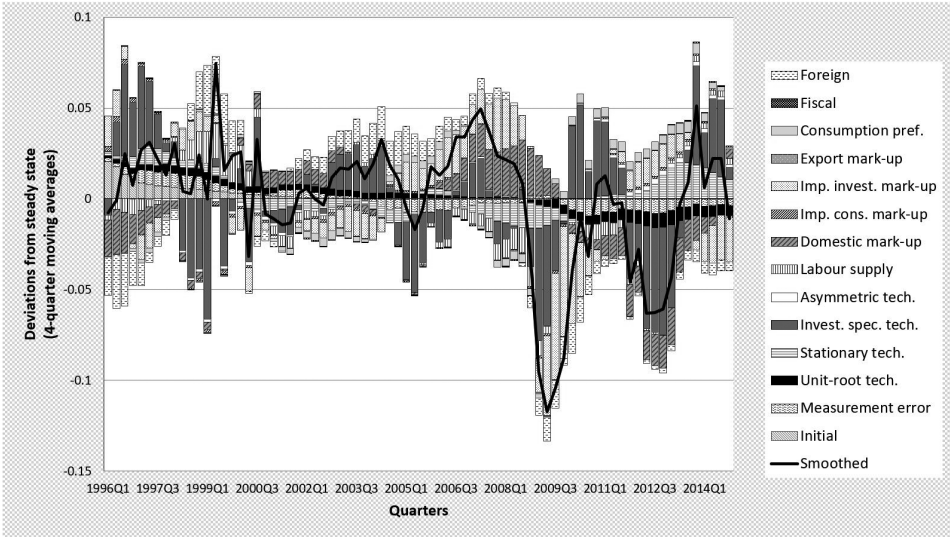
G HISTORICAL DECOMPOSITIONS

Figure G.1: *Historical decomposition of consumption growth in terms of structural shocks*



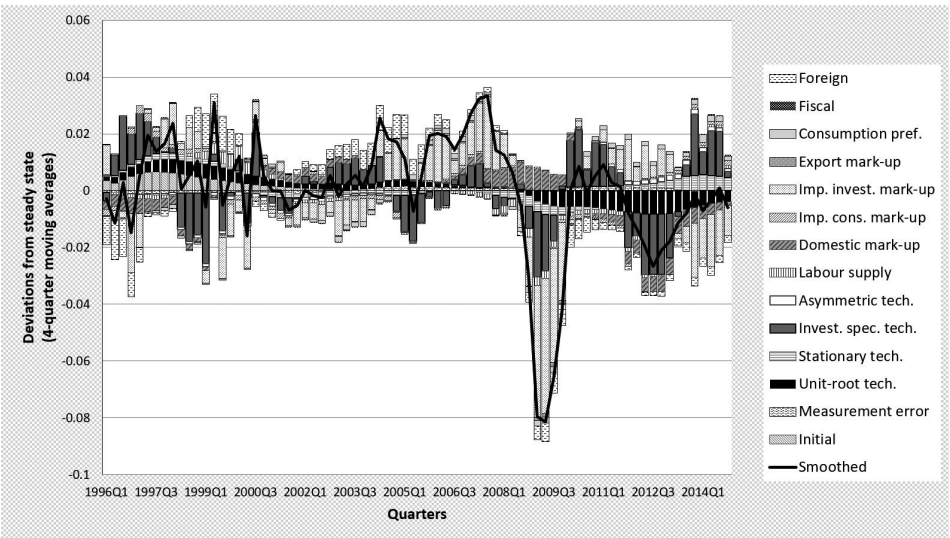
Notes: The smoothed observed time series is plotted excluding its mean.

Figure G.2: *Historical decomposition of investment growth in terms of structural shocks*



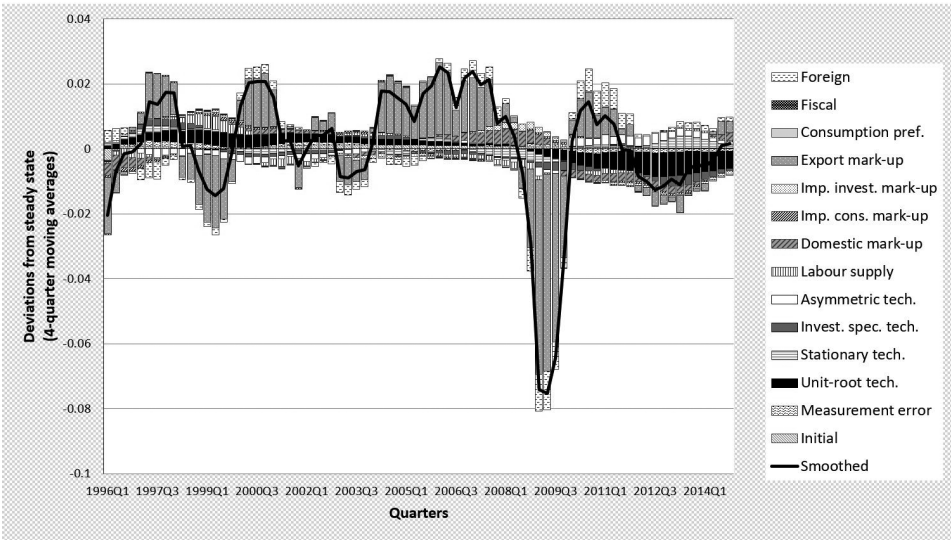
Notes: The smoothed observed time series is plotted excluding its mean.

Figure G.3: *Historical decomposition of import growth in terms of structural shocks*



Notes: The smoothed observed time series is plotted excluding its mean.

Figure G.4: *Historical decomposition of export growth in terms of structural shocks*



Notes: The smoothed observed time series is plotted excluding its mean.

The Influence of Socio-Demographic Characteristics on Environmental Concern and Ecologically Conscious Consumer Behaviour among Macedonian Consumers

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ABSTRACT: *Western Balkan countries face a decisive moment in the development of their economies, societies and the environment. According to the European Environment Agency, household consumption patterns in these countries have changed rapidly in the recent years and are of key interest due to the fact that unsustainable patterns of consumption are an important cause of environmental problems. The main purpose of this paper is to add to the body of knowledge on environmental consumer profiling, especially in the context of post-transition economies. We present the results of a survey on 323 Macedonian consumers, relating their attitudes and consumption patterns to socio-demographic characteristics.*

Key words: *environmental concern, ecologically conscious consumer behaviour, socio-demographic characteristics, the Republic of North Macedonia*

JEL classification: M31, Q01

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1 INTORDUCTION

Over the last decades, substantial efforts have been put into policies aimed at production processes to cope with the depletion of natural resources, climate change, air pollution and waste generation. However, more recently the focus has shifted to the consumption perspective, as high levels of consumption endanger the quality of the environment and the processes of sustainable development (Liobikene & Bernatoniene, 2017). Unsustainable consumption puts a threefold of environmental burdens to the environment: via the natural resource depletion, pollution and biodiversity reduction. Consumption is directly related to global climate change, identified as the major environmental issue of modern life. Hence, one of the main responsibilities for environmental degradation lies with the consumers and their consumption choices (Berglund & Matti, 2006). Therefore, in order to reduce the environmental consequences of consumption, it is essential to stimulate

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the consumption of environmentally friendly products (Liobikiene, Grincevičiene, & Bernatoniene, 2017).

Understanding consumer behaviour is important for any marketer and it is especially critical for environmental products. There is a general belief among researchers and environmental activists that by buying environmentally friendly products consumers can contribute significantly to improve the quality of the environment (Abdul-Muhmim, 2007). Groening, Sarkis and Zhu (2018) point out that the need to understand green purchasing behaviour is especially relevant owing to environmental, scientific, and communication developments, such as the internet and social media, and increases environmental awareness and concerns in consumers.

Green consumers are those who associate the act of purchasing or consuming products with the possibility of acting in line with preservation of the environment (Hailes, 2007). In a similar vein, Roberts (1996) defines ecologically conscious consumers as individuals who try to consume only products that produce the least or do not cause any impact on the environment. When profiling green consumers, companies can use standard bases for customer segmentation. On the one hand, many companies focus primarily on socio-demographics when segmenting the market for green products, due to the fact that these segmentation measures are easily available and simple to implement (Park, Choi, & Kim, 2012; Patel, Modi, & Paul, 2017). Furthermore, socio-demographic variables are often used to improve the accessibility of segments for subsequent profiling and targeting strategies (Park et al., 2012). However, a review of literature indicates that several studies on socio-demographic profiling of green consumers report mixed results, therefore limiting the value of the use of socio-demographic variables for consumer segmentation and profiling (Diamantopoulos et al., 2003; Fisher, Bashyal, & Bachman, 2012). Further studies are therefore needed to determine whether these characteristics play a significant role in green consumer profiling, especially in markets where marketing research is not very developed. The reason why the present study focuses on socio-demographics is that in transition and post-transition markets, which are less developed in terms of marketing research, it is easier for companies to use simple variables for consumer profiling. However, it is important to establish how relevant they are in profiling green consumers and this is where this study aims to make a contribution.

The main purpose of this paper is to add to the body of knowledge on environmental concern and ecologically conscious consumer behaviour, especially in the context of transition and post-transition economies. Past studies on the attitudes of consumers toward the environment and ecologically conscious consumer behaviour have been conducted mostly in developed or developing countries (for an overview see Patel, Modi, & Paul, 2017), with less focus on transition and post-transition countries. However, according to the European Environment Agency (EEA Report No 1/2010, 2010), household consumption patterns in the Western Balkan countries have changed rapidly and are of key interest due to the fact that unsustainable patterns of consumption are an important cause of environmental problems. Therefore, it is important to advance our knowledge about

environmental attitudes and consumer behaviour in these markets. Of Western Balkan countries this study focuses on the Republic of North Macedonia, which has the worst air quality in Europe (Migrio, 2018). The problem intensifies every winter as a consequence of industrial emissions, smoke from wood-burning stoves and exhaust fumes from old cars (Georgievski, 2018), of which the last two pertain to consumers and could be better managed by having a deeper insight in consumer environmental concern and behaviour. The contribution of this study is therefore not only academic, but it gives implications for every day practice of policy makers and domestic and international marketers that are present or plan to enter this market.

The main goal of this research is to analyse consumers' environmental concern and ecologically conscious consumer behaviour and to discover if significant differences exist based on socio-demographic profiles that would enable companies to use them in profiling green consumers. This study should therefore provide answers to the following core research questions: (1) What is the awareness of the importance of environmental issues in the examined context? (2) What is the presence of ecologically conscious consumer behaviour in the market? (3) How are environmental concern and ecologically conscious consumer behaviour related to socio-demographic characteristics?

The paper is structured as follows. First, we define environmental concern and ecologically conscious consumer behaviour. This is followed by the section on demographic characteristics and their influence on environmental concern and ecologically conscious consumer behaviour. In the next section we present research design and research results. This is followed by a discussion of implications for theory and practice, limitations and opportunities for future research.

2 ENVIRONMENTAL CONCERN AND ECOLOGICALLY CONSCIOUS CONSUMER BEHAVIOUR

2.1 Environmental concern

There are some variations in the definition of environmental concern across the literature, but most researchers use the term to refer to attitudes about environmental issues or perceptions that such issues are important (Cruz, 2017). Liu, Vedlitz, and Shi (2014) stress that identifying and understanding the determinant factors of consumers' environmental concern is one of the major necessary conditions to make sound policies and promote consumers' engagement in pro-environmental behaviour.

As evidenced, almost all Europeans say that environmental protection is important to them personally and over 75% believe that environmental problems have a direct effect on their lives (Special Eurobarometer 416, 2014). By recognizing the severity of environmental problems, people in general have become more environmentally aware (Han, Hsu, & Lee,

2009) and their sensitivity and consciousness toward environmental issues should have an effect on their buying behaviour (Brochado, Teiga, & Oliveira-Brochado, 2017).

Despite traditional beliefs that environmental concern is limited to the wealthy nations, research shows that consumer environmental concern is not dependent on national wealth (Dunlap & York, 2008). People in poor and developing countries have shown as much concern about environmental issues as those in developed countries, which is confirmed in North Macedonia as well (Angelovska, Sotiroska, & Angelovska, 2012).

2.2 Ecologically conscious consumer behaviour

Kuchinka et al. (2018) point out that in general consumer behaviour is primarily motivated by benefits and costs, and can bring instant personal gain or gratification benefit, while environmentally conscious behaviour is attempting to achieve a future outcome with benefits for the entire society. If consumers care about the environment, they will most likely consider the consequences of their purchasing decisions (Brochado et al., 2017).

There has been a lot of research attention devoted to the study of consumers' environmentally friendly behaviour because it is extremely beneficial for companies to understand what factors influence consumers' behaviour (Fisher et al., 2012). The growing importance of protecting the environment has changed the way people see the market, and consumers now believe that their purchasing behaviour will find a better match in products (Akehurst, Afonso, & Gonçalves, 2012).

As already pointed out in the introduction, green (named also pro-environmental or ecologically conscious) consumers associate the act of purchasing or consuming products with the possibility of acting in line with preservation of the environment (Hailes, 2007). In this study, the focus is on the pro-environmental purchase behaviour (e.g., eco-labelled products, reusable packaging, lower emission cars, and low-energy appliances) and not on the pro-environmental consumption (e.g., household waste separation, noise control, use of recycling points and water saving) (Sánchez, López-Mosquera, & Lera-López, 2016).

Researchers have studied several factors leading to ecologically conscious consumer behaviour. Groening, Sarkis, and Zhu (2018) provide a comprehensive overview of green marketing and green consumerism theoretical relationships. They draw upon existing models and include topics featuring factors affecting relationships between attitudes and behaviours (e.g., situational, sociological and psychological factors) and barriers to environmental action. Based on the prior consumer decision making literature, Groening et al. (2018) propose six theory groupings: values and knowledge, beliefs, attitudes, intentions, motivations, and social confirmation. Values and knowledge are the foundation for beliefs, which in turn form attitudes that predict behaviour (as in Theory of Reasoned Action by Fishbein & Ajzen, 2011). However, contradictory results were found regarding the relationship between attitude and behaviour, leading to conclusion that the fact that

consumers exhibit a positive attitude towards green products does not necessarily indicate they will engage in green purchase behaviour (Kuchinka et al., 2018). Groening et al. (2018) also present theory groupings that could explain why attitudes do not directly result in green purchase behaviour, including intentions, motivations, facilitators or instantiaters, and social confirmation.

3 SOCIO-DEMOGRAPHIC CHARACTERISTICS AND THEIR INFLUENCE ON ENVIRONMENTAL CONCERN AND ECOLOGICALLY CONSCIOUS CONSUMER BEHAVIOUR

The latest green marketing consumer-level literature has among others illustrated the focus on identifying the profile of the environmentally conscious consumers (e.g., Akehurst et al., 2012; Brochado et al., 2017; Sánchez et al., 2016; Pinto et al., 2014), including the socio-demographic characteristics of environmentally conscious consumers, such as age, gender, education, income and so on. The inconsistency of the results in a variety of studies (for an overview see Diamantopoulos et al., 2003; Fisher et al., 2012; Verain et al., 2012) has perhaps shown how complicated it is to accurately identify the demographic profile of an environmentally conscious consumer. Even though these results provide insufficient data for profiling environmentally conscious consumers, they can be a useful tool to marketers in describing market segments (D'Souza et al., 2007). In the following sections we present the socio-demographic characteristics that have been most often related to environmental concern and environmentally conscious consumer behaviour (Diamantopoulos et al., 2003; Fisher et al., 2012) and we propose hypotheses about the Macedonian consumers.

Groening et al. (2018) provide a large-scale review of more than 20 consumer-level theories used in the field of green marketing. This study builds on role theory (Biddle, 1986) to explain the differences in consumers' environmental concern and ecologically conscious consumer behaviour. Biddle (1986) proposes that individuals hold social positions in society which reflect their roles and create expectations for their own behaviours and others' expectations of behaviour. Role theory can be used both to explain and predict social behaviour of individuals based on situations and identities. According to role theory, different groups of people playing different roles exhibit different patterned behaviours. Gender role theory argues that women and men behave according to roles related with their genders. Han, Hsu and Lee (2009) provide a review of studies that found differences in gender roles analysed in environmental studies. These studies show that women are more nurturing, which is associated with their greater concern for the environment and willingness-to-pay more for green products (Han et al., 2009). Role theory has also been utilised to explain the differences in pro-environmental behaviours among sustainable and apathetic consumers (Park & Ha, 2012). In line with role theory this study proposes that there are differences in attitudes and behaviour of consumers based on the roles they play in the society (for example, based on gender, educational level, income level and similar). Argumentations for the differences are provided in the next sections.

This study therefore focuses on socio-demographic characteristics and with those related social roles in explaining environmental concern and ecologically conscious consumer behaviour. Due to the low explanatory power of socio-demographic characteristics to predict ecologically conscious consumer behaviour (e.g., Roberts, 1996; Diamantopolous et al., 2003; Brochado et al., 2017), in the last step the analysis will be complemented by adding environmental concern as an additional predictor of ecologically conscious consumer behaviour. Various studies report that consumers with higher environmental concern are more likely to evaluate the environmental consequences of their purchase behaviour and that environmental concern positively influences ecologically conscious consumer behaviour (Mainieri et al., 2007; Nath et al., 2013; Brochado et al., 2017).

3.1 Gender

Gender has been one of the most often used variables when profiling green consumers. One important, well-established finding is that females are more environmentally sensitive about general environmental issues than males and more likely to express concern about the social and environmental impacts of their consumption (Koos, 2011; Zelezny, Chua, & Aldrich, 2000; Park et al., 2012). They consider the environmental issues in the purchase decisions to a larger extent and are more willing to engage in ecologically conscious consumption than men (Brochado et al., 2017; Liobikiene et al., 2017; Sánchez et al., 2016; Diamantopoulos et al., 2003; Luchs & Mooradian, 2012). Furthermore, women show more willingness to buy and pay a premium price for environmentally benign products (Laroche, Bergeron, & Barbaro-Forleo, 2001). On the other hand, Mostafa (2007) found that men possess a deeper knowledge of environmental issues, express higher levels of environmental concern and have more positive attitudes towards green purchase, while Chen at al. (2011) and Rice (2006) found no significant relationship of gender with environmental variables.

Based on the results of the study of purchase differences of environmentally labelled products in 18 European countries, women are more likely to consider the environmental issues when they do their shopping (Koos, 2011). Similarly, Zelezny et al. (2000) evaluated 13 studies on environmentally responsible consumption and state that in nine of them women appeared to have a higher level of pro-environmental attitudes and behaviours, three reported no significant differences between sexes, but only one has shown that males were more environmentally concerned than females.

Based on the above, we can conclude that gender is an important socio-demographic predictor of environmental concern and ecologically conscious consumer behaviour; women appear to be more concerned about the environment and are more likely to act in accordance to those concerns when making a purchase decision. Therefore, it is hypothesised that:

H1a: Females are more concerned about the environment than males.
H1b: Females demonstrate more ecologically conscious consumer behaviour than males.

3.2 Age

Age is another demographic variable that has been widely examined in past studies. Findings about the age of consumers can provide a useful base in market segmentation, however, the results in relation to this demographic variable have been inconsistent. Most studies reveal that younger individuals are likely to be more sensitive and concerned about environmental issues (Chen & Peng, 2012; Diamantopoulos et al., 2003). On the other hand, Liu et al. (2014) found a positive relationship between age and environmental concern.

When researching consumer behaviour, the results are somewhat different. Roberts (1996) found that age is significantly related to ecologically conscious consumer behaviour, concluding that middle aged consumers are more prone to ecologically conscious consumption activities. Likewise, Anić, Jelenc and Šebetić (2015) and Mohr and Schlich (2016) examining sustainable food consumption detected that middle aged respondents show the highest level of environmentally conscious consumption behaviour. Also, Brochado et al. (2017) found that older consumers (compared to the youngest group) are more prone to ecologically conscious consumer behaviour. These results might be due to the fact that younger individuals are mostly students without jobs who have a lower buying power and who cannot afford environmentally friendly products or more expensive alternatives (Jain & Kaur, 2006). On the other hand, some researchers have found that the relationship between age and ecologically conscious consumption is significant and negative (Zimmer, Stafford, & Stafford, 1994). In relation to these mixed findings, Chan (1996) in his two-country study, found that the respondents' age has a significant influence on the environmentally sustainable purchases in Canada (i.e., younger respondents more frequently purchase recyclable products), while no association between these two variables was found for respondents in Hong Kong. Due to the contradicting results related to the relationship between the age of consumers and their environmental concern and environmentally conscious consumer behaviour, we posit exploratory hypotheses, only assuming that differences exist, but not predicting the direction of these differences.

H2a: Younger and older consumers differ in terms of environmental concern.
H2b: Younger and older consumers differ in terms of ecologically conscious consumer behaviour.

3.3 Educational level

A consumer's level of education is in many studies considered as a socio-demographic factor that affects environmental practices of the consumer. In terms of education, most empirical studies have shown that more educated people are more sensitive and

aware of environmental issues (Zsóka et al., 2013; Zhao, Wu, & Wang, 2014). They show higher preferences for environmental protection and willingness to pay leading to environmentally conscious consumer behaviour (Diamantopoulos et al., 2003; do Paço, Raposo, & Filho, 2009; Zhao et al., 2014). For illustration, Koos (2011) in his study on sustainable consumption across Europe states that buying environmentally-labelled products increases with education. Because higher educated people in general are better informed and could understand environmental issues better, they express higher concern about the quality of the environment and have strong desire to protect it. Consequently, they are more willing to practice ecologically conscious consumer behaviour (Torgler & Garcia-Valinas, 2007; Zhao et al., 2014). Based on these findings, it is hypothesised that:

H3a: Less educated people are less environmentally concerned than people with higher educational levels.
H3b: Less educated people exhibit less ecologically conscious consumer behaviour than people with higher educational levels.

3.4 Income level

Consumers with higher income have less economic problems and can turn to other concerns; at the same time they have higher willingness and ability to pay for goods (Franzen & Vogl, 2013). Results from previous research show that consumers with higher income are more interested in protecting the environment (Royne, Levy, & Martinez, 2011) and prefer life style based on environmentally friendly consumption (Anić et al., 2015). A positive relationship between respondents' income and their environmental concern is also confirmed in the studies by Zimmer, Stafford and Stafford (1994) and Roberts (1996). On the other hand, Park et al. (2012) report a non-linear relationship between these two variables. In their study, consumers in the lowest and in the highest income group were found to be the most environmentally concerned. In relation to ecologically conscious consumer behavior, the results from previous research are somehow mixed but still mostly indicate that income has positive and meaningful influence on purchase decision (do Paço et al., 2009; Hines, Herald, & Audrey, 1987; Anić et al., 2015; Welsch & Kühling, 2009). This notion is mainly based on the fact that pro-environmental products are usually priced higher than conventional ones, and people with higher income may be more likely to buy these products because they can bear the associated marginal increase in their cost (Zhao et al., 2014). On the other hand, some researchers have found that people with a lower level of income are more prone to ecologically conscious consumer behaviour (Roberts, 1996) or even that the income level does not affect their green consumption decisions significantly (Straughan & Roberts, 1999; Ci-Sheng, Xiao-Xia, & Meng, 2016). Therefore, due to contradicting results related to the relationship between income of consumers and their environmental concern and environmentally conscious consumer behaviour, we posit exploratory hypotheses, only assuming that differences exist, but not predicting the direction of these differences.

H4a: There are differences in the concern about the environment based on the income level.
H4b: There are differences in the ecologically conscious consumer behaviour based on the income level.

3.5 Marital status

There have been some attempts to link environmental attitude and behaviour to marital status (Diamantopoulos et al., 2003; Fisher et al., 2012; Chen et al., 2011). The argument behind these relationships is that spouses can act as a social referent in influencing environmental attitude and behaviour (Neuman, 1986). Not many studies found support for the influence of marital status on environmental concern (e.g. Research 2000 in Diamantopoulos et al., 2003). On the other hand, few studies indicate that married people are more likely to participate in green activities (Diamantopoulos et al., 2003; Fisher et al., 2012). Although this is a rarely tested variable in environmental research, we build on argumentation developed by Neuman (1986) and for transitional context expect positive relationships between these variables.

H5a: Single people are less concerned about the environment.
H5b: Single people exhibit less ecologically conscious consumer behaviour.

3.6 Number of children

Research shows that the presence of children in the household positively affects environmental concern and environmentally conscious behaviour (Laroche et al., 2001; Loureirro, McCluskey, & Mittlehammer, 2002). The reason would be that due to discussions on ecology at school children have certain expectations regarding environmentally friendly behaviour of their parents (Schlossberg, 1992). On the other hand, Diamantopoulos et al. (2003) did not find significant relationships between the number of children and environmental consciousness measures (knowledge, attitudes and behaviour), while Fisher et al. (2012) found that only one part of behaviour (usage of recyclable bags) is related to the number of children in the household. In line with role theory and findings of Laroche et al. (2001) and Loureirro et al. (2002) we expect a positive relationship between the number of children and environmental concern and behaviour.

H6a: The more children a consumer has, the stronger the concern about the environment.
H6b: The more children a consumer has, the greater the participation in ecologically conscious consumer behaviour.

4 RESEARCH DESIGN

4.1 Questionnaire design

Existing scales were used to measure constructs under study. To measure environmental concern we used statements from the Socially Responsible Consumption Behaviour scale (Antil, 1984), while for ecologically conscious consumer behaviour we used statements from the Ecologically Conscious Consumer Behaviour scale (Roberts, 1996). Respondents were presented with statements and they were asked to evaluate them on a five point Likert scale (1 = I entirely disagree, 5 = I entirely agree). The last set of questions was related to demographic characteristics of the respondents. Gender, age, educational level, income, marital status and number of children under 15 years were included.

The questionnaire applied for collecting the primary data was translated twice, from English into Macedonian and vice versa, to ensure that all difficulties due to language differences would be minimized and that the meanings of the statements were properly transferred. Then, the questionnaire was tested on a small sample of 15 respondents of different age, gender and educational level. The questionnaire testing was made in order to identify possible problems related to the questionnaire's clarity, bias and possible ambiguity. The participants were asked for their opinion regarding the wording, sequencing and timing as well. No difficulties in understanding the statements were indicated and it was not suggested that the time needed for answering the questions was too long.

4.2 Data collection and sample characteristics

The research population is defined as persons over the age of 18 years living in Skopje, the capital of the Republic of North Macedonia. Printed questionnaires were administered to teachers in four primary schools in different areas in Skopje and their students later forwarded them to their parents or grandparents. In addition, questionnaires were distributed to students at a private university and to additional known citizens with different demographic characteristics. Altogether, we distributed 399 questionnaires and 368 were returned (response rate of 81%), while the number of fully filled questionnaires bearing the status of "completed" was 323, on which the final analysis was done. Sample characteristics were compared to the latest attainable official statistical data for the inhabitants of Skopje and the population of North Macedonia acquired from the State Statistical Office of the Republic of North Macedonia. The inspection indicated that despite some deviations the sample was close enough to the population to continue the analysis.

Some of the respondents' socio-demographic characteristics used in further analysis are presented in Table 1. Regarding the gender structure, 46.7% of respondents were male and 53.3% female. The average age was 39.6 years (standard deviation 13.4). Regarding the level of education, a substantial number (48.9%) of the respondents completed at least a bachelor degree. The majority reported to have an average monthly household income

(62.5%). Additionally, the majority were married or living with a partner (71.8%), while the rest were single, separated, divorced or widowed. The average number of children under the age of 15 years was 1.0 (standard deviation 0.9), where one third of the sample had no children.

Table 1: *Some demographic characteristics of the respondents*

Demographic characteristics	**Frequency**	**Relative frequency in %**
Age		
00 – 20	44	13.6
21 – 30	33	10.2
31 – 40	98	30.3
41 – 50	96	29.7
51 – 60	25	7.7
61 – 70	20	6.2
71 +	7	2.2
Total	323	100.0
Level of education		
Elementary school	11	3.4
Vocational school	117	36.2
Secondary (high) school	37	11.5
Bachelor degree	139	43.0
Master's degree	12	3.7
PhD	7	2.2
Total	323	100.0
Household average monthly income		
Below average/ in lower half of below average	12	3.7
Below average/ in upper half of below average	15	4.6
Average	202	62.5
Above average/ in lower half of above average	42	13.0
Above average/ in upper half of above average	37	11.5
I do not know	15	4.6
Total	323	100.0
Marital status		
Single	73	22.6
Married	229	70.9
Living together without being married	3	0.9
Divorced	8	2.5
Separated	3	0.9

Demographic characteristics	Frequency	Relative frequency in %
Widowed	7	2.2
Total	323	100.0
Number of children		
0	109	33.7
1	104	32.2
2	105	32.5
3	3	0.9
4	1	0.3
5	1	0.3
Total	323	100.0

4.3 Data analysis

We used univariate statistical techniques (frequencies, means and standard deviations) to present sample characteristics and results for the statements measuring environmental concern and ecologically conscious consumer behaviour. The reliability of measurement for the individual constructs (Table 2) was evaluated before the hypotheses test. We tested the hypotheses using independent samples t-test, one-way ANOVA and correlation analysis. In the end, multiple regression analysis was carried out to test the effect of all variables at the same time. Further results validation was performed using clustering and discrimination analysis.

The value of reliability coefficient (Cronbach's α) for the ecologically conscious consumer behaviour scale consisting of eleven items is 0.859, which shows good internal consistency of the scale. Cronbach's alpha coefficient for environmental concern (0.610) is below the recommended 0.7 threshold, but since the value of over 0.60 for Cronbach alpha can be still considered acceptable (Kline, 2000, p. 13), we can use both constructs in further analyses. Both constructs are also sufficiently different from each other (correlation coefficient is 0.509, $p < 0.01$).

Table 2: *Statistics for environmental concern and ecologically conscious consumer behaviour*

	Summary statistics				
Environmental measures	**Number of items**	**Mean**	**Standard deviation**	**Possible range**	**Cronbach's α**
Environmental concern	6	24.05	3.23	6 - 30	0.610
Ecologically conscious consumer behaviour	11	38.90	7.06	11 - 55	0.859

5 FINDINGS

5.1 Descriptive statistics for environmental concern and ecologically conscious consumer behaviour

Descriptive statistics for statements measuring the focal constructs are presented in Tables 3 and 4. Consumer **environmental concern** was measured with six items. As presented in Table 3, all items have a mean value above the neutral/undecided response option in the range between 3.77 and 4.27, which means that on average, Macedonian consumers are environmentally concerned. The highest average agreement was expressed with the statement that pollution affects their life.

Table 3: *Descriptive statistics for consumer environmental concern*

Scale item	*M*	*SD*
You feel that pollution affects your life personally.	4.27	0.77
You think all the worried comments made about air and water pollution are all justified.	4.11	0.90
You become incensed when you think about the harm being done to the plant and animal life by pollution.	4.11	0.85
You have often thought that if we could just get by with a little less there would be more left for future generations.	4.00	1.01
Natural resources must be preserved even if people must do without some products.	3.81	0.94
Pollution is presently one of the most critical problems facing this nation.	3.77	1.04

Descriptive statistics for individual scale items of **ecologically conscious consumer behaviour** are presented in Table 4. All items have a mean value above the neutral/undecided response option in the range between 3.18 and 4.02. The overall conclusion is that on average the respondents seem to engage in ecologically conscious consumer behaviour, yet the average scores are lower than at environmental concern. The easier behaviour (When you have a choice between two equal products, you always purchase the one less harmful to other people and the environment; $M = 4.02$, $SD = 0.93$) is more practiced than the more demanding forms (for example, buying only products that can be recycled and avoiding or not buying products that have excessive packaging).

Table 4: *Descriptive statistics for ecologically conscious consumer behaviour*

Scale item	***M***	***SD***
When you have a choice between two equal products, you always purchase the one less harmful to other people and environment.	4.02	0.93
If you understand the potential damage to the environment that some products can cause, you do not purchase those products.	3.78	0.90
When you purchase products, you always make a conscious effort to buy those products that are low in pollutants.	3.74	0.99
You do not buy a product if the company that sells it is ecologically irresponsible.	3.69	1.10
When there is a choice, you always choose the product that contributes to the least amount of pollution.	3.66	0.98
Whenever possible you buy products packaged in reusable containers.	3.54	1.06
You have switched products for ecological reasons.	3.46	1.03
You have convinced some members of your family and friends not to buy some products that are harmful to the environment.	3.35	1.04
You normally make a conscious effort to limit the use of products that are made of or use scarce resources.	3.27	0.84
You try only to buy products that can be recycled.	3.21	1.05
You do not buy products that have excessive packaging.	3.18	0.99

5.2 Testing individual influences of socio-demographics on environmental concern and ecologically conscious consumer behaviour

With the first set of hypotheses we tested the effect of gender on environmental concern and ecologically conscious consumer behaviour. Based on an extensive literature review we proposed that women demonstrate more ecologically conscious consumer behaviour than men. The results (Table 5) are in line with the proposed hypotheses. Women are on average more environmentally concerned and report more sustainable consumer behaviour than men. Therefore, H1a and H1b are supported.

Table 5: *Impact of gender on environmental concern and ecologically conscious consumer behaviour*

	Gender		
	Female	**Male**	**t-value (1-tailed sig.)**
Environmental measures	***M (SD)***	***M (SD)***	
Environmental concern	24.57 (3.07)	23.45 (3.30)	3.16 (0.001)
Ecologically conscious consumer behaviour	39.75 (6.43)	37.94 (6.43)	2.28 (0.011)

With the second set of hypotheses we tested the effect of age on consumers' attitudes and behaviour. The results of the correlation analysis indicate that there is a significant positive relationship between age and environmental concern ($r = 0.229$, $p < 0.01$), as well as age and ecologically conscious consumer behaviour ($r = 0.303$, $p < 0.01$). In order to test the differences among age groups we used one-way ANOVA. We used three age groups (30 years and less, 31 to 50 years old, and 51 years and above) to differentiate consumers. The analysis of variance shows that the effect of age for both environmental concepts is significant ($F = 16.341$, P = 0.000 for environmental concern; $F = 28.215$, $P = 0.000$ for ecologically conscious consumer behaviour). The Bonferroni post hoc test indicates that the average for environmental concern is significantly lower in the youngest age group ($M = 22.38$, $SD = 3.16$), compared to the other two age groups (for 31 to 50 years old $M = 24.40$, $SD = 2.99$, and for 51 years and above $M = 25.24$, $SD = 3.30$). The results are similar to the ones about ecologically conscious consumer behaviour. The youngest age group ($M = 34.18$, $SD = 7.82$) scored significantly lower than the other two age groups (for 31 to 50 years old M = 39.97, $SD = 6.12$, and for 51 years and above $M = 41.92$, $SD = 5.93$). We can therefore support H2a and H2b that differences exist between younger and older consumers regarding environmental concern and ecologically conscious consumer behaviour.

With the third set of hypotheses we tested the influence of educational level on the consumers' environmental concern and ecologically conscious consumer behaviour. The educational level of respondents as an independent variable originally presented with six groups (1 – elementary, 2 – vocational, 3 – secondary, 4 – bachelor degree, 5 – master and 6 – PhD) was regrouped in two groups (respondents with lower education comprising groups 1 to 3 and respondents with higher education comprising groups 4 to 6). Although the results indicate that the respondents with lower education exhibit lower environmental concern and ecologically conscious consumer behaviour, the differences between the two groups are not statistically significant (Table 6). Therefore, at $\alpha = 0.05$ we cannot conclude that in this research context less educated people exhibit lower environmental concern and less ecologically conscious consumer behaviour than people with higher educational levels. We also conducted a more detailed analysis (one-way ANOVA), comparing environmental concern and ecologically conscious consumer behaviour among all six educational groups. The results indicate there are no statistically significant differences among different educational groups ($F = 0.911$, P = 0.474 for environmental concern; $F = 1.167$, $P = 0.325$ for ecologically conscious consumer behaviour). Thus, hypotheses H3a and H3b are not supported.

Table 6: *Impact of educational level on environmental concern and ecologically conscious consumer behaviour*

	Educational level		t-value (1-tailed sig.)
	Lower	**Higher**	
Environmental measures	***M (SD)***	***M (SD)***	
Environmental concern	23.78 (3.05)	24.32 (3.39)	-1.51 (0.065)
Ecologically conscious consumer behaviour	38.36 (7.28)	39.46 (6.81)	-1.40 (0.081)

Next, we tested the effect of household income on environmental variables. We regrouped the original five categories of household income into three (below average, average and above average) to ensure sufficiently large groups for analysis. The results indicate that significant differences exist between these three groups for environmental concern (F = 6.635, P = 0.002) but not for ecologically conscious consumer behaviour (F = 1.720, P = 0.181). There are statistically significant differences in environmental concern between consumers with below average household income (M = 25.81, SD = 3.24) and those with above average household income (M = 23.27, SD = 3.41), indicating that those coming from less wealthy households are more concerned about the environment. H4a is therefore supported, while H4b is not.

The results for the influence of marital status on environmental variables (Table 7) indicate that on average single people are less environmentally concerned and practice less ecologically conscious consumer behaviour. Therefore, H5a and H5b are supported.

Table 7: *Impact of marital status on environmental concern and ecologically conscious consumer behaviour*

	Marital status		t-value (1-tailed sig.)
	Single	**Married**	
Environmental measures	***M (SD)***	***M (SD)***	
Environmental concern	22.96 (3.27)	24.48 (3.11)	-3.89 (0.000)
Ecologically conscious consumer behaviour	34.76 (7.24)	40.53 (6.30)	-7.09 (0.000)

The last set of hypotheses tested the relationship between the number of children (under the age of 15) and environmental variables. The results of the correlation analysis indicate that there is a significant positive relationship between the number of children and environmental concern (r = 0.172, P < 0.01) and the number of children and ecologically conscious consumer behaviour (r = 0.235, P < 0.01). H6a and H6b are thus supported.

5.3 Testing the joint influence of socio-demographics on environmental concern and ecologically conscious consumer behaviour

In the next section we present the results of multiple regression analyses that were carried out to test the joint explanatory value of socio-demographics for environmental attitudes and behaviour. We performed two regression analyses, where environmental concern and ecologically conscious consumer behaviour were separately used as dependent variables and the earlier discussed socio-demographic characteristics as the independent variables. Age and number of children were measured on ratio scales, so they were directly entered in the regression analysis. Gender, marital status, educational level and income had to be transformed into dummy variables. In the case of the first three each was represented by a single dummy variable, while income was measured with two dummy variables (the details are explained below in Table 9 and Table 10). The nspection of correlations among the predictors did not indicate collinearity concerns (the highest correlation coefficient was 0.481), which was also confirmed by multicollinearity checks with assessment of tolerance (values in the range 0.643 – 0.948) and variance inflation factor (values in the range 1.055 – 1.555). Both regressions are significant and independent variables account for 13.2% of variance in environmental concern and 18.4% in ecologically conscious consumer behaviour (Table 8).

Table 8: *Regression results*

	Summary statistics			
Environmental measures	**Multiple *R***	***Adj. R2***	***F* value**	**Significance**
Environmental concern	0.388	0.132	7.962	0.000
Ecologically conscious consumer behaviour	0.449	0.184	11.313	0.000

Table 9: *Regression coefficients for environmental concern*

	Summary statistics		
Independent variables	**β**	***t***	**Significance**
Gender	0.200	3.708	0.000
Age	0.156	2.559	0.011
Educational level	0.048	0.880	0.380
Income below average	0.139	2.606	0.010
Income above average	-0.085	-1.537	0.125
Marital status	0.099	1.520	0.130
Number of children	0.102	1.767	0.078

Codes for dummy variables: Gender (1 = female, 0 = male), Education level (1 = bachelor and higher, 0 = secondary or lower), Income below average (1 = below average, 0 = otherwise), Income above average (1 = above average, 0 = otherwise), Marital status (1 = married, 0 = single).

Table 10: *Regression coefficients for ecologically conscious consumer behaviour*

	Summary statistics		
Independent variables	**β**	***t***	**Significance**
Gender	0.178	3.414	0.001
Age	0.178	3.012	0.003
Educational level	0.008	0.150	0.881
Income below average	0.018	0.339	0.735
Income above average	-0.034	-0.641	0.522
Marital status	0.251	3.984	0.000
Number of children	0.112	2.006	0.046

Codes for dummy variables: Gender (1 = female, 0 = male), Education level (1 = bachelor and higher, 0 = secondary or lower), Income below average (1 = below average, 0 = otherwise), Income above average (1 = above average, 0 = otherwise), Marital status (1 = married, 0 = single).

Environmental concern (Table 9) is predicted by gender, age and income below average, with gender having the strongest influence. As already indicated in hypothesis testing, women and those consumers that reported to have below average income tend to be more concerned about the environment. Environmental concern on average also increases with age. On the other hand, ecologically conscious consumer behaviour (Table 10) is predicted by gender, age, marital status and number of children. The main difference to the previous analysis is that while in the regression analysis marital status and number of children do not seem to significantly influence environmental concern, they still have a positive effect on ecologically conscious consumer behaviour.

When environmental concern is included as a predictor in the regression analysis of ecologically conscious consumer behaviour, this substantially increases the percentage of explained variance (adjusted R^2 is 0.336 compared to R^2 of 0.184 without environmental concern), as expected. In this case ecologically conscious consumer behaviour is explained by environmental concern ($\beta = 0.417$, $P = 0.000$), marital status ($\beta = 0.211$, $P = 0.000$), age ($\beta = 0.117$, $P = 0.031$) and gender ($\beta = 0.099$, $P = 0.042$).

To validate the results we additionally performed a cluster analysis on attitudinal and behavioural variables (the seventeen variables measuring environmental concern and ecologically conscious consumer behaviour). The TwoStep cluster analysis revealed a two cluster solution (with cluster quality rated as fair) where variables related to behaviour carry a heavier importance at predicting cluster membership than those related to attitudes. The largest cluster (55.8% of sample elements) consisted of consumers that rank consistently lower in environmental concern and ecologically conscious consumer behaviour than the smaller group (44.2% of sample elements). The results for the summated scales of ecologically conscious consumer behaviour ($M_1 = 34.63$, $SD = 6.00$; $M_2 = 44.32$; $SD = 3.93$) and environmental concern ($M_1 = 22.16$; $SD = 2.68$; $M_2 = 26.43$; $SD = 2.10$) also

revealed greater variability in the less ecological group. In the discriminant analysis that we performed with the previously mentioned socio-demographic variables, the percentage of variance explained was similar to our previous analyses (16%). The correlation between the discriminant scores and the levels of the dependent variable was weak to moderate (0.371) and Wilks' lambda (0.862) was statistically significant (P = 0.000). The analysis revealed that the two groups differ significantly in marital status, age, number of children, gender and education, while the difference in income is not statistically significant. In line with the results of the previous analysis, consumers in the more ecological group are to a larger extent married, older, female, with higher education and have on average more children.

6 DISCUSSION AND CONCLUSIONS

The main goal of this research was to analyse consumers' environmental concern and ecologically conscious consumer behaviour and discover if significant differences exist based on socio-demographic characteristics that would enable companies and policy makers to use these variables in profiling green consumers. In regards to the recognition of the importance of environmental issues among consumers, it can be said that Macedonian consumers seem to be quite concerned about the general issues related to environmental protection. Although people seem to be highly concerned about the state of the environment due to high pollution the country experiences, this has not yet translated into their buying decisions.

6.1 Theoretical implications

The broad theoretical underpinning of this research is role theory (Biddle, 1986) that can be used both to explain and predict social behaviour of individuals based on situations and identities. In line with role theory this study proposes that there are differences in attitudes and behaviour of consumers based on the roles they play in the society (for example, based on gender, educational level, income level and similar). Testing these relationships in the examined context can give better insights to companies and policy makers with more prominent roles. Although the results of previous studies are quite mixed and ambiguous (Verain et al., 2012), the majority of the proposed hypotheses were supported in our research.

Women are on average more environmentally concerned and report to engage more in ecologically conscious consumer behaviour than men, which is in line with the findings of several authors (e.g., Brochado et al., 2017; Diamantopoulos et al., 2003; Koos, 2011; Luchs & Mooradian, 2012;). We can conclude that gender is a socio-demographic variable that seems to work across cultures and level of market development and can be used in post-transition contexts, as well as for profiling green consumers.

Age is also an important predictor of environmental variables in the examined context. The results indicate that age is positively related to both environmental concern and ecologically conscious consumer behaviour. Further analyses revealed that the youngest age group (30 and below) is less environmentally concerned and less engaged in ecologically conscious consumer behaviour than the other two age groups (31 to 50 years and 51 years and above). Mixed results exist on these relationships in the literature and our research adds to the group of authors that found that older consumers are more environmentally concerned (Liu et al., 2014) and more engaged in ecologically conscious consumer behaviour (e.g. Anić et al., 2015; Brocado et al., 2017; Mohr & Schlich, 2016).

Furthermore, our research did not find statistically significant differences in environmental concern and ecologically conscious consumer behaviour regarding educational level, which is in contradiction to previous research. Most empirical studies have shown that higher educated people tend to perceive environmental issues better and are more sensitive and aware of environmental issues (e.g. Zhao et al., 2014; Zsóka et al., 2013) and that highly educated people are more prone to ecologically conscious consumption in developed (Diamantopoulos et al., 2003; do Paço et al., 2009) and developing countries (Zhao et al., 2014; Zsóka et al., 2013). A closer inspection of the results reveals that differences among the groups exist and are statistically significant at $P = 0.065$ and $P = 0.081$, respectively, but not at our threshold ($\alpha = 0.05$). Therefore, at a less stringent threshold ($\alpha = 0.10$) both hypotheses regarding education would be supported. However, the results of clustering and discriminant analysis reveal that when ecologically conscious consumer behaviour and environmental concern are jointly analysed, the level of education discriminates between the more and less ecological groups.

Regarding income, the results indicate that significant differences exist in environmental concern between consumers with below average household income and those with above average household income, indicating that those coming from less wealthy households are more concerned about the environment. This is in contradiction with most previous studies, except partially with Park et al. (2012) who also found people from less wealthy households to be more environmentally concerned compared to the group with average income. No differences regarding income exist for ecologically conscious consumer behaviour, which is in line with mixed findings in the published literature, especially with Ci-Sheng et al. (2016) and Straughan and Roberts (1999) who also found that income level does not affect green consumption decisions significantly. The explanation for these findings could be in line with the discussion offered by Roberts (1996) that pollution and environmental degradation may have reached the point where consumers from all (also the lower) socioeconomic strata are becoming involved. Skopje is one of the most polluted European cities and it is possible that consumers from poorer households live in more polluted areas and are consequently more concerned about the environmental problems.

In the last section, we tested the influence of spouses and children on environmental concern and ecologically conscious consumer behaviour. Regarding the marital status (married were those living together with a significant other in a household), our results

support that on average married people are more environmentally concerned and report to exhibit more ecologically conscious consumer behaviour. This study therefore adds to the scarce empirical evidence of the influence of marital status on environmental concern (e.g. Research 2000 in Diamantopoulos et al., 2003) and ecologically conscious consumer behaviour (Diamantopoulos et al., 2003; Fisher et al., 2012). The relationship of the number of children in the household is closely related to environmental variables. The results indicate that the number of children is positively related to environmental concern and ecologically conscious consumer behaviour, which supports the results of previous studies on environmental concern and environmentally friendly behaviour (Laroche et al., 2001; Loureirro et al., 2002). We can conclude that in this context, possibly due to discussions on ecology at school, children influence environmentally friendly behaviour of their parents. The other explanation could be in line with role theory that parents play the role of responsible adults and try to lead by example.

When testing the joint influence of socio-demographics on environmental concern and ecologically conscious consumer behaviour, there are some differences compared to hypotheses testing. Environmental concern is predicted by gender, age and income below average, with gender having the strongest influence, which is in line with the findings using role theory (Han et al., 2009). Marital status and number of children that were significantly related to environmental concern when tested individually do not have a statistically significant effect on environmental concern. When age was not in the equation, marital status had a statistically significant effect on environmental concern, while the effect of the number of children became significant only after also marital status was excluded from the equation. Despite multicollinearity not being an evident issue in this dataset, a close inspection of the correlations reveals that correlations between the independent variables (marital status, age and number of children below 15 years) are higher than correlations between the respective independent variables and environmental concern), which is a possible explanation why not all of the above mentioned regression coefficients are statistically significant when examined jointly. Ecologically conscious consumer behaviour is predicted by gender, age, marital status and number of children, which is in line with our previous analyses.

The results indicate that in the examined context, socio-demographic variables have substantially larger explanatory power for environmental concern and ecologically conscious consumer behaviour than in more developed economies. For example, in the study on U.S. consumers, conducted by Roberts (1996), socio-demographic variables explained 6% of variance in ecologically conscious consumer behaviour, while for the UK, with slightly different scales, Diamantopoulos et al. (2003) had less than 6% of variance in environmental measures explained (5.7% for environmental attitudes and 3.9% for purchasing behaviour). More recently, Brochado et el. (2017) explained 12.9% of variance in ecologically conscious consumer behaviour with socio-demographic variables, compared to 13.2% for environmental concern and 18.4% for ecologically conscious consumer behaviour in our study. The percentage of variance that remains unexplained indicates there might be other influences, such as psychographic characteristics or the

impact of other situational factors on consumers' purchase decisions rather than socio-demographics. When we included environmental concern as a predictor in the regression analysis of ecologically conscious consumer behaviour, this, as expected, considerably increased the percentage of the explained variance (adjusted R2 is 0.336 compared to 0.184 without environmental concern). However, in transition or post-transition markets where companies do not spend a lot of money on marketing research, this R2 indicates that socio-demographic variables do offer a relevant, although not ideal, base for profiling green consumers.

6.2 Implications for managers and policy makers

Even though in general consumers want to take a part in ecologically conscious behaviour and there are varieties of available options to do so, the environmental impacts from consumption are continuously increasing. Therefore, it is essential that researchers shed more light on consumer behaviour. In that line, this research gives its own impact investigating attitudes toward the environment and ecologically conscious consumer behaviour in the context of a post-transition and heavily polluted country, where this type of research is quite scarce.

Companies can use the results presented in this research in several ways. First, the research offers information about the level of environmental concern and ecologically conscious consumer behaviour in the examined market. This information can be used to assess market readiness for green products and initiatives. Second, the results of testing individual and joint influences on environmental variables can be used in profiling green consumers. Due to not very developed market in terms of marketing research, it is easier for companies to use socio-demographic variables for segmentation of green consumers. This research suggests which variables could be used.

This study also offers some implications for policy makers. It is evident from the results that the general public needs more education to raise environmental awareness and motivation for ecologically conscious consumer behaviour. This is especially the case for younger consumers who scored lower on environmental variables compared to older consumers. The implication for policy makers is to incorporate more environmental content in the curriculum to properly educate the youngest population in the country, even though it might take years to see the effect of the educational system on their higher awareness of environmental issues. Thus the country could be on the right way to create a more environmentally responsible society of active, environmentally conscious consumers and citizens. In the short term, policy makers should offer more financial stimulation for replacing old wood-burning stoves and old cars with greener ones in order to reduce air pollution. In this context ecologically conscious behaviour is not significantly affected by income, but environmental awareness is. The results show that consumers from households with below average income are more environmentally aware than others, but they do not have the budget to transform their environmental attitudes to behaviour.

Additionally, by accepting and implementing the concept of sustainable development, the government develops strategies to promote more ecologically conscious consumer behaviour. Regarding their effectiveness, it is important to understand and evaluate consumer behaviour in order to develop ways which can help to influence consumer behaviour in the desired direction. Thus, the results from the current study concerning the relation between socio-demographic, attitudinal and behavioural factors might be used by all relevant players involved in implementing the strategies for promoting more ecologically conscious consumption in the society. It seems a lot of additional efforts are needed to bring consumers' behaviour into accordance with the sustainable development policy on the national and international levels.

6.3 Limitations and opportunities for future research

As with any research, the present study has its own limitations. One of the limitations is the use of non-probability sampling, which limits its generalization; although, due to a careful selection of respondents, the sample does resemble the population in several characteristics. Nevertheless, the results give insights into the situation on the Macedonian market regarding the current issues of ecologically conscious consumption. In order to achieve a more representative sample, the use of probability sampling is one of the options suggested for further research. Additionally, the respondents gave self-reported responses that might not be entirely accurate because they tended to show their perception of their own behaviour, rather than their actual behaviour. The data was collected outside of the actual buying situation, which might give an inaccurate picture of real decision-making processes. Thus, we suggest that further data collection needs to be performed in real purchase situations in order to examine the relevant product categories more effectively.

The current study can be seen as the beginning of a journey into further research of ecologically conscious consumer behaviour in transition and post-transition contexts. Since the issue with all of its relevant factors has not yet been comprehensively studied in these contexts, there is a great opportunity for further research in the field by examining additional factors that may impact ecologically conscious consumer behaviour. Besides socio-demographic characteristics several psychographic characteristics could be included (e.g., values, attitudes and lifestyles), which would also increase explanatory power. Groening et al. (2018) offer future theoretical directions for green marketing research, especially in the area of behavioural intentions, which can also be tested in the context of transition and post-transition economies. One highly interesting topic for further research could also be the influence of eco-labels on consumer decision making. Another research with great potential could be examining young people's knowledge of sustainability issues in general, which could help find ways to implement appropriate educational strategies in order to motivate, enable, and empower future consumers to engage in more ecologically conscious consumer behaviour and sustainable development processes.

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ARE MIDDLE MANAGERS' COST DECISIONS STICKY? EVIDENCE FROM THE FIELD

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ABSTRACT: *Anderson, Banker, and Janakiraman (2003) show that costs are "sticky" (i.e., costs change relatively less when sales decrease than when sales increase) because managers are reluctant to cut resources when sales decrease. We predict that cost behavior at the middle management level is sticky also when the magnitude of sales increase is sufficiently large, considering that middle managers have more limited ability in adding resources and are more risk averse. Using a survey instrument and interviews, we find evidence that middle managers' cost decisions are sticky at both ends. Our findings are supported by empirical evidence based on segment-level data.*

Key words: *cost stickiness; asymmetric cost behavior; middle manager; resource allocation; budget constraints; risk aversion; business segments*

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1 INTRODUCTION

Anderson, Banker, and Janakiraman (2003, hereafter ABJ) and subsequent studies in the management accounting literature document that costs decrease relatively less when sales decrease than they increase when sales increase by an equivalent amount; i.e., costs are "sticky". While the literature explains such asymmetric cost behavior as a result of asymmetric cost decisions by managers, most studies in cost stickiness literature either examine cost behavior at the corporate level or focus on CEOs as decision makers. In this study, we focus on middle managers who have significant influence on the corporate strategy through day-to-day operational decisions and also have characteristics distinct from those of CEOs or other top managers. Unlike prior studies that rely heavily on archival data to examine cost stickiness, we take a behavioral approach and more directly ask middle managers in practice about their cost decisions, using a survey instrument and interviews in addition to a regression analysis. We find that middle managers' cost decisions are sticky not only when sales decrease but also when the magnitude of sales increase is sufficiently large.

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Cost decisions at the middle management level are important and thus worth examining because of two reasons. First, middle managers are more involved in the day-to-day operations of a company than top managers and are also likely to be the ultimate decision makers for the business unit and thus can have significant influence on the firm's overall costs (Kanter, 1982). Second, at the same time, middle managers' cost decisions are likely to be different from those of top managers because middle managers are likely to (1) have more limited ability in adding resources due to limited annual budgets and corporate-level policies or strategies to follow, which are typically set by top managers (Williamson, 1975; Mueller, 2003), and (2) be more risk averse because of their compensation structure, which is focused relatively more on fixed salary and less on incentives such as cash bonus and equity-based compensation.

To examine cost behavior at the middle management level, we conducted both a survey and field interviews, directly asking middle managers in practice to describe their decisions related to various types of costs, including overall SG&A costs, under various situations regarding the change in sales revenue. The analysis results based on the detailed interviews and 152 survey responses indicate that middle managers' cost decisions are sticky when sales decrease (or, to be more accurate, when the magnitude of sales decrease is sufficiently large), consistent with the findings in the previous empirical studies, and also when the magnitude of sales *increase* is sufficiently large. To complement our behavioral findings, we also conducted an empirical analysis using segment level data. The regression results based on 26,050 segment/year observations support our prediction and behavioral findings.

Our study contributes to the accounting and management literature in several ways. First, using a survey instrument and field interviews, we provide direct evidence that managers' resource capacity decisions are sticky, which supports the explanations in the previous studies based on empirical models and archival data (e.g., ABJ). Second, more importantly, we provide an additional insight that at least at the middle management level costs are sticky not only when sales decrease but also when a firm experiences a sufficiently large increase in sales revenue.

The rest of the paper is organized as follows. In Section 2, we review the prior literature on cost stickiness and middle managers and provide our research hypothesis. In Section 3, we describe the design and procedures of the survey instrument and interviews. Section 4 presents our data and summary statistics. In Section 5, the results of the quantitative and qualitative analyses are presented, followed by the conclusion in Section 6.

2 LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Cost stickiness

The asymmetric cost behavior, called "cost stickiness," was first documented by ABJ. Using archival data spanning 20 years (from 1979 to 1998), ABJ showed that costs decrease less when sales fall than they increase when sales rise by an equivalent amount. ABJ argued that the fundamental reason for cost stickiness is that changing the levels of committed resources is costly. Adjustment costs include severance pay when employees are laid off, recruiting and training costs when new employees are hired, as well as organizational costs such as loss of morale among the remaining employees when colleagues are terminated. Because of the adjustment costs, managers will choose to retain unutilized resources to some extent when sales decline and there is uncertainty about the permanence of a decline in demand. In contrast, when demand increases beyond the available resource capacity, managers do not have as much discretion in adding resources because not doing so would result in losing not only current sales but also future sales because of disappointed customers. As a result of the asymmetry in resource capacity decisions, costs become sticky, i.e., costs decrease relatively less when sales fall than they increase when sales increase by an equivalent amount.

Consistent with this explanation, previous studies have shown that the degree of cost stickiness is related to macroeconomic factors and firm-specific factors which constrain resource adjustment. For instance, ABJ find that the cost stickiness is weaker when sales revenue also declined in the preceding period, stronger during periods of macroeconomic growth, and positively associated with the asset intensity and the employee intensity. Balakrishnan, Petersen, and Soderstrom (2004) find that the degree of cost stickiness is influenced by capacity utilization. Banker, Byzalov, and Chen (2013) focus on cross-country differences and find that the degree of cost stickiness is increasing in the strictness of employment protection legislation, consistent with ABJ's adjustment cost theory.

While the literature explains the asymmetric cost behavior using asymmetric cost decisions of managers, behavioral factors affecting the cost decisions have been largely ignored in the prior literature. A few exceptions are Dierynck, Landsman, and Renders (2012), Kama and Weiss (2013), Chen, Lu, and Sougiannis (2012), and Banker, Jin, and Mehta (2018), all of whom focused, either explicitly or implicitly, on CEOs as the ultimate decision makers. Dierynck, Landsman, and Renders (2012), and Kama and Weiss (2013) find that incentives to avoid losses and earnings decreases or to meet financial analysts' earnings forecasts managers expedite downward adjustments of slack resources when sales fall, lessening cost stickiness. Chen, Lu, and Sougiannis (2012) find that managers' incentives to grow the firm beyond its optimal size or to maintain unutilized resources with the purpose of increasing personal utility from status, power, compensation, and prestige (i.e., empire building incentives) induce greater cost stickiness. Banker, Jin, and Mehta (2018) focus on managerial decision horizon and show that short-term cash bonus provides managers with incentives to cut more slack resources and thus induce less cost stickiness while long-

term incentives, such as stock option and restricted stock award, extend the managerial decision horizon and thus induce more cost stickiness.

2.2 Middle managers

While prior studies in the cost stickiness literature generally regard a firm's cost behavior as a result of the asymmetry in the cost decisions either at the corporate level or by top management, many cost-related decisions, including employment, asset acquisition, and overall SG&A spending decisions, are made by middle managers, such as department managers and regional managers, especially in decentralized firms. Middle managers and their business decisions are important mainly because middle managers have significant influence on strategic decision making process of the company. Middle managers are more involved in the day-to-day operations of a company than top managers and are often said to have their fingers on the "pulse of operation" (Kanter, 1982). Because of their deep involvement into the day-to-day operations, middle managers have the opportunity to report valuable information and suggestions from the inside of a company (Likert, 1961), which makes them play a critical role in the corporate level decision making process. By using bottom-up management processes, they communicate information and propose issues for top management (Floyd & Wooldridge, 1994; Dutton & Ashford, 1993; Dutton et al., 1997).[3] The significant influence of middle managers on corporate decisions, including investment in resource capacity decisions, suggests that firm-level cost behavior is also heavily affected by middle management decisions.

What makes middle managers and their cost decisions even more important and thus worth examining is that middle managers have characteristics distinct from those of top managers. First, middle managers are likely to have more constraints in the decision making process than top managers. The primary responsibility of a middle manager is to implement a strategy, set by the top management, in an effective and efficient manner (Floyd & Wooldridge, 1997; Huy, 2002; Delmestri & Walgenbach, 2005). During the implementation process, however, middle managers tend to have limited ability in adding resources, including human resources and long-term assets. Such a limit is typically set by top managers only. Managerial discretion arises, at least partly, from the authority to allocate the funds of the company to pursue their own interests (Mueller, 2003). This suggests that if middle managers are given too much power on resource allocation and pursue their own interests, for example, performance of the department, fewer resources or funds will be left for top managers who have their own interests, for example, company-level performance (Fama & Jensen, 1983; Eisenhardt, 1989). Thus, top managers tend to restrict middle managers' ability and monitor their behaviors in order to prevent middle managers from wasting the resources of the company and thereby limiting the top management's ability to utilize such resources (Williamson, 1975; Mueller, 2003).

3 For more insights into middle managers' involvement in the strategy or decision making process, see Burgelman (1983), Floyd & Wooldridge (1992a, 1992b, 1997, 1999), Huy (2001, 2002), Kanter (1988), Westley (1990), and Wooldridge & Floyd (1990).

Another distinctive characteristic of middle managers is that they are generally more risk averse than top managers because their future is narrowly dependent on their current tasks (Eisenhardt, 1989; Gomez-Mejia & Balkin, 1992; Shimizu, 2012). According to the agency theory, principals use various forms of non-salary components in the compensation package, such as cash bonus or long-term equity incentives, to provide risk-averse agents with incentives to take risk (Jensen & Meckling, 1976; DeFusco, Johnson, & Zorn, 1990; Murphy, 1999; Rajgopal & Shevlin, 2002). However, the portion of non-salary incentives is substantially smaller for middle managers compared to CEOs and other top managers (Belcher & Atchison, 1987), suggesting that managerial decisions of middle managers are likely to be more risk averse than those of top managers.

2.3 Research hypothesis

The distinctive characteristics of middle managers suggest that cost behavior at the middle management level may look different from that at the company or top management level. In specific, the cost stickiness theory assumes that companies' or top managers' ability to add resources are relatively less limited than their ability to cut slack resources, and as a result the relation between sales change and cost change is kinked at the point where sales change equals zero, as illustrated in Figure 1A. On the other hand, the middle managers' ability to change the level of cost or investment is limited for both adding and cutting as discussed above. In addition, middle managers, who are relatively more risk averse than top managers, are less likely to increase cost or investment substantially when the company or the business unit experiences a huge increase in revenue, concerning the permanence of the increase in demand. Based on this intuition, we formulate our main hypothesis as follows:

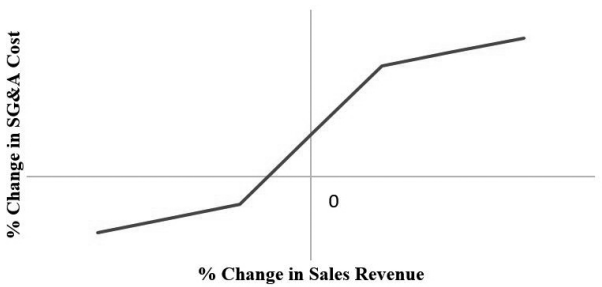
> Hypothesis: Middle managers' decisions to change the level of cost or investment are "sticky" when the magnitude of sales change is sufficiently large.

In other words, we predict that at the middle management level, costs change relatively less not only when sales decrease (or when the magnitude of sales decrease is large), but also when the magnitude of sales *increase* is sufficiently large. This suggests that the relation between sales change and cost change at the middle management level is expected to be kinked at two different points as illustrated in Figure 1B. The main objectives of this study include (1) examining how costs behave at the middle management level (and especially if the cost behavior is consistent with our prediction) and (2) providing an explanation for the observed behavior based on qualitative information obtained through the survey and the interviews.

Figure 1: *Graphical illustrations of SG&A cost behavior*

Figure 1A Asymmetric SG&A cost behavior (Anderson et al., 2003)

Figure 1B Middle management's SG&A cost behavior with two kinks



Note: Figure 1A, drawn based on the theory of Anderson, Banker, and Janakiraman (2003), illustrates the asymmetric SG&A cost behavior, "cost stickiness". The relation can be described as SG&A costs changing relatively less when sales decrease than when sales increase by an equivalent amount. The line is kinked at % change in sales revenue = 0. The y-intercept is not necessarily zero.
Figure 1B illustrates the behavior of SG&A costs at the middle management level. The non-linear costs-sales relation can be described as SG&A cost changing relatively less when the change in sales revenue is sufficiently large in magnitude. The flatter parts at both ends are not necessarily parallel to each other.

3 METHODOLOGY

3.1 Surveys and interviews

To examine the characteristics of middle management cost decisions and also to complement prior studies in the cost stickiness literature, we use a combination of a survey instrument and field interviews in this study. The prior literature on cost stickiness relies heavily on archival firm-level data. The main advantage of using archival data is

that it enables researchers to perform relatively objective analyses based on historical real data. As discussed by Graham, Harvey, and Rajgopal (2005), however, studies based on archival analyses can also suffer from several weaknesses related to model/variable specification. In most cases, a regression analysis cannot be entirely free from model/variable misspecification or measurement error. Sometimes it is also difficult to develop a good economic proxy. Another weakness of archival studies is the inability to ask qualitative questions. In contrast, surveys and interviews provide an opportunity to ask managers very specific and qualitative questions about the motivation behind managerial decisions without relying on potentially misspecified regression models (Graham, Harvey, & Rajgopal, 2005). On the other hand, potential caveats related to surveys and interviews include subjective or biased inputs from survey respondents or interviewees.

In this study, we mainly use a combination of a survey instrument and field interviews for the purpose of complementing those archival studies in the prior literature. Specifically, surveys and interviews enable us to examine the characteristics of middle managers' resource capacity decisions without worrying about any model specification issues which have been previously addressed in the literature (e.g., Balakrishnan, Labro, & Soderstrom, 2014; Banker & Byzalov, 2014). In addition, surveys and field interviews provide us with an opportunity to identify factors affecting managerial resource capacity decisions, which are not easily identifiable using archival data. Considering the potential caveats associated with surveys and interviews, we also conduct an empirical analysis based on archival data as an additional analysis to back up our main findings from the surveys and interviews.[4]

3.2 Research design

We developed a survey instrument based on a review of the cost stickiness literature. In specific, we designed the main survey questions to ask how a manager's decisions to adjust overall SG&A expenditure, as well as the capacity level of individual resources, including human resources, long-term assets, raw materials and merchandises, vary under hypothetical scenarios regarding sales change. In addition, qualitative questions were asked to identify limitations in the resource capacity decisions and other affecting factors. The survey contained 25 questions including: 13 questions about respondents and their companies and 12 quantitative and qualitative questions addressing their cost decisions.

The interviews were designed to obtain more detailed qualitative information about decision behavior at the middle management level, as well as impact factors and limitations in the decision making process. The potential interviewees were contacted using our personal network, a basic introduction was provided through a telephone/email briefing and then the 25 survey questions were sent. The main telephone interviews asking about detailed decision-making mechanisms were conducted about a week after the survey questionnaires were sent.

4 See Section 5.3 for the detailed model and sample data for the empirical analysis.

4 DATA

We used the Cint service to recruit 175 U.S.-based respondents who were identified as middle managers.[5,6] After manually identifying 23 responses with an error (e.g., using dollar amounts instead of percentages) and spam responses, 152 valid responses remained for quantitative and qualitative analyses. Table 1 presents self-reported summary information about demographic characteristics of the sample companies and respondents. The survey gathered information frequently used in empirical research for subsample analyses to consider potential conditioning effects.

Table 1: *Summary statistics*

Panel A – Demographic characteristics of sample companies (n = 152)

Avg. sales revenue for past 5 years	Percent	*Years of operation*	Percent
< $200,000	4.6	0-5 years	3.9
$200,000 - $500,000	7.9	5-10 years	25.0
$500,000 - $1,000,000	17.8	10-20 years	28.9
$1,000,000 - $1,500,000	21.1	20-30 years	21.7
$1,500,000 - $2,000,000	15.8	> 30 years	20.4
> $2,000,000	32.9		
SG&A as % of sales revenue		*Industry*	
0-5%	3.9	Construction	17.8
5-10%	21.7	Manufacturing	15.1
10-20%	27.6	Transportation and Utilities	5.3
20-30%	23.0	Wholesalers and Retailers	7.9
30-50%	16.4	Financial Services	12.5
> 50%	7.2	Business Services	17.8
		Consumer Services	13.8
Number of employees		Public Administration and Other	9.9
≤ 10	2.6		
11-50	18.4		
51-100	17.8		
101-500	28.9		
> 500	32.2		

5 Cint is a market research company which has access to a large number of preregistered members who vary in demographics and other social characteristics (e.g., occupation or title). Once a client selects a target respondent group, Cint sends the client's survey until it collects a predetermined number of responses. Our survey was sent to 459 middle managers in the U.S. and completed by 175 of them (i.e., the response rate was 38.3%).

6 In the survey, a qualifying question asking respondents to self-identify their job title was also included.

Panel B – Demographic characteristics of sample managers (n = 152)

Primary responsibility	Percent	*Gender*	Percent
Hiring	5.9	Male	64.5
Purchasing	7.2	Female	35.5
Production	15.1		
Sales & Marketing	11.2	*Age*	Year
Accounting & Finance	11.8	Mean	39
Administration	19.1	25th percentile	32
General management	29.6	50th percentile (median)	36
		75th percentile	42
Experience at current position			
0-3 years	15.1	*Total annual compensation*	$ thousand
3-5 years	21.7	Mean	82.6
5-10 years	40.1	25th percentile	60.0
10-15 years	17.8	50th percentile (median)	80.0
> 15 years	5.3	75th percentile	100.0
Experience in current industry		*Composition of compensation package (as % of total comp.)*	Avg. Percent
0-3 years	5.3	Fixed salary	70.9
3-5 years	14.5	Short-term cash bonus	11.7
5-10 years	32.9	Long-term incentives	7.0
10-15 years	23.7	Pension	5.3
> 15 years	23.7	Perks and other	5.1

Note: Table 1 presents demographic characteristics of sample companies (Panel A) and managers (Panel B). Revealing the dollar amount of total annual compensation was optional. 151 out of 152 respondents chose to answer this question.
For the mean calculation, all amounts greater than $150,000 were treated equal to $150,000. Considering only six out of 151 valid responses were $150,000, the effect of potential understatement is expected to be minimal.

Panel A of Table 1 presents descriptive statistics of the sample companies. Our sample companies range from small to large in terms of average sales revenue and number of employees. In specific, 30.3% of the sample firms were relatively small with less than $1 million of average sales revenue, while 32.9% were relatively large firms earning more than $2 million of sales revenue per year. Also, 32.2% of the firms had more than 500 employees. For more than half of the companies, SG&A costs were between 10% and 30% of sales revenue, comparable to the statistics reported in the previous archival studies (e.g., ABJ). Most of the companies (96.1%) have operated for more than five years. The industry

distribution indicates that the sample firms are from a wide range of industries, which reduces the concern with sample clustering.

Panel B reports demographic information of the sample managers (i.e., survey respondents). While various roles are played by sample managers, the largest group consists of general managers (29.6%), who are expected to have the most influence over SG&A spending for the business unit. Most of the respondents have experience of 3 years or longer either at their current position or in the current industry. The mean age was 39 and about two thirds of the sample managers were male. On average, total annual compensation was $82.6 thousand, which consists of 70.9% of fixed annual salary, 18.7% of short-term or long-term incentives, and 10.4% of other types. The large portion of fixed salary suggests that the compensation structure of middle managers is very different from that of top executives who typically receive significant portions of total compensation as incentives.[7]

5 RESULTS

5.1 Quantitative analysis

5.1.1 SG&A cost decisions of middle managers

To gauge the degree to which middle managers are willing to change the overall SG&A spending for a given sales change, we asked the following hypothetical question:

Hypothetical question: Assume sales have been increasing for the past five years. How much change in SG&A costs would you make under the following situations?[8]

1. when sales growth this year is 0%?

2. when sales increase by 5%? 10%? 15%?

3. when sales decrease by 5%? 10%? 15%?

The two extreme situations, 15% increase and 15% decrease, are still considered within the normal range of annual sales change, which also means that the responses for these scenarios are considered a normal operational decision. The assumption of past sales

7 Banker, Jin, and Mehta (2018) report that on average, a CEO of a S&P 1500 company receives 68.2% of the total compensation in the form of incentives.

8 The survey asked respondents' decisions regarding SG&A costs, as well as other cost items. The responses for SG&A cost, the main cost item in the cost stickiness literature, are separated from others for reporting purposes. See Table 3 for responses for the rest of the cost items.

increase was given considering that managers' positive expectation for future sales is the main assumption in the cost stickiness theory (ABJ).[9]

Table 2: *Survey responses to the question: "How much change in SG&A costs would you make under the following situations?"*

	Change in SG&A costs (%)					
Hypothetical situation	*Mean*	*Comparison with prior range*	*One-tailed p-value*	*25th percentile*	*50th percentile (median)*	*75th percentile*
When sales growth this year is 0%	4.53%			0.00%	5.00%	5.00%
When sales increase by …						
5%	6.40%	+1.87%***	0.01	0.75%	5.00%	6.00%
10%	7.03%	+0.63%	0.31	1.00%	5.00%	7.25%
15%	7.28%	+0.26%	0.39	2.00%	5.00%	10.00%
When sales decrease by …						
5%	2.78%	-1.75%***	< 0.01	0.00%	0.00%	5.00%
10%	2.85%	+0.07%	0.54	0.00%	0.00%	5.00%
15%	2.06%	-0.79%*	0.07	0.00%	0.00%	5.00%

Note: Table 2 summarizes the survey response to the question "How much change in SG&A costs would you make" under various scenarios regarding sales change. Respondents are given the assumption that sales have been increasing for the past five years.
"Comparison with prior range" column presents the mean comparison between ranges regarding sales change. For ranges of sales *increase*, it is tested whether the mean SG&A cost change for the range is statistically *larger* than that for the previous sales increase range. (E.g., for the situation of +10% sales change, it is tested whether the mean response is statistically greater than the mean response for the +5% sales change.) For ranges of sales *decrease*, it is tested whether the mean SG&A cost change for the range is statistically smaller than that for the previous sales decrease range. (E.g., for the situation of -10% sales change, it is tested whether the mean response is statistically *smaller* than the mean response for the -5% sales change.) *, **, and *** denote significance at levels of 0.1, 0.05, and 0.01, respectively.

Table 2 presents the summary of the responses. Empirical studies in the cost stickiness literature generally use the zero sales change as the point where the slope of the sales-costs relation changes, meaning the cost decisions at zero sales growth may serve as a benchmark when examining whether the cost behavior is sticky. On average, the respondents indicate that they are willing to increase overall SG&A costs by 4.53% even when sales revenue does not grow at all in the current period. A potential explanation for this positive cost change is that the managers are optimistic and believe the sales will rise in the future. Considering

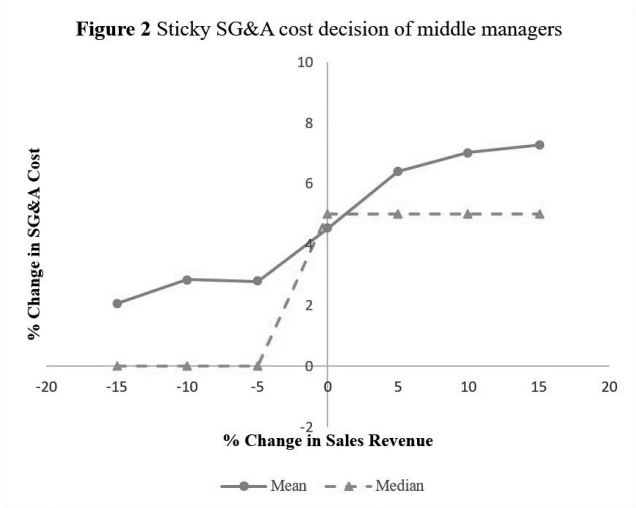
9 Prior literature also finds that costs are "anti-sticky" (i.e., costs change relatively more when sales decrease than when sales increase) when managers are pessimistic about future sales revenue (Banker et al., 2014).

the respondents are middle managers, another explanation is that there is a corporate-level strategy or policy to follow regarding the minimum level of SG&A spending.

Next, the responses for the scenarios of sales increase indicate that middle managers tend to increase overall SG&A spending as expected sales growth increases, as intuitively expected. More interestingly, the increase in SG&A cost change is mitigated as sales growth increases, suggesting that middle managers increase SG&A spending relatively less when the magnitude of sales increase is large compared to when the magnitude of sales increase is small. In particular, the mean response was to add 1.87% (= 6.40% - 4.53%) extra SG&A spending when sales growth changes from 0% to +5%. However, the extra increase in SG&A spending drops to 0.63% (= 7.03% - 6.40%) when sales growth changes from +5% to +10% and further drops to 0.25% (= 7.28% - 7.03%) when sales growth changes from +10% to +15%. The difference in means was statistically significant only for 0% vs. +5% and insignificant at the conventional level of significance for +5% vs. +10% and +10% vs. +15%. This is consistent with our expectation based on the characteristics of middle management including limited ability in adding resources and risk aversion.

Last, the responses for the scenarios of sales decrease indicate that middle managers tend to reduce the increase in overall SG&A spending as sales decrease, again, as intuitively expected. Similarly to the case of sales increase, the degree of the SG&A cost change is relatively smaller when the sales decrease is large compared to when the sales decrease is small. In particular, the extra cut in the SG&A spending was 1.75% (= 4.53% - 2.78%, p-value < 0.01) when sales growth changes from 0% to -5%. However, the cut in the SG&A cost is substantially mitigated when sales growth drops further. In particular, the difference in mean cost changes between -10% and -15% sales growth scenarios is statistically insignificant. The additional SG&A cut when sales growth further drops from -10% to -15% was 0.79% (= 2.85% - 2.06%, p-value = 0.07), which is insignificant at the conventional level of significance (p-value < 0.05) and much smaller in magnitude compared to 1.75%, the SG&A cut for the sales growth range between 0% and -5%. The relatively smaller decrease in SG&A costs for a large sales decrease is consistent with the empirical findings in the prior cost stickiness literature (e.g., ABJ). It is also consistent with our expectation based on (1) limited ability of middle managers and (2) risk aversion by middle managers.

Figure 2: *Sticky SG&A cost decision of middle managers*



Note: Figure 2 presents the mean and median survey responses to the question "How much change in SG&A costs would you make?" given the sales growth in this year is 0%, +5%, +10%, +15%, -5%, -10%, and -15%. The respondents are given the assumption that sales have been increasing for the past five years.

Figure 2 graphically summarizes the non-linear SG&A cost decisions of middle managers observed from the survey responses. For the line representing the mean responses, the slope is relatively steeper when the sales change is relatively small in magnitude (from -5% to +5%) and relatively flatter when the sales change is relatively large in magnitude (-5% or lower and +5% or higher). Similarly, the median response of 0% of SG&A cost change for -5% sales change does not decrease further when the magnitude of sales decrease gets larger and the median response of 5% for zero sales growth does not rise when the expected sales growth increases. Overall, the non-linear cost behavior of middle managers shown in Figure 2 is consistent with our expectation.

The shape of the two plots in Figure 2 also suggests that while the empirical models in the prior cost stickiness literature generally use zero sales growth as the point where the slope changes, the change in managerial behavior may not be triggered by a mere sales decrease. Figure 2 suggests that it is rather a "sufficient large" sales decrease. More generally, the cost behavior at the middle management level can be described as costs changing relatively less when the magnitude of sales change (i.e., sales increase or decrease) is sufficiently large.[10]

10 The criteria for being "sufficiently large" are not necessarily the same for sales increase and for sales decrease.

5.1.2 Other cost and investment decisions of middle managers

While the prior literature on cost stickiness focuses on SG&A costs, where managers are supposed to have the most discretion, we also examine middle managers' decisions regarding other cost and investment items. Similarly to the main questions about SG&A cost decisions, we asked the following question for (1) human resources (i.e., hiring and firing), (2) investment in fixed assets (e.g., machine and equipment), and (3) investment in intangible assets (e.g., patent and software):

Hypothetical question: Assume sales have been increasing for the past five years. How much change in cost or investment would you make under the following situations?

1. when sales growth this year is 0%?

2. when sales increase by 5%? 10%? 15%?

3. when sales decrease by 5%? 10%? 15%?

For these cost and investment decisions on which managers are supposed to have relatively smaller discretion compared to that on SG&A cost decisions, we excluded responses of the managers who self-reported that they have weak or no discretion on the corresponding decision.

The survey responses summarized in Table 3 and Figure 3 show a pattern very similar to that of SG&A cost decisions shown in Table 2 and Figure 2. In specific, the mean and median responses show that the change in the cost or investment is less sensitive to the change in sales revenue when the magnitude of sales change is relatively large. This suggests that first, similarly to the case of SG&A costs, the magnitude of employee layoffs or cut in asset investments by middle managers is relatively small when the magnitude of sales decline is sufficiently large, consistent with the cost stickiness theory and our prediction. Second, also similarly to the case of SG&A costs, middle managers do not want to substantially increase the number of employees or investments in assets when experiencing a sales boom, which is consistent with our hypothesis.

Table 3: *Survey responses to the question: "How much change in cost or investment would you make under the following situations?"*

	Change in number of employees (%)		*Change in fixed asset investment (%)*		*Change in intangible asset investment (%)*	
Hypothetical situation	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*
When sales growth this year is 0%	6.02%	2.00%	6.24%	4.00%	4.98%	5.00%
When sales increase by …						
5%	6.48%	5.00%	5.58%	4.00%	6.40%	5.00%
10%	9.15%	5.00%	7.03%	5.00%	7.03%	5.00%
15%	8.92%	5.00%	7.28%	5.00%	7.28%	5.00%
When sales decrease by …						
5%	3.58%	0.00%	2.78%	0.00%	2.78%	0.00%
10%	2.75%	0.00%	2.85%	0.00%	2.85%	0.00%
15%	2.52%	1.00%	2.06%	0.00%	2.06%	0.00%

Note: Table 3 summarizes survey responses to the question asking the intended level of change in number of employees, fixed asset investment, and intangible asset investment. The responses of managers who self-reported that they have weak or no discretion on the corresponding cost or investment item are excluded. The number of responses is 130 for employment, 117 for fixed asset investment, and 126 for intangible asset investment. Respondents are given the assumption that sales have been increasing for the past five years.

Figure 3: *Employment and asset investment decisions of middle managers*

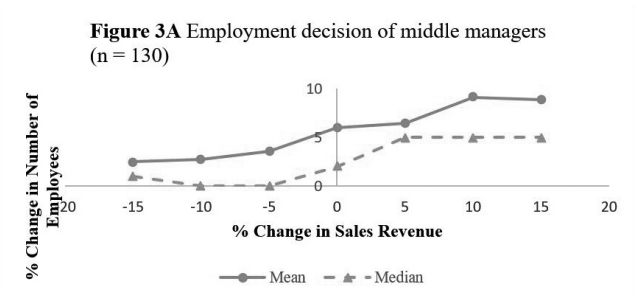


Figure 3B Fixed asset investment decision of middle managers (n = 117)

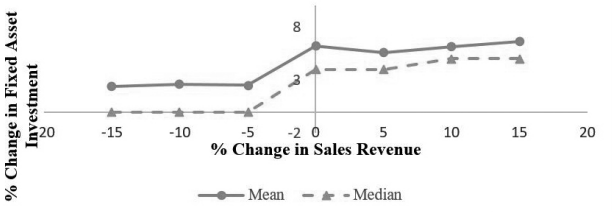
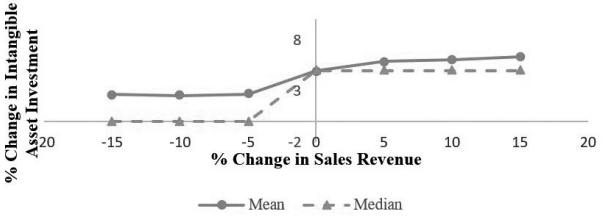


Figure 3C Intangible asset investment decision of middle managers (n = 126)



Note: Figure 3 presents the mean and median survey responses to the question "How much change in cost or investment would you make?" given the sales growth in this year is 0%, +5%, +10%, +15%, -5%, -10%, and -15%. The respondents are given the assumption that sales have been increasing for the past five years. Figures 3A, 3B, and 3C are for the number of employees, fixed asset investment, and intangible asset investment, respectively.

5.1.3 Subsample analysis of the impact of compensation structure

One of our explanations for the reverse Z-shaped cost behavior at the middle management level is that middle managers are likely to be more risk averse than top managers, due to their compensation structure which includes a relatively small portion of incentives. To test the validity of this explanation, we conducted a subsample analysis. Using the median value of total incentives as a percentage of total annual compensation (20.0%), we constructed two subsamples and repeated the main analysis described above for each of the two subsamples.[11]

11 Total incentive is defined as the sum of short-term cash bonus and long-term incentives.

Table 4: *Subsample analysis of the impact of the compensation structure*

	Change in SG&A costs (%)					
	Managers with small incentives (≤ 20% of total compensation) (n = 101)			*Managers with large incentives (> 20% of total compensation) (n = 51)*		
Hypothetical situation	*Mean*	*Comparison with prior range*	*50th percentile (median)*	*Mean*	*Comparison with prior range*	*50th percentile (median)*
When sales growth this year is 0%	4.94%		5.00%	3.73%		2.00%
When sales increase by …						
5%	7.06%	+2.12%**	5.00%	5.10%	+1.37%**	3.00%
10%	7.72%	+0.66%	5.00%	5.65%	+0.55%	5.00%
15%	7.37%	-0.36%	5.00%	7.12%	+1.47%**	5.00%
When sales decrease by …						
5%	2.45%	-2.49%***	0.00%	3.45%	-0.27%	2.00%
10%	2.71%	+0.27%	0.00%	3.12%	-0.33%	2.00%
15%	2.07%	-0.64%	0.00%	2.04%	-1.08%	2.00%

Note: Table 4 presents the results of the subsample analysis performed to examine the impact of the compensation structure on cost decisions. Using the median value of total incentives (= cash bonus + long-term incentives) as a percentage of total compensation, two subsamples have been constructed. "Comparison with prior range" column presents the mean comparison between ranges regarding sales change. For ranges of sales *increase*, it is tested whether the mean SG&A cost change for the range is statistically *larger* than that for the previous sales increase range. (E.g., for the situation of +10% sales change, it is tested whether the mean response is statistically greater than the mean response for the +5% sales change.) For ranges of sales *decrease*, it is tested whether the mean SG&A cost change for the range is statistically *smaller* than that for the previous sales decrease range. (E.g., for the situation of -10% sales change, it is tested whether the mean response is statistically smaller than the mean response for the -5% sales change.) *, **, and *** denote significance at levels of 0.1, 0.05, and 0.01, respectively.

Figure 4: *Subsample analysis of the impact of compensation structure*

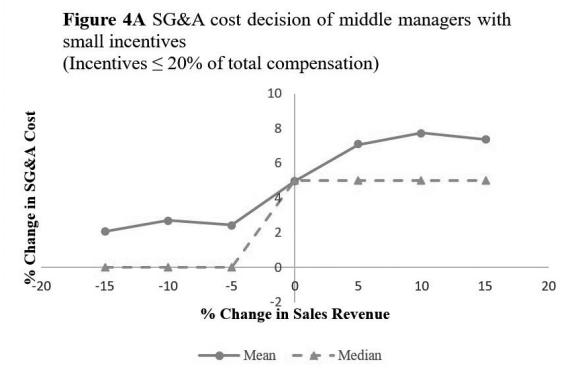


Figure 4B SG&A cost decision of middle managers with large incentives
(Incentives > 20% of total compensation)

Note: Figure 4 presents the mean and median survey responses to the question "How much change in SG&A costs would you make?" for two subsamples constructed based on the compensation structure. The respondents are given the assumption that sales have been increasing for the past five years. Figure 4A summarizes the responses of the managers who receive equal to or less than 20% of total compensation as incentives. Figure 4B summarizes the responses of the managers who receive more than 20% of total compensation as incentives.

Table 4 and Figure 4 present the results of the subsample analysis. For the middle managers who receive relatively small incentives (equal to or less than 20% of total compensation), the responses remain very similar to those for the main sample (i.e., change in SG&A costs is relatively small when the magnitude of sales change is large). On the other hand, the responses of the middle managers who receive relatively large incentives (greater than 20% of total compensation) show that the "sticky" cost behavior at the higher end is less significant. In specific, Table 4 shows that the increase in the mean response when sales growth increases from 10% to 15% is statistically significant (one-tailed p-value = 0.025), suggesting that the increase in SG&A spending is not mitigated even when sales growth reaches 15%. The median also rises at least until the sales growth reaches 10%, unlike the case for the main sample or the subsample of middle managers with small incentives where the median does not increase at all in the range of increasing sales. The difference in the cost behavior between the two subsamples can be more easily identified in Figure 4. Overall, the result of the subsample analysis suggests that middle managers who receive compensation relatively more in the form of incentives are less likely to slow down in adding resources when experiencing a sales boom, which supports our expectation that incentive compensation mitigates the risk-averse behavior of managers.

5.2 Qualitative analysis

5.2.1 Survey

To obtain a better understanding of the cost behavior at middle management level, we also asked qualitative questions in the survey in addition to the quantitative questions discussed above. First, we asked which factors affected their cost decisions in the quantitative section. From the prior literature on cost stickiness, we obtained potential factors as follows:

- Economy
- Company's past performance
- Long-term relation between company and employees
- Morale of employees
- Short-term cash bonus
- Long-term incentives
- Expenses related to hiring/firing process (e.g., training fees, severance pay)
- Expenses related to machine/equipment (e.g., installation fees, transportation fees)

The question has been asked using a 5-point Likert scale from 1 to 5 (1=No impact, 2=Minor impact, 3=Neutral, 4=Moderate impact, 5=Major impact). In addition, we also asked if there were any other factors which affected their decision-making process.

Figure 5: *Factors affecting middle managers' cost decisions*

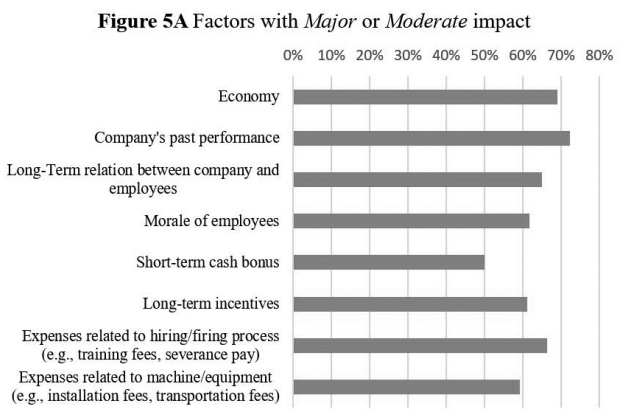
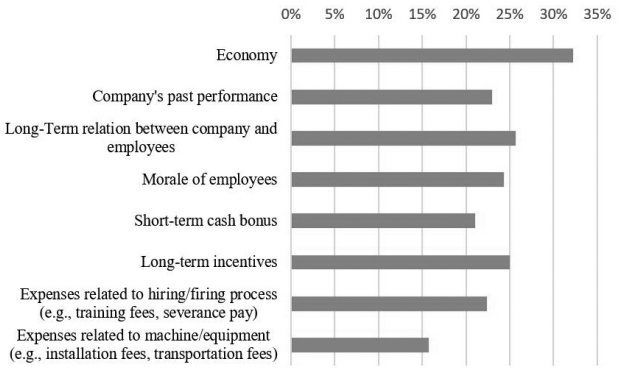


Figure 5B Factors with *Major* impact



Note: Figure 5 summarizes the survey responses regarding factors affecting cost decisions at the middle management level. For each factor obtained from the prior literature, respondents were asked to indicate the significance of the impact using a 5-point Likert scale (1=No impact, 2=Minor impact, 3=Neutral, 4=Moderate impact, 5=Major impact).

Figure 5 summarizes the responses regarding the impact of each factor. Figure 5A shows that all the potential factors were identified to have at least a moderate impact by 50% or more respondents. A relatively small number of respondents indicated short-term cash bonus (50.0%) or long-term incentives (61.2%) as a factor with a major or moderate impact, consistent with the fact that only 11.7% and 7.0% of total compensation are received in the form of short-term cash bonus and long-term incentives, respectively. Figure 5B shows that the most respondents (32.2%) selected the economy as a factor with a major impact on their cost decisions, which supports the argument in the prior literature that the economic condition affects managers' belief about permanence of the current sales decline, ultimately affecting their cost decisions (ABJ; Banker et al., 2014). Again, a relatively small number of respondents (21.1%) chose short-term cash bonus as a factor with a major impact on their cost decisions.

The respondents also indicated that their cost and investment decisions are affected by several factors in addition to those provided from the survey. Based on their nature, we classified those additional factors as follows:

- Factors restricting middle managers' cost or investment decisions
  - Annual budget or availability of cash
  - Minimum acceptable rate of return
  - Availability of qualified labor force
  - Long-standing contracts with suppliers
  - Corporate level strategy

- Other additional factors
  - General trend in business or market
  - Behavior or strategy of main competitor(s)
  - Needs from customers or clients

Consistent with our prediction, many respondents indicated that there are factors which limit their cost or investment decisions. First, annual budget and availability of cash directly limit the middle managers' ability to add resources. Also, minimum acceptable rate of return, which is often demanded by top managers, forces middle managers to limit their expenses to maintain a high return. In addition, middle managers' employment-related decisions are also affected by availability of qualified labor force for the current period. These factors are likely to set the upper limit in increasing costs, consistent with the relatively small increase in costs when the sales increase is large as shown in Table 2 and Figure 2. On the other hand, long-standing contracts with suppliers are likely to set a contractual minimum (i.e., the lower limit) for raw material or merchandise purchase per year, resulting in limited ability in cutting resources, consistent with the relatively small change in costs when the magnitude of sales decrease is large. Many respondents also indicated their decisions are significantly affected by corporate- or top management-level strategy such as globalization or increasing market share, which can set either an upward limit or a downward limit, depending on its nature.

Respondents also reported additional factors which do not necessarily restrict their decisions. Those factors include (1) general trends in the market or industry, (2) strategy or behavior of their major competitors, and (3) needs from their clients or customers. These responses confirm the widely-accepted fact that management decisions are heavily influenced by Porter's (1979) five forces (i.e., industry rivalry, bargain powers of buyers/suppliers, threats of new entrants/substitutes).

Last, the survey directly asked the participants if there was any personal or corporate policy or strategy to follow regarding the maximum and minimum levels of cost or investment. The results summarized in Figure 6 show that a significant number of respondents have a certain policy to follow when making cost or investment decisions. In specific, 37.1% of valid responses indicated the existence of a personal or corporate policy regarding the maximum level of cost or investment. Specific examples include an increase in SG&A expenses by a maximum of 5% from the prior period's expenses, a maximum number of line workers limited due to factory or equipment capacity, maximum SG&A spending limited to the annual budget, etc. Regarding the minimum level of cost or investment, 42.3% of valid responses indicated the existence of a restricting policy. Examples include an increasing number of temporary workers by 1% every year, not cutting SG&A spending regardless of performance, spending all the budget given for the period, etc. Interestingly, the annual budget seems to serve as both the upper limit and the lower limit for cost and investment decisions.

Overall, the result of the qualitative analysis suggests that middle managers are likely to face the upper limit and/or the lower limit when making a cost or investment decision, which explains the reverse Z-shape of cost-sales relation identified from the quantitative analysis.

Figure 6: *Existence of policy, strategy, or norm regarding the minimum or maximum level of annual investment*

Figure 6A Existence of policy or strategy for *Maximum* level of cost or investment

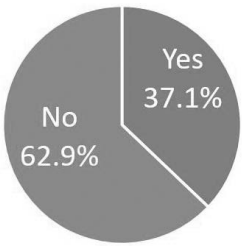
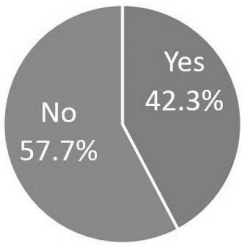


Figure 6B Existence of policy or strategy for *Minimum* level of cost or investment



Note: Figure 6 summarizes the survey responses to the question asking if there is any policy, strategy, or norm regarding the minimum or maximum level of annual investment. Many of the respondents who answered "Yes" to the question also provided a description of the policy or strategy. The examples of policies for the maximum level include (1) the increase in SG&A cost limited to a certain percentage of prior SG&A costs and (2) the maximum number of line workers limited due to the factory capacity. The examples for the minimum level include (1) not cutting SG&A cost regardless of the current performance and (2) spending all the budget given for the period.

5.2.2 Interview

To obtain an even deeper understanding of the decision-making mechanism at the middle management level, we conducted interviews with two middle managers currently in

practice, who were selected and approached using our personal network; Manager A is a director of client services at a company which provides seismic data to the oil and gas industry; Manager B is a production manager at a manufacturer of custom molded plastic parts. As a part of the briefing, our survey questionnaires were provided to each of the interviewees and the actual interviews were conducted a few days later through telephone. Similarly to the survey respondents, both of the interviewees indicated that their decisions to add or cut resources are affected by top management and/or other factors, although the degree varies.

Manager A, who self-reported that he has "a great deal of discretion" in terms of spending and resource allocation, stated:

> "If I think a $500 resource is needed for an operation or a project, I simply spend the capital and continue. However, if the resource needed approaches the $10,000 mark, I send it to upper management for confirmation before executing the order … My discretion range to give raises (to the employees) is 3-5%, without consulting or push-back from top management. If I want to consider an employee for a 10% raise, then this requires approval at the executive level and from upper management."

Similarly, Manager B, who exercises a "moderate level of discretion" in terms of spending and human resource allocation, stated:

> "(SG&A spending) is rarely my complete decision but rather the committee's that I work and consult with. I need to go through upper management for most of the major decisions."

These statements suggest that their managerial decisions to increase spending are limited by top management, although the degree varies, which is consistent with the survey responses in general.

Regarding the factors affecting their resource allocation decisions, Manager A stated:

> "We are in a "sales driven" business and have to maintain an operation that can react and bring a deal to fruition within a quick delivery window, closing out the few competitors we do have. There are about ten other companies we compete with domestically, so this makes it easy for customers to work with us, as they know who has the services in this field."

This implies that competitors and customers are limiting his discretion in cutting resources to a certain degree, as many survey respondents also indicated. On the other hand, Manager B stressed the significant influence of company-level strategy:

> "Prior to 2009, the company was in a growth stage as was the industry (and thus my discretion in cutting resources was limited) … On the contrary, subsequent to the 2009 economic upheaval, the industry, and my company as well, have yet to truly recover from the recession (meaning my discretion in increasing costs is somewhat limited.)"

To summarize, the interview statements are consistent with our intuition and observation from the survey. Although the real world decision making processes, identified during the interviews, are much more complicated and dynamic compared to the simplified plots we have drawn from the survey results, the interviews confirmed at least that middle managers' discretion in spending decisions is limited both upward and downward and the limiting factors include top managers and their strategies.

5.3 Empirical analysis

Middle managers include heads of business segments, such as division managers and regional managers, who can be reasonably considered to have the most significant influence on the segment level cost decisions. As such, we also conducted an empirical analysis using segment level data obtained from Compustat, which covers all publicly traded companies in the U.S., to complement our findings from the survey and field interviews. Our sample period spans fiscal years 2008–2015 and the number of segment/year observations was 26,050.[12]

Cost behavior at the middle management (or segment) level was examined using the following regression model:

$$\begin{aligned} \Delta SG\&A_t = {} & \beta_0 + \beta_1 \Delta REV_t + \beta_2 DEC_t \times \Delta REV_t + \beta_3 DEC_t \times \Delta REV_t \times SUCCESSIVE\_DEC_t \\ & + \beta_4 DEC_t \times \Delta REV_t \times ASSETINT_t + \beta_5 LARGE\_INC_t \times \Delta REV_t \\ & + Industry/Year\ Fixed\ Effects \end{aligned} \quad (1)$$

where *ΔSG&A* is natural logarithm of current SG&A costs over prior SG&A costs and *ΔREV* is natural logarithm of current sales revenue over prior sales revenue. Both *ΔSG&A* and *ΔREV* are winsorized at the 1% level. *DEC* is a dummy variable which takes the value of 1 if sales revenue of the firm decreases in the current period, and 0 otherwise. Similar to ABJ, a negative β2 would indicate that costs decrease relatively less when sales decrease. We also include interaction terms containing a dummy variable for successive sales decrease (*SUCCESSIVE_DEC* = 1 if sales decrease for two consecutive years) and asset intensity (*ASSETINT* = log (total assets / sales revenue)), considering the factors affecting the degree of cost stickiness. We use dummy variables based on the two-digit Standard Industry Classification (SIC) codes and year dummies to control for the industry and year fixed effects, respectively. The main variable of interest is the interaction term containing

12 Our sample period spans 8 years (2008-2015), since our data source, Compustat's Current Segments database, provides information for the past 8 years.

LARGE_INC, a dummy variable for a large sales increase, which is defined using different values of sales increase. (See Note for Table 5 for detailed variable definitions.) A negative β_5 would indicate that SG&A costs become sticky when the magnitude of sales increase reaches a given level of sales increase.

Table 5: *Regression analysis of SG&A cost behavior at the segment level*

	(1)	(2)	(3)	(4)	(5)
VARIABLES	$\Delta SG\&A_t$	$\Delta SG\&A_t$	$\Delta SG\&A_t$	$\Delta SG\&A_t$	$\Delta SG\&A_t$
ΔREV_t	0.403***	0.341***	0.424***	0.487***	0.537***
	(68.93)	(9.67)	(14.07)	(18.68)	(23.30)
$DEC_t \times \Delta REV_t$	-0.093***	-0.029	-0.115***	-0.182***	-0.238***
	(-6.59)	(-0.74)	(-3.37)	(-5.96)	(-8.50)
$DEC_t \times \Delta REV_t \times SUCCESSIVE\_DEC_t$	0.093***	0.094***	0.093***	0.093***	0.092***
	(6.26)	(6.29)	(6.25)	(6.21)	(6.18)
$DEC_t \times \Delta REV_t \times ASSETINT_t$	-0.046***	-0.047***	-0.046***	-0.046***	-0.045***
	(-15.31)	(-15.40)	(-15.18)	(-14.94)	(-14.68)
$LARGE\_INC15_t \times \Delta REV_t$		0.061*			
		(1.79)			
$LARGE\_INC20_t \times \Delta REV_t$			-0.021		
			(-0.72)		
$LARGE\_INC25_t \times \Delta REV_t$				-0.083***	
				(-3.30)	
$LARGE\_INC30_t \times \Delta REV_t$					-0.133***
					(-6.01)
Constant	0.033***	0.035***	0.032***	0.029***	0.025***
	(13.78)	(13.57)	(12.21)	(10.65)	(9.08)
Industry/Year Fixed Effects	Included	Included	Included	Included	Included
Observations	26,050	26,050	26,050	26,050	26,050
Adjusted R-squared	0.217	0.217	0.217	0.218	0.218

Note: Table 5 presents the results of the multivariate regression analysis based on 26,050 segment/year observations.
*, **, and *** denote significance at levels of 0.1, 0.05, and 0.01, respectively. T-statistics are in parentheses.
$SG\&A_t$ = Selling, general, and administrative costs in year *t* (in million $); $\Delta SG\&A_t$ = Log ($SG\&A_t$ / $SG\&A_{t-1}$); REV_t = Sales revenue in year *t* (in million $); ΔREV_t = Log (REV_t / REV_{t-1}); DEC_t = 1 if $REV_t < REV_{t-1}$, = 0 otherwise; $SUCCESSIVE\_DEC_t$ = 1 if $REV_{t-1} < REV_{t-2}$, = 0 otherwise; TA_t = Total assets (in million $); $ASSETINT_t$ = Log (TA_t / REV_t); $LARGE\_INC15_t$ = 1 if $\Delta REV_t > 0.15$, = 0 otherwise; $LARGE\_INC20_t$ = 1 if $\Delta REV_t > 0.20$, = 0 otherwise; $LARGE\_INC25_t$ = 1 if $\Delta REV_t > 0.25$, = 0 otherwise; $LARGE\_INC30_t$ = 1 if $\Delta REV_t > 0.30$, = 0 otherwise.

The regression results are presented in Table 5. Consistent with the prior literature, the coefficient on *DEC*×*ΔREV* is significant and negative in general, indicating that cost becomes sticky when sales decrease. The coefficient on *SUCCESSIVE_DEC* interaction term is significant and positive in general, suggesting a lower degree of SG&A cost stickiness at the lower end when sales decline for two consecutive years. The significant and negative coefficients on *ASSETINT* interaction term indicate that SG&A costs are stickier at the lower end for firms that require relatively more assets to support their sales.

Most interestingly, the coefficients on the interaction term for a large sales increase show that cost becomes sticky when the magnitude of sales increase is "sufficiently" large. In specific, the coefficients are not significantly negative when the sufficiently large sales increase is defined as *ΔREV* of 0.15 or higher (Column (2)) or 0.2 or higher (Column (3)), suggesting that a sales increase up to about 20% does not trigger the cost stickiness at the higher end. The coefficient becomes significantly negative when the sufficiently large sales increase is defined as *ΔREV* of 0.25 or higher (Column (4)), suggesting that approximately 25% change in sales revenue is sufficiently large to induce sticky cost behavior at the higher end. Considering that a significant portion of the sample (20.9%) has *ΔREV* of 0.25 or higher (untabulated), the conditions that trigger sticky cost behavior at the higher end (e.g., 25% sales increase) are still considered normal rather than extreme. The negative coefficient becomes even more significant and larger in magnitude when *ΔREV* of 0.3 is used to define the dummy variable (Column (5)), as intuitively expected. Overall, the regression results based on segment level data suggest that cost behavior at the segment level is sticky not only when sales decrease but also when the magnitude of sales increase is large, consistent with our findings from the survey instrument and the interviews.

6 DISCUSSION WITH CONCLUSIONS

6.1 Theoretical contributions

Decisions at the middle management level are different from those at the top management or corporate level because middle managers are likely to have limited ability in both adding and cutting resources and also because the salary-focused compensation structure for middle managers are likely to induce more risk-averse behavior. In this study, we examine cost behavior at the middle management level using two different approaches.

First, we take a behavioral approach and conduct a survey and field interviews. The analysis results based on the detailed interviews and 152 survey responses indicate that middle managers' cost decisions are sticky (i.e., change relatively less) when the magnitude of sales change is sufficiently large at both increasing and decreasing ends. Our findings contribute to the prior literature on cost stickiness by suggesting the existence of stickiness at the higher end (i.e., when the sales increase is large) at least at the middle management level and also by confirming the empirical findings in the literature using behavior approaches.

Second, we use archival data to empirically confirm our findings from the survey and the interviews. Using a regression analysis based on 26,050 segment-level observations for publicly traded companies in the U.S., we show that cost decisions at the segment level are sticky at both low and high ends, consistent with our findings from the survey and the interviews. Using segment level data also contributes to the prior literature which relies heavily on company level data and examines the cost asymmetry at the low end only (i.e., firms facing a sales decline).

6.2 Practical implications

Middle managers' cost decisions, which are sticky not only when sales decrease but also when the magnitude of sales increase is large, have practical implications for both top managers and investors. For top managers, the sticky cost behavior at the high end suggests that the cost decisions of middle managers are restricted by annual budgets and corporate-level strategies or policies, as evidenced by the survey results and the interviews. This further suggests that a company may face an undesirable situation of losing an opportunity to grow because investments or expenditures at the middle management level are restricted for internal reasons.

For investors and analysts, the sticky cost behavior at the high end suggests that analysts' earnings forecasts are likely to be biased when the magnitude of sales increase is large. Banker, Jin, and Mehta (2018) argue that if analysts fail to fully consider the cost stickiness (at the low end), costs of firms facing sales decline will be under-forecasted, and, by extension, earnings of those firms will be over-forecasted. In contrast, the cost stickiness at the high end that is documented in this study suggests that costs will be over-forecasted and thus earnings will be under-forecasted for firms facing a large increase in sales.

6.3 Limitations with future research directions

As this study mainly uses a survey instrument and interviews, it is subject to potential caveats associated with behavioral studies, such as biased inputs from the survey/interview respondents and/or samples not representative of the whole population. To mitigate this concern, we also conduct an empirical analysis using archival data for publicly traded companies in the U.S.

Another limitation in our study is that while we show that middle managers' cost decisions are sticky when the magnitude of sales increase is sufficiently large, whether the corporate-level cost behavior is also sticky at the higher end remains untested. This suggests that examining the corporate-level cost behavior at the high end will be an interesting venue for future research.

Also, our survey and interview responses suggest that Porter's (1979) five forces have significant influence on cost and investment decisions, consistent with the common belief

in the management literature. This suggests that it will be interesting and thus worth exploring to examine how the five forces affect non-linearity in cost decisions individually and collectively.

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INFLATION – THE HARROD-BALASSA-SAMUELSON EFFECT IN A DSGE MODEL SETTING

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ABSTRACT: *This paper sets up a two-country two-sector dynamic stochastic general equilibrium model that introduces sector specific productivity shocks with quality improvement mechanism of goods. It provides a model-based theoretical background for the Harrod-Balassa-Samuelson phenomenon that describes the relationship between productivity and price inflation within different sectors in a particular economy. Both, the calibrated and the estimated model are able to show that the Harrod-Balassa-Samuelson effect is confirmed by inducing tradable sector productivity shocks as they drive the non-tradable sector price inflation higher than the tradable sector price inflation. By doing this, we overcome the problem that the tradable productivity increase in a typical open economy specification reduces the relative price of domestic tradable goods relative to the foreign ones.*

Key words: *Harrod-Balassa-Samuelson effect, DSGE model, inflation, productivity, quality improvement*

JEL classification: C32, E31, E32

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1 INTRODUCTION

The relationship between productivity and price inflation is described by the theory of the Harrod-Balassa-Samuelson phenomenon (henceforth HBS). Harrod (1933), Balassa (1964) and Samuelson (1964) independently developed and formulated the HBS productivity approach in order to explain the purchasing power parity[2]. The HBS effect represents a tendency for countries that experience higher tradable-sector productivity growth compared to non-tradable sector productivity growth to have higher overall price levels (Obstfeld and Rogoff, 1996). In more detail, the basic idea behind it is that the growth in the productivity of a tradable sector influences the growth of wages in the tradable and later on in the non-tradable sector. Wage growth in the tradable sector consequently affects the growth of prices in the non-tradable sector. Depending on the nominal exchange rate regime of a particular economy, it affects the real exchange rate as well. However, Betts and Kehoe (2008) studied the relationship between the real exchange rate and the relative price of non-tradable to tradable goods. Their conclusion is that the relation between the

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2 Baumol and Bowen (1967) developed a similar model that only describes the relationship between productivity and wages, and presents an important part of the HBS hypothesis, as discussed by Wagner and Hlouskova (2004).

two variables is stronger in an intense trade environment. Therefore, the basic assumption is that the relationship between the relative growth in the productivities of the tradable to non-tradable sector and the relative price of non-tradable to tradable goods is relatively straightforward if we include sectoral data for European countries, for example. In addition to the close trade environment, the sole Euro area integration process suppresses the ability of economies to adjust through the nominal exchange rate channel, which could consequently put more pressure on non-tradable price inflation.

The HBS hypothesis can be tested on different entities, which in general represent countries, regions, or in many cases, sectors. In our case, we divide these entities into a tradable sector and a non-tradable sector; we use a similar principle as the De Gregorio, Giovannini, and Wolf's (1994) methodology by using the ratio of exports to total production to define both sectors. In order to do that we include and combine the NACE Revision 2 10-sector breakdown statistical classification time series data of economic activities, which provides data on labour productivity and price levels across the two sectors, and the ratio of exports to total production data calculated from the input-output tables, which are available at the World Input-Output Database (WIOD)[3]. By obtaining the relevant tradable and non-tradable data for further analysis and adding other observable macroeconomic data, we estimate the constructed DSGE model.

The problem of permanent tradable productivity increase in a typical dynamic open economy specification is reducing the relative price of domestic tradable goods relative to the foreign ones. This implies worsening the terms of trade for the domestic economy and consequently, its real exchange does not increase. These dynamics are not consistent with empirical evidence found for the new European Union member states. The main contribution of the paper is to overcome the typical dynamic open economy setting by constructing and estimating a two-country two-sector DSGE model with the quality improvement extension, proposed by Masten (2008), in a smaller calibrated version of a dynamic model. The basic assumption is therefore the separation of the economy into a tradable and a non-tradable sector. The tradable sector is open and allows domestic goods to be exported and foreign goods to be imported, whereas the non-tradable sector is closed to foreign markets (a similar structure was used by Masten, 2008; Rabanal, 2009; Micaleff and Cyrus, 2013). The assumption is that the tradable and non-tradable sectors are exposed to different productivity shocks; this means that non-stationary real variables can grow at a different pace, thus providing a case for the HBS effect. In specifying technology, we allow a quality improvement mechanism, which is needed to replicate the appreciation of prices, without resorting to the unrealistic assumption of perfect competition in the tradable sector (Masten, 2008).

We find evidence for the HBS effect, based on an augmented technology process that considers a quality improvement mechanism, which affects marginal costs by requiring

3 In defining the tradable and the non-tradable sector we differ from the standard approach used in the literature by excluding the not distinctively tradable or non-tradable sectors from the analysis.

the use of more advanced inputs in the production process. The quality improvement of goods overcomes the typical open economy theoretical specification that reduces the relative prices of domestic tradable goods relative to foreign prices, and consequently worsens the terms of trade for the domestic economy. By introducing a sector-specific domestic tradable technology shock, the modelled economy responds by increasing price differential of non-tradable relative to tradable prices and the overall domestic inflation. Doing this we are able to theoretically explain why the economies with higher economic and productivity growth during the catching-up phase experienced higher inflation.

In Section 2, a review of the HBS related literature is presented and discussed. Section 3 provides a theoretical framework for the DSGE model. In section 4, the classification and definition of economic activities into a tradable and a non-tradable sector is presented, obtaining sectoral price indices and time series of sectoral labour productivity growths. The calibrated model is presented in Section 5, while the estimation results of the DSGE model are given and discussed in Section 6. Section 7 presents the conclusions.

2 LITERATURE REVIEW

Despite treating the HBS theory as an old idea, in which the sectoral productivity differential is seen as the driver for price inflation in the non-tradable sector (Harrod, 1933; Balassa, 1964; and Samuelson, 1964), the empirical testing of the HBS effect only became more popular in recent years as econometric methods advanced and new (or additional) time series data became available. This availability was largely due to the establishment of the EU and later on its enlargement process, together with advances and convergence of methodologies in collecting data by the national statistical offices. At the same time, addressing the HBS issue became relevant from the economic policy perspective trying to identify the different sources of (structural) inflation. Betts and Kehoe (2008) show that a close trade environment lowers the significance of the nominal exchange rate adjustment. This was (and can still be) especially important for the future EU and euro area countries, which are obliged to satisfy the Maastricht criterion of low and stable inflation, as well as for other emerging economies in trying to stabilise their overall inflation.

In their comprehensive survey, Tica and Družić (2006) gather empirical evidence regarding the HBS effect. They point out that most of the empirical work supports the HBS effect. Especially strong evidence comes from the work based on cross-section empirical studies, similar to Balassa's (1964) work. A large number of papers focus on studying the magnitude of the HBS effect in accession countries in the EU. Čihák and Holub (2001) for instance study the presence of the HBS effect in the Czech Republic *vis-à-vis* EU countries, while allowing for differences in structures of relative prices. Jazbec (2002) considers Slovenia as the HBS case of an accession country, while Dedu and Dumitrescu (2010) test the HBS effect using Romanian data. Papers by Cipriani (2000), Coricelli, and Jazbec (2004), Halpern and Wyplosz (2001), Arratibel, Rodríguez-Palenzuela, and Thimann (2002), Breuss (2003), Wagner and Hlouskova (2004), Mihaljek and Klau (2008) consider

a larger accession country panel. Some of the work focuses also on emerging economies. Jabeen, Malik, and Haider (2011) test the HBS hypothesis on Pakistani data, while Guo and Hall (2010) test the HBS effect on Chinese regional data.

These empirical strands of the HBS effect related literature opened up new questions regarding data issues and were related mostly to availability in reliability of sectoral data. As databases, especially in Europe, became more complete, new available data enabled studying the HBS effect between individual tradable and non-tradable sectors of a particular economy. Since it is difficult to clearly divide tradable and non-tradable commodities in the real world, some of the early papers tried to identify the tradability/non-tradability of commodities. Officer (1976) proposed that manufacturing and/or industry combine a tradable sector, while the services represent the non-tradable sector. De Gregorio, Giovannini, and Wolf (1994) used a ratio of exports to total production of each sector to define both sectors.

In empirical studies, mostly total factor productivity (TFP) or average productivity of labour are used. Marston (1987), De Gregorio, Giovannini, and Wolf (1994), De Gregorio and Wolf (1994), Chinn and Johnston, (1997), Halikias, Swagel, and Allan (1999), Kakkar (2002), and Lojshová (2003) use total factor productivity as a productivity proxy, while due to the lack of data on TFP, many others, i.e., Coricelli and Jazbec (2004) and Žumer (2002), use average productivity of labour. Comparing total factor productivity and average productivity of labour, the argument against the use of average productivity of labour is that it is not completely clear if average labour productivity should be regarded as a reliable indicator for representing a sustainable productivity growth, which has a long-term effect on the economy (De Gregorio and Wolf, 1994). However, according to Canzoneri, Cumby, and Diba (1999), the argument against TFP is that TFP is a result of a possibly unreliable data collection of sectoral capital stocks comparing to data collection of sectoral employment and sectoral gross value added, especially in the case of the shorter-term series. Sargent and Rodriguez (2000) also conclude that if the intent of the research is to examine trends in the economy over a period of less than a decade or so, labour productivity would be a better measure than total factor productivity. According to Kovács (2002), another setback of using TFP is that during the catching-up phase the capital accumulation intensifies faster in the transition/accession countries than in the developed countries, due to the lower starting point in fundamentals of transition/accession countries. Therefore, the HBS effect might be overestimated. Listing some of the arguments against using TFP, we rather include the average labour productivity as a productivity proxy in the model.

Comparing to the vast HBS literature in the 2000s in the accession process of the countries to the EU and the monetary union, less theoretical work was done with regards to the HBS effect in more structural and more complex models. Rogoff (1992) was the first to implement a general equilibrium framework, introducing the demand side of the economy within the HBS theory. This opened the possibility to further investigate the effects of relative productivities of production factors and the effects of the demand side of the economy on price levels. For instance, Mihaljek and Klau (2002) conclud that the

HBS effect could have important policy implications for the EU accession countries in order to satisfy the Maastricht inflation criterion. To further investigate Mihaljek's point, Masten (2008) constructs a two-sector DSGE model to see whether the HBS effect could represent an issue in satisfying the Maastricht inflation criterion. Further on, Natalucci and Ravenna (2002) compare the magnitude of the HBS effect within different exchange rate regimes in the general equilibrium model, while Restout (2009) allows for varying mark-ups in its general equilibrium framework. However, Asea and Mendoza (1994) conclude that the proof of the HBS theory within the framework of general equilibrium cannot reliably asses the relationship between output per capita and domestic relative prices. In other words, conclusions regarding the HBS theory from cross-country analyses can only be conditionally accepted since it is difficult to account for cross-country trend deviations from purchasing power parity (PPP). Even more, Bergin, Glick, and Taylor (2004) show that the relationship between output per capita and domestic relative prices had historically oscillated too much for the HBS theory to be proved by cross-section empirical studies. In order to test the HBS theory their suggestion is that it should be tested with a sector-specific analysis.

Following the general equilibrium strand of the HBS related literature, Rabanal (2009) offers three explanations for studying sectoral inflation dynamics in Spain in a DSGE model structure. The first explanation relates to the role of productivity growth differentials, which directly brings the possibility to study the HBS effect. Altissimo et al. (2005) introduced a seminal paper on productivity growth differentials in a DSGE model setting. The second explanation adds the role of the demand-side effects in shaping the inflation dynamics (López-Salido et al., 2005). The third explanation suggests that, due to different product and labor market structures, there is heterogeneity of inflation dynamics processes in each country of the union (Angeloni and Ehrmann, 2007; Andrés et al., 2003). Rabanal (2009) concludes that even when economies are hit by symmetric external shocks, such as for example oil prices, world demand, or nominal exchange rate, the response of sectoral inflation will be different across countries. The Rabanal's model was adopted by Micaleff and Cyrus (2013) as well. They analyse the relative importance of the three main determinants of inflation differentials in Malta. Based on these considerations, a structured theoretical framework is presented in the following section.

3 MODEL

In this section, we present the theoretical framework for the two-country two-sector DGSE model. The DSGE framework follows the Rabanal (2009) model, but the main contribution of the theoretical model is its extension for sectoral wage rigidites, thus making the model more realistic. Additionally, we introduce an augmented technology process with quality improvement (Masten, 2008). In order to investigate the HBS effect phenomenon, different sectoral productivity shocks have to be introduced providing assymetricity between sectors. The monetary union is made of two economies; a domestic and a foreign country with the common monetary policy rule. They are indexed on intervals $[0,s]$ and $[s,1]$, respectively, where s denotes the size of the domestic country with

respect to the two-country universe. In our case, we relate to Slovenia and the rest of the euro area. The following section only gives a structural domestic economy description since the foreign economy block is analogous to the domestic economy, which is in our case Slovenia.

3.1 Households

The assumption is that the representative household maximizes its utility function, given by

$$E_0 \sum_{t=0}^{\infty} \beta^t = \left[\ln(C_t(i) - hC_{t-1}(i)) - \frac{L_t(i)^{1+\varpi}}{1+\varpi}\right] \quad , \tag{1}$$

where C_t (i) and L_t (i) present consumption and quantity of work effort of a particular household. The parameter $0<\beta<1$ is the discount factor of household. We assume that households value the current consumption more than the future one. The parameter $0<\varpi<\infty$ is the inverse of the elasticity of work effort with respect to the real wage (Frisch elasticity parameter). We assume consumption habits as well, which is represented by the parameter $0<h<1$.

The consumption index C_t (i) is defined by the constant elasticity of substitution (CES) function between tradable and non-tradable goods and holds for all households, so that C_t (i)=C_t^4

$$C_t = \left[(\omega_{TN})^{\frac{1}{\nu_{TN}}}(C_t^T)^{\frac{\nu_{TN}-1}{\nu_{TN}}} + (1-\omega_{TN})^{\frac{1}{\nu_{TN}}}(C_t^N)^{\frac{\nu_{TN}-1}{\nu_{TN}}}\right]^{\frac{\nu_{TN}}{\nu_{TN}-1}}, \tag{2}$$

where the parameter ω_{TN} presents the share of the tradable goods in the aggregate consumption basket. The parameter $\nu_{TN}>1$ presents the elasticity of substitution between tradable and non-tradable goods.

Since the demand for tradable goods is not dependent only on domestic goods but foreign as well, the index of the tradable consumption good is written analogously to the equation (3) with which the aggregate consumption index is defined

$$C_t^T = \left[(\omega_{HF})^{\frac{1}{\nu_{HF}}}(C_t^H)^{\frac{\nu_{HF}-1}{\nu_{HF}}} + (1-\omega_{HF})^{\frac{1}{\nu_{HF}}}(C_t^F)^{\frac{\nu_{HF}-1}{\nu_{HF}}}\right]^{\frac{\nu_{HF}}{\nu_{HF}-1}} \quad , \tag{3}$$

4 We scale the variables in the model with $Z_t^C = (Z_t^T)^{\omega_{TN}}(Z_t^N)^{(1-\omega_{TN})}$ so that the variables enter the model detrended, for example, $c_t = \tilde{C}_t/Z_t^C$. The scaling variable Z_t^C ensures a constant steady-state level of utility and is determined by productivity dynamics (Masten, 2008).

where ω_{HF} represents the share of domestic tradable goods in the tradable consumption basket. The parameter $\nu_{HF}>1$ is therefore the elasticity of substitution between domestic tradable goods and tradable goods produced abroad.

The indexes of individual goods are defined by the following equations and represent a continuum of differenced goods of the same type

$$C_t^H \equiv \left[\int_0^s c_t^H(h)^{\frac{\nu-1}{\nu}} dh\right]^{\frac{\nu}{\nu-1}} \tag{4}$$

$$C_t^F \equiv \left[\int_s^1 c_t^F(f)^{\frac{\nu-1}{\nu}} df\right]^{\frac{\nu}{\nu-1}} \tag{5}$$

and

$$C_t^N \equiv \left[\int_0^s c_t^N(n)^{\frac{\nu-1}{\nu}} dn\right]^{\frac{\nu}{\nu-1}}. \tag{6}$$

The parameter $\nu>1$ denotes the elasticity of substitution within one type of differentiated goods: c_t^H, c_t^F and c_t^N. The same principle can be applied to price indexes. The aggregate price index P_t is then given by

$$P_t = [\omega_{TN}(P_t^T)^{1-\nu_{TN}} + (1-\omega_{TN})(P_t^N)^{1-\nu_{TN}}]^{\frac{1}{1-\nu_{TN}}}. \tag{7}$$

As above, the price index for tradable goods is given by

$$P_t^T = [\omega_{HF}(P_t^H)^{1-\nu_{HF}} + (1-\omega_{HF})(P_t^F)^{1-\nu_{HF}}]^{\frac{1}{1-\nu_{HF}}} \tag{8}$$

Households have a set of contingent riskless euro area bonds B_t^{EA} at their disposal that pay one unit of currency in every possible state of nature in t+1. The assumption is that households can trade these bonds that pay a gross interest rate of R_t^{EA}. Since households are *ex ante* identical, they face the same budget constraint in each period:

$$\frac{B_t^{EA}}{P_t Z_t R_t^{EA}} \leq \frac{B_{t-1}^{EA}}{Z_t P_t} + W_t L_t - C_t + \varsigma_t \tag{9}$$

where W_t represents the real wage, while ς_t represents other income sources of households. As shown in Chari, Kehoe, and McGrattan (2002), the real exchange rate is given by

$$RER_t = \frac{P_t^*}{P_t} = \frac{\mu_t^*}{\mu_t}, \tag{10}$$

where the variables μ_t and μ_t^* represent the marginal utilities of domestic and foreign consumption, respectively.

Labour market is, in comparison to the Rabanal (2009) model, differentiated, thus provides a more realistic model assumption. Further on, the aggregation of work effort of both sectors (i.e., tradable and non-tradable) holds

$$L_t = L_t^T + L_t^N \quad . \tag{11}$$

Against this backdrop, each household working in the tradable or the non-tradable sector sets its own wage (Erceg et al., 2000; Christiano et al., 2005). Firms aggregate the differentiated supply of labour by transforming it into a homogenous input of labour L_t^j, where $j=N,T$, in accordance with the Dixit-Stiglitz (1977) aggregator

$$L_t^j = \left[\int_0^1 L_t^j(i)^{\frac{\nu_{L,j}-1}{\nu_{L,j}}}\, di\right]^{\frac{\nu_{L,j}}{\nu_{L,j}-1}} \quad . \tag{12}$$

The parameter $\nu_{L,j}$ is defined as the wage elasticity within different varieties of labour services in a particular sector, where $j=N,T$. Based on that the labour demand function for a particular is given by

$$L_t^j(i) = \left[\frac{W_t^j(i)}{W_t^j}\right]^{-\nu_{L,j}} L_t^j \quad . \tag{13}$$

Combining equations (12) and (13) we get the aggregate wage, which is obtained from differentiated labour

$$W_t^j = \left[\int_0^1 W_t^j(i)^{1-\nu_{L,j}}\, di\right]^{\frac{1}{1-\nu_{L,j}}} \quad . \tag{14}$$

In order to introduce wage frictions in the model, we apply the Calvo (1983) principle. Each household has monopolistic power over the setting of its wage $W_t^j(i)$, where $j=N,T$. Yet not all the households can set their optimal wage at any point of time, but only a fraction of households $(1-\alpha_{L,j})$, where the Calvo parameter is defined on the interval $0<\alpha_{L,j}<1$. The other part of households $(\alpha_{L,j})$ indexate their wage according to inflation target and current inflation. The wage inflation of a non-optimizing household is then given by

$$W_{t+k}^j(i) = \prod_{n=1}^{k}\left(\frac{P_{t+k-1}}{P_{t-1}}\right)^{\varphi_{L,j}} \Pi^{1-\varphi_{L,j}} W_t^j(i) \quad , \tag{15}$$

where the parameter $0<\varphi_{L,j}<1$ stands for the degree of wage indexation with respect to inflation target and current inflation, where $j=N,T$.

When reoptimizing their wage in period t, workers of a particular sector choose an optimal wage $W_t^{j,opt}$ in order to maximize household utility as opposed to their individual utility, where $j=N,T$. The utility is subject to a sequence of iso-elastic demand schedules for their labour type, and the usual sequence of household flow budget constraints. The first order condition associated with that problem can be written as

$$E_t \sum_{k=0}^{\infty} (\alpha_{L,j})^k \Lambda_{t,t+k} \times \left[\left(\frac{W_t^{j,opt} \left(\frac{P_{t+k-1}}{P_{t-1}} \right)^{\varphi_{L,j}} \Pi^{k(1-\varphi_{L,j})} - (C_{t+k} - hC_{t+k-1}) \left(L_{t+k}^j(i) \right)^{\varpi}}{P_{t+k}} \right) L_{t+k}^j(i) \right] , \quad (16)$$

where the expression $\Lambda_{t,t+k}=\beta^k \lambda_{t+k}/\lambda^t$ represents the stochastic discount factor. The wage dynamics should therefore be

$$W_t^j \equiv \left[\alpha_{L,j} \left(W_{t-1}^j (\Pi_{t-1})^{\varphi_{L,j}} (\Pi_T)^{1-\varphi_{L,j}} \right)^{1-\nu_{L,j}} + (1-\alpha_{L,j}) \left(W_t^{j,opt} \right)^{1-\nu_{L,j}} \right]^{\frac{1}{1-\nu_{L,j}}}, \quad (17)$$

where $j=N,T$. The average wage on an economy scale is then given by $W_t=(W_t^T)^{\omega TN}(W_t^N)^{1-\omega TN}$.

3.2 Firms

On the supply side, there are three types of firms, producing two types of tradable goods (indexed by $H,H\star$) and domestic non-tradable goods (indexed by N). Each type of firm is facing price rigidities (Calvo, 1983). That means that only a fraction of firms $(1-\alpha_i)$, where $i=N,H,H\star$, can set their optimal price. Other firms (α_i), where $i=N,H,H\star$, index their prices according to the inflation target and current inflation based on the parameter $0<\varphi_i<1$, where $i=N,H,H\star$, which stands for the degree of price indexation with respect to inflation target and current inflation.

Domestic and foreign economies are facing the same deterministic technology process, providing a case for output growth. This means that all the real variables entering the model are non-stationary in levels, but stationary in first differences.

3.2.1 Tradable sector

In the tradable sector there are two types of firms. One type of firm produces tradable goods for the domestic market and tries to satisfy domestic consumption of tradable

goods, C_t^H. The other type of firm produces tradable goods meant for export and tries to satisfy the foreign consumption of domestic goods, $C_t^{H,*}$. Each firm in the tradable sector follows the Cobb-Douglas production function, where work effort is the only production factor

$$y_t^H(h) = A_t^T L_t^{T,H}(h) \tag{18}$$

and

$$y_t^{H,*}(f) = A_t^T L_t^{T,H,*}(f) \quad . \tag{19}$$

The variable A_t^T is a sector-specific productivity process that is characterised by quality improvement of higher-quality goods in the tradable sector index $\chi_t=(Z_t^T)^{\theta Z}$ with quality improvement parameter $\theta_Z>0$ (Masten, 2008), so that

$$\ln A_t^T = \ln Z_t^T - \ln \chi_t \quad . \tag{20}$$

The variable χ_t represents a quality improvement of goods index that influences wages and marginal costs via positive productivity shocks. Masten (2008) finds that the problem of permanent tradable productivity improvement in a typical open economy specification reduces the relative price of domestic tradable goods relative to the foreign ones, thus worsens the terms of trade. Consequently, the real exchange does not increase and is not consistent with empirical evidence based on the new European Union member states. On the other hand, introducing quality improvement of higher-quality goods may require the use of more advanced inputs in the production process and will consequently increase the marginal costs and product prices. Sallekaris and Vijselaar (2004) introduce a similar mechanism, as they adjust capital with a simple quality correction.[5]

The variable Z_t^T represents a tradable sector productivity shock, which is country-specific

$$Z_t^T = \rho_{Z,T} \ln Z_{t-1}^T + \varepsilon_t^Z + \varepsilon_t^{Z,T} \quad . \tag{21}$$

We assume that productivity shocks of both sectors can be different and that their growth rates could be different. We let the tradable productivity process Z_t^T to be affected by two different productivity innovations $\varepsilon_t^{Z,T}$, which are country and sector specific, and ε_t^Z, which represents a euro-area wide innovation. For the labour supply it holds $L_t^T=L_t^{T,H}+L_t^{T,H,*}$.

5 The idea of adjusting prices with quality improvements goes back into the 90s, as the study of Gordon (1990) tried to empirically document these biases. Later research focused on constructing quality-adjusted price indexes (Hulten, 1992; Greenwood et al., 1997; Cummins and Violante, 2002), production based estimates (Bahk and Gort, 1993), and capital model (Hobijn, 2000).

Tradable sector firms producing domestic goods for the domestic market maximize their profits according to

$$E_t \sum_{k=0}^{\infty} \alpha_H^k \Lambda_{t,t+k} \left[\frac{P_t^{H,opt}(h) \left(\frac{P_{t+k-1}^H}{P_{t-1}^H} \right)^{\varphi_H} (\Pi_H)^{k(1-\varphi_H)} - MC_{t+k}^T}{P_{t+k}} y_{t+k}^{H,d}(h) \right] \tag{22}$$

subject to

$$y_{t+k}^{H,d}(h) = \left[\frac{P_t^{H,opt}(h)}{P_{t+k}^H} \left(\frac{P_{t+k-1}^H}{P_{t-1}^H} \right)^{\varphi_H} (\Pi_H)^{k(1-\varphi_H)} \right]^{-\nu} Y_{t+k}^H \quad , \tag{23}$$

where the expression $\Lambda_{t,t+k}=\beta^k \lambda_{t+k}/\lambda_t$ represents the stochastic discount factor, and $y_{t+k}^{H,d}(h)$ is the tradable goods demand of a firm in time $t+k$. Y_t^H is the aggregate domestic-made tradable goods demand.

Similarly, we can write the maximization profit function for tradable sector firms producing domestic goods for the foreign market

$$E_t \sum_{k=0}^{\infty} \alpha_{H,*}^k \Lambda_{t,t+k} \left[\frac{P_t^{H,*,opt}(n) \left(\frac{P_{t+k-1}^{H,*}}{P_{t-1}^{H,*}} \right)^{\varphi_{H,*}} (\Pi_F)^{k(1-\varphi_{H,*})} - MC_{t+k}^T}{P_{t+k}} y_{t+k}^{H,*,d}(f) \right] \tag{24}$$

subject to

$$y_{t+k}^{H,*,d}(f) = \left[\frac{P_t^{H,*,opt}(f)}{P_{t+k}^{H,*}} \left(\frac{P_{t+k-1}^{H,*}}{P_{t-1}^{H,*}} \right)^{\varphi_{H,*}} \left(\Pi_{H,*} \right)^{k(1-\varphi_{H,*})} \right]^{-\nu} Y_{t+k}^{H,*} \quad , \tag{25}$$

where the expression $\Lambda_{t,t+k}=\beta^k \lambda_{t+k}/\lambda_t$ represents the stochastic discount factor, and $y_{t+k}^{H,*,d}(h)$ is the tradable goods demand of a firm in time $t+k$. $Y_t^{H,*}$ is the aggregate domestic tradable goods demand from abroad.

Real marginal costs in the tradable sector for both types of firms are defined as MC_t^T. Marginal costs are defined as the real wage normalized for augmented productivity

$$MC_t^T = \frac{W_t^T}{A_t^T} \quad . \tag{26}$$

Both types of tradable sector firms maximize their profit with respect to prices p_t^H *(h)* and $p_t^{H,*}$ *(f)* and demands $y_{t+k}^{H,d}(h)$and $y_{t+k}^{H,*,d}(f)$, respectively. The tradable price dynamics of domestic produced goods for the domestic market is

$$P_t^H \equiv \left[\alpha_H (P_{t-1}^H (\Pi_{t-1}^H)^{\varphi_H} (\Pi_H)^{1-\varphi_H})^{1-\nu} + (1-\alpha_H)\left(P_t^{H,opt}\right)^{1-\nu}\right]^{\frac{1}{1-\nu}} \quad , \tag{27}$$

where $P_t^{H,*opt}$ is the optimal price and $\Pi_{t-1}^H = P_{t-1}^H / P_{t-2}^H$. The tradable price dynamics of domestic goods for the foreign market is

$$P_t^{H,*} \equiv \left[\alpha_{H,*}\left(P_{t-1}^{H,*}\left(\Pi_{t-1}^{H,*}\right)^{\varphi_{H,*}}\left(\Pi_{H,*}\right)^{1-\varphi_{H,*}}\right)^{1-\nu} + \left(1-\alpha_{H,*}\right)\left(P_t^{H,*,opt}\right)^{1-\nu}\right]^{\frac{1}{1-\nu}} , \tag{28}$$

where $P_t^{H,*opt}$ is the optimal price and $\Pi_{t-1}^{H,*} = P_{t-1}^{H,*} / P_{t-2}^{H,*}$.

3.2.2 Non-tradable sector

Analogously to the tradable sector, each non-tradable sector firm follows the Cobb-Douglas production function, where work effort is the only production factor

$$y_t^N(n) = A_t^N L_t^N(n) \quad . \tag{29}$$

The variable A_t^N is a sector-specific productivity process that is characterised by quality improvement index $\chi_t = (Z_t^T)^{\theta_Z}$ so that

$$\ln A_t^N = \ln Z_t^N - \ln \chi_t \quad . \tag{30}$$

In this respect, we assume that the sector-specific productivity process A_t^N is affected by quality improvement of goods χ^t in the tradable sector, while the variable Z_t^N represents a non-tradable sector productivity shock, which is again country-specific

$$\ln Z_t^N = \rho_{Z,N} \ln Z_{t-1}^N + \varepsilon_t^{Z,N} \quad , \tag{31}$$

where we let the non-tradable productivity process Z_t^N to be affected by a sector-specific innovation, $\varepsilon_t^{Z,N}$.

Non-tradable sector firms maximize their profits

$$E_t \sum_{k=0}^{\infty} \alpha_N^k \Lambda_{t,t+k} \left[\frac{P_t^{N,opt}(n)\left(\frac{P_{t+k-1}^N}{P_{t-1}^N}\right)^{\varphi_N}(\Pi_N)^{k(1-\varphi_N)} - MC_{t+k}^N}{P_{t+k}} y_{t+k}^{N,d}(n)\right] \tag{32}$$

subject to

$$y_{t+k}^{N,d}(n) = \left[\frac{P_t^{N,opt}(n)}{P_{t+k}^N}\left(\frac{P_{t+k-1}^N}{P_{t-1}^N}\right)^{\varphi_N}(\Pi_N)^{k(1-\varphi_N)}\right]^{-\nu} Y_{t+k}^N \quad , \tag{33}$$

where the expression $\Lambda_{t,t+k}=\beta^k \lambda_{t+k}/\lambda^t$ represents the stochastic discount factor, and $y_{t+k}^{N,d}(n)$ is the non-tradable goods demand of a firm in time $t+k$. Y_t^N is the aggregate non-tradable goods demand. Real marginal costs in the non-tradable sector are defined as MC_t^N. From the cost-optimization perspective, the marginal costs are defined as the real wage normalized for productivity

$$MC_t^N = \frac{W_t^N}{A_t^N} \quad . \tag{34}$$

A non-tradable sector firm maximizes its profit with respect to price $p_t^N(n)$ and demand $y_{t+k}^{N,d}(n)$. The non-tradable price dynamics should therefore be

$$P_t^N \equiv \left[\alpha_N(P_{t-1}^N(\Pi_{t-1}^N)^{\varphi_N}(\Pi_N)^{1-\varphi_N})^{1-\nu} + (1-\alpha_N)\left(P_t^{N,opt}\right)^{1-\nu}\right]^{\frac{1}{1-\nu}} \quad , \tag{35}$$

where $P_t^{N,opt}$ is the optimal price and $\Pi_{t-1}^N = P_{t-1}^N/P_{t-2}^N$.

3.3 Monetary policy

Monetary policy is modelled as a Taylor rule (Taylor, 1993) and is the same for both economies

$$R_t^{EA} = \bar{R}^{1-\varrho_r}(R_{t-1}^{EA})^{\varrho_r}\left(\frac{\Pi_t^{EA}}{\bar{\Pi}}\right)^{(1-\varrho_r)\gamma_\pi}\left(\frac{Y_t^{EA}}{\bar{Y}}\right)^{(1-\varrho_r)\gamma_y} e^{\varepsilon_t^{MP}} \quad , \tag{36}$$

where ε_t^{MP} represents the monetary policy shock, while the interest rate R_t^{EA} responds to inflation and output gaps. The total output of the euro area is defined by $Y_t^{EA}=(Y_t)^s (Y_t^*)^{1-s}$, while the overall inflation in the euro area is defined by $\Pi_t^{EA}=(\Pi_t)^s (\Pi_t^*)^{1-s}$, where s is the size of the domestic country. The parameter ϱ_r is the weight parameter for the responsiveness of the past interest rate, while γ_π and γ_y are Taylor type paramaters for the response of the interest rate accordingly to both gaps.

3.4 Market clearing

The clearing conditions are

$$Y_t^T = C_t^H + C_t^{H,*} + G_t^T \tag{37}$$

and

$$Y_t^N = C_t^N + G_t^N, \tag{38}$$

where variables G_t^T and G_t^N represent exogenous government spending shocks. Combining equations (37) and (38), the real GDP is

$$Y_t = \frac{P_t^T}{P_t} Y_t^T + \frac{P_t^N}{P_t} Y_t^N \quad . \tag{39}$$

What is left to do is to define the government sectoral spending process

$$\ln G_t^i = \rho_{G,i} \ln G_{t-1}^i + \varepsilon_t^{G,i}, \tag{40}$$

where i=N,T.

4 TRADABILITY OF SECTORS AND DATA

As the theoretical model is divided into tradable and non-tradable sectors, some attention is needed for the specification and the sectoral definition of the data. The dataset consists of quarterly Slovene and euro area sectoral data, which is available from the Eurostat[6] website. The time series data spans from 1998Q4 to 2018Q1 and includes sectoral gross value added data and sectoral price indexes data.

4.1 Tradability of sectors

To begin with, the tradability of the sectors has to be defined. Officer (1976) proposes the following sector division. Manufacturing and other industry activities represent the tradable sector, while the services represent the non-tradable sector. De Gregorio et al. (1994) use a ratio of exports to total production to define both sectors. Their division threshold is set to 10 percent, stating that the sector is defined as tradable if the ratio of exports exceeds the 10 percent threshold, and the sector is defined as non-tradable if the ratio of exports does not exceed the 10 percent threshold. Following the De Gregorio et al. (1994) sector division, we take a step further by strictly distinguishing between the tradable and the non-tradable sector. This means that we exclude those activities from the analysis that oscillate around the 10 percent threshold too much. We provide a more detailed specification below.

6 Available at the European Commmission's statistical database site http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/.

First, data on the share of exports in total value added have to be extracted from the input-output tables available at the World Input-Output Database (WIOD). We use a standard ISIC/NACE Revision 2 aggregation category, which is used for reporting data from the System of National Accounts (SNA) for a wide range of countries. We present a 10-sector breakdown in Table 1.

Table 1: *NACE Revision 2 10-sector classification of economic activities*

NACE Revision 2	Sector description	Ratio of exports (in %)	Tradability
A	Agriculture, forestry and fishing	18.32*	
B, C, D, E	Manufacturing, mining and quarrying and other industry	45.99	T
F	Construction	2.20	N
G, H, I	Wholesale and retail trade, transportation and storage, accommodation and food services	17.25	T
J	Information and communication	10.42	
K	Financial and insurance activities	12.63	
L	Real estate activities	0.56	N
M, N	Professional, scientific, technical, administrative and support services	16.39**	
O, P, Q	Public administration, defence, education, human health and social work services	0.95	N
R, S, T, U	Other services	6.27	N

Source: European Commission, author's calculations.
*Note: Countries, such as Belgium, the Netherlands and Luxembourg, stand out with their ratio-of-export figures, thus driving up the average of ratio of exports in the agriculture sector.
**Note: Countries, such as Ireland, the Netherlands and Luxembourg, stand out with their ratio-of-export figures, thus driving up the average of ratio of exports in the professional services sector.

As mentioned above, to divide the 10 sectors into tradable and non-tradable sectors, we use a similar approach as De Gregorio et al. (1994). However, in the present paper we put emphasis only on strictly tradable and non-tradable sectors, meaning that the sectors which are not distinctively tradable or non-tradable are exluded from the analysis. A sector is then treated as tradable if its ratio of exports exceeds the 10 percent threshold for at least 75 percent of time using the WIOD data in the 2000-2011 period. The same principle is applied for the definition of a non-tradable sector. A sector is treated as non-tradable if its ratio of exports is under the 10 percent threshold for at least 75 percent of time using the WIOD data in the 2000-2011 period. Applying stricter conditions regarding the division of sector means that NACE Rev. 2 sectors, such as agriculture, forestry and fishing (A), information and communication (J), financial and insurance activities (K), professional, scientific, technical, administration and support services (M and N), are excluded from the analysis. These excluded sectors account for around 20 percent in total value added. Based on this threshold the manufacturing, mining, quarrying and other industries (B, C,

D and E), wholesale, retail, transportation, storage, accommodation and food services (G, H and I) are treated as tradable sectors, while construction (F), real estate activities (L), public administration, defence, education, human health, social work services (O, P and Q), and other services (R, S, T and U) are treated as non-tradable sectors.

4.2 Sectoral inflation and productivity

Based on quarterly data available from the Eurostat website and consideration of the classification of economic activities into a tradable and a non-tradable sector (as defined in Table 1), supported by time-varying sectoral gross value added weights expressed in millions of euros in 2015, growth rate in prices for the tradable and the non-tradable sector are obtained. We use the same principle that was applied to divide economic activities into the tradable and non-tradable sectors to divide sectoral growth rate of value added for both sectors, based on the aggregation done for sectoral inflation. This way we get growth rates for the output on a quarterly frequency basis for a separate sector, i.e. tradable and non-tradable.

4.3 Data entering the model

After defining and obtaining the sectoral data, we can provide a full description of the dataset entering the model in Table 2. There are 9 observable variables at a quarterly frequency in the period of 1998Q4-2018Q1, thus providing 78 observations. Tradable sector figures stand out the most and have the highest variability. Intuitively, this means that the tradable sector is more responsive to changes in different phases of business cycles. Additionally, Slovene data in comparison to the euro area data varies more, thus providing a case that small open economies are more vulnerable to macroeconomic imbalances.

Table 2: *Descriptive statistics (in p.p. deviations from the steady state)*

Variable description	Data transformation	Country	Minimum	Maximum	Standard deviation
Weighted tradable sector inflation	demeaned log-differences	SI	-2.59	2.21	0.92
Weighted tradable sector inflation	demeaned log-differences	EA	-1.08	1.31	0.39
Weighted tradable sector gross value added	demeaned log-differences	SI	-10.17	3.02	1.64
Weighted tradable sector gross value added	demeaned log-differences	EA	-6.36	1.23	1.07
Weighted non-tradable sector inflation	demeaned log-differences	SI	-1.22	1.84	0.69
Weighted non-tradable sector inflation	demeaned log-differences	EA	-0.76	0.80	0.30

Variable description	Data transformation	Country	Minimum	Maximum	Standard deviation
Weighted non-tradable sector gross value added	demeaned log-differences	SI	-3.20	5.13	1.51
Weighted non-tradable sector gross value added	demeaned log-differences	EA	-0.73	1.02	0.41
3-month Euribor	Interest rate given by $\log(1+r_t/400)$, demeaned log-differences	EA	-0.55	0.78	0.42

Source: Eurostat, author's calculations.

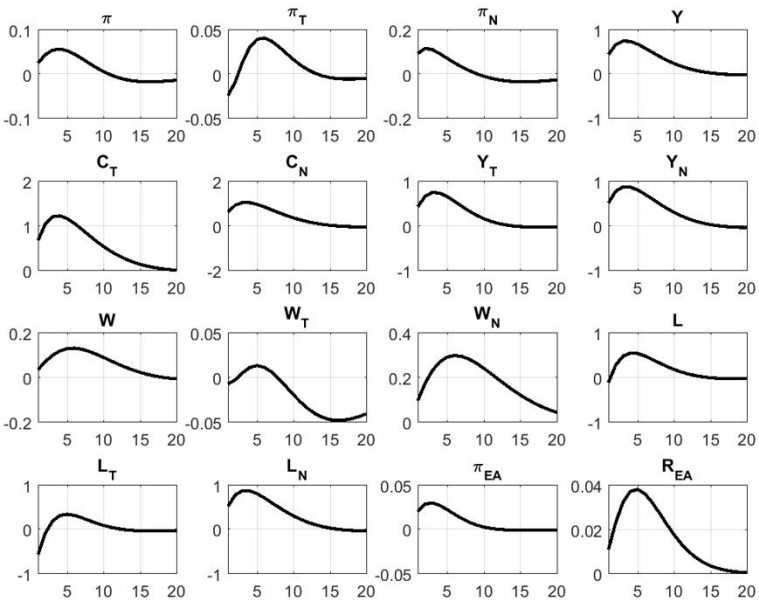
5 CALIBRATION OF THE MODEL

We set the values of the calibrated parameters accordingly to known empirical facts from the existing literature and characteristics of the modelled economies, in our case Slovenia and the euro area. The discount factor β is set to 0.99, following Smets and Wouters' (2003) paper. The degree of habit formation parameter h for Slovenia is set to 0.80 (as in Kilponen et al., 2015), while for the euro area it is set to 0.60 (as in Smets and Wouters, 2003), thus making Slovenia's consumption slower to respond and more persistent. The Slovene economy size parameter s is set to 0.01.[7] The Frisch elasticity or the inverse of the elasticity of work effort for both economies has a typical parameter value of 2 (Smets and Wouters, 2003; Rabanal, 2009; Rabanal, 2012; Micallef and Cyrus, 2013). The elasticities of substitution between tradable and non-tradable goods for both, domestic (ν_{TN}) and foreign ($\nu_{TN,*}$), economies, take the value of 0.44, following the values set by Stockman and Tesar (1995). The elasticities of substitution between domestic produced and foreign produced goods for both, domestic (ν_{HF}) and foreign ($\nu_{HF,*}$) economies, take the value of 1.5, following Chari, Kehoe, and McGrattan (2002). Furthermore, the shares of important economic variables are calibrated as well. The share of government spending relative to GDP in Slovenia is set to 0.17 and for the euro area it is set to 0.20, while the average share of tradable goods in the consumption basket is set to 0.58 in Slovenia and 0.61 in the euro area. The Calvo wage parameters for both areass and both sectors are set to 0.81, while the price stickiness is set to 0.75, following the values set for Slovenia in Clancy, Jacquinot, and Lozej (2014) and Kilponen et al. (2015). The wage indexation parameters are set to 0.75, according to Rabanal (2012). The quality improvement parameters θ_Z and $\theta_{Z,*}$ for both economies are set to 0.25. The Taylor rule values inflation and output gap response parameters $\gamma_\pi = 1.5$ and $\gamma_y = 0.1$ take usual values when modelling the euro area monetary policy close to Fourçans and Vranceanu's (2004) estimation of the euro area parameters.

7 In comparison to the euro area the size of the Slovene economy is even smaller. The reason behind a slightly bigger economy size parameter is that very small numbers of the parameters could represent numerical difficulties for the model. These are shown in a very slow convergence after shocking the model or even in the inability of computing the responses of the shocks. However, 0.01 economy size parameter does not significantly influences the universum of both economies, which would be the case for small open economies.

The calibrated model is able to produce the HBS type of productivity shock. The following figure shows the impulse responses of the main macroeconomic variables to a 1 p.p. domestic tradable sector productivity shock, based on the calibrated model. The productivity shock increases the production of both sectors, tradable and non-tradable. As the quality improvement mechanism takes place, firms are compelled to raise wages since more sophisticated labour force is needed with the productivity picking up. The pick-up in wages increases inflation and consumption in both sectors. What is noteworthy is that inflation in the non-tradable sector increases more than in the tradable sector, thus providing a case for the HBS effect.

Figure 1: *Impulse responses of the main variables to a 1 p.p. domestic tradable sector productivity shock (deviations from steady state, in p.p.)*



6 ESTIMATION OF THE MODEL AND COMPARISON WITH THE CALIBRATED MODEL

With the obtained dataset and the calibration parameters set, the two-country two-sector DSGE model is ready to be estimated. Doing that, we use the Bayesian inference methodology. We set the prior distribution of the estimated parameters, given in Table 3. The prior and the posterior distribution of the estimated parameters and the shocks is presented in Table 3, while the figures with comparisons between the prior and the posterior distribution of the parameters are presented in Appendix A, and in Appendix B the dynamics of the exogenous shocks is presented. The Metropolis-Hastings MCMC algorithm is used with 300,000 steps and two sequential chains with the acceptance rate per chain of around 30%.

We estimate the quality improvement parameters θ_Z and $\theta_{Z,*}$ for both economies. The priors of both parameters were set to 0.25, while the estimates of both parameters took the values of 0.1676 and 0.2127, respectively. The estimated values of both quality improvement parameters are below the calibrated value of the parameter for the domestic economy in Masten (2008). Since Slovenia was catching up the average of the euro area and experienced higher growth and inflation, the estimate of the quality improvement mechanism had to be stronger during this period. With respect to the other estimated parameters, the shock persistence parameters seem to suggest that the productivity persistence parameters show less persistence than the demand shocks entering both the non-tradable and the tradable sector. The parameter ϱ_r of the monetary policy rule is estimated as well and takes the value of 0.6250, suggesting a relatively high persistence of the past interest rate.

In comparison to the calibrated model, the Calvo price and wage rigidity parameters (α's) are estimated to be higher, meaning that the prices and wages respond slower to exogenous shocks. The values of the Calvo parameters are similar comparing the foreign or domestic economy.

Table 3: *Prior and posterior distribution of the estimated parameters and shocks*

Parameter	Calibration model values	Prior mode	Posterior mode	90% HPD interval		Prior distribution	Prior distribution
θ_Z	0.250	0.250	0.1676	0.1061	0.2268	inv. gamma	0.100
$\theta_{Z,*}$	0.250	0.250	0.2127	0.1153	0.3393	inv. gamma	0.100
α_H	0.750	0.750	0.6259	0.5828	0.6676	beta	0.150
α_F	0.750	0.750	0.8955	0.8524	0.9355	beta	0.150
$\alpha_{H,*}$	0.750	0.750	0.8742	0.7620	0.9975	beta	0.150
$\alpha_{F,*}$	0.750	0.750	0.9200	0.8963	0.9412	beta	0.150
α_N	0.750	0.750	0.8519	0.8250	0.8746	beta	0.150
$\alpha_{N,*}$	0.750	0.750	0.9550	0.9415	0.9686	beta	0.150
$\alpha_{W,T}$	0.810	0.810	0.9010	0.8395	0.9659	beta	0.070
$\alpha_{W,T,*}$	0.750	0.750	0.8249	0.7279	0.9198	beta	0.070
$\alpha_{W,N}$	0.810	0.810	0.8889	0.8392	0.9367	beta	0.070
$\alpha_{W,N,*}$	0.750	0.750	0.7920	0.6909	0.8920	beta	0.070
ν_{TN}	0.440	0.500	0.5471	0.1888	0.8864	gamma	0.200
ν_{HF}	1.500	1.500	1.1671	0.5602	1.7190	gamma	0.500
φ_H	0.500	0.500	0.2600	0.0614	0.4389	beta	0.200
φ_F	0.500	0.500	0.4762	0.2029	0.7278	beta	0.200
$\varphi_{H,*}$	0.500	0.500	0.4643	0.3093	0.6329	beta	0.100
$\varphi_{F,*}$	0.500	0.500	0.1014	0.0120	0.1864	beta	0.200
φ_N	0.500	0.500	0.3958	0.2158	0.6011	beta	0.100

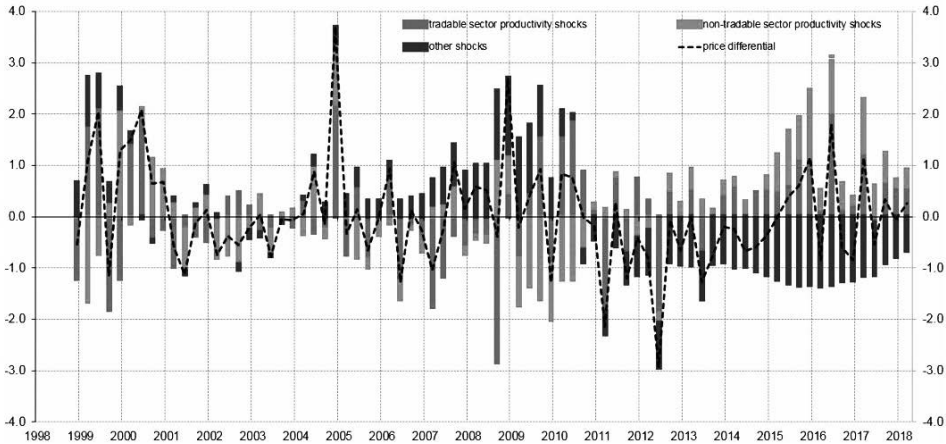
Parameter	Calibration model values	Prior mode	Posterior mode	90% HPD interval		Prior distribution	Prior distribution
$\varphi_{N,*}$	0.500	0.500	0.2926	0.1718	0.4120	beta	0.100
$\rho_{Z,T}$	0.750	0.750	0.3940	0.2721	0.5210	beta	0.100
$\rho_{Z,T,*}$	0.750	0.750	0.3958	0.2485	0.5370	beta	0.100
$\rho_{Z,N}$	0.750	0.750	0.5840	0.4225	0.7360	beta	0.100
$\rho_{Z,N,*}$	0.750	0.750	0.4358	0.2903	0.6000	beta	0.100
$\rho_{G,T}$	0.750	0.750	0.8392	0.6415	0.9662	beta	0.100
$\rho_{G,T,*}$	0.750	0.750	0.8468	0.7520	0.9511	beta	0.100
$\rho_{G,N}$	0.750	0.750	0.9030	0.6564	0.9918	beta	0.100
$\rho_{G,N,*}$	0.750	0.750	0.8062	0.6567	0.9330	beta	0.100
ϱ_r	0.750	0.750	0.6250	0.4788	0.7758	beta	0.100
ε_{MP}	-	0.4000	0.1266	0.1113	0.1417	inv. gamma	0.1000
ε_{Z}	-	0.5000	0.1840	0.1509	0.2156	inv. gamma	0.2000
$\varepsilon_{Z,T}$	-	0.7000	0.2593	0.2211	0.2978	inv. gamma	0.2000
ε_{Z,T^*}	-	0.5000	0.3710	0.2322	0.5064	inv. gamma	0.2000
$\varepsilon_{Z,N}$	-	0.7000	0.2472	0.2126	0.2803	inv. gamma	0.2000
$\varepsilon_{Z,N,*}$	-	0.5000	0.5192	0.2784	0.7470	inv. gamma	0.2000
$\varepsilon_{G,T}$	-	1.0000	0.5061	0.4420	0.5733	inv. gamma	0.2000
$\varepsilon_{G,T,*}$	-	1.0000	0.4088	0.3539	0.4595	inv. gamma	0.2000
$\varepsilon_{G,N}$	-	1.0000	0.6004	0.5109	0.6883	inv. gamma	0.2000
$\varepsilon_{G,N,*}$	-	1.0000	0.4032	0.3538	0.4484	inv. gamma	0.2000

Source: Author's calculations.

6.1 Impulse response functions and the historical shock decomposition

In this subsection, we present the historical shock decomposition and impulse response functions. The purpose of both is to provide a description of the severity of shocks that influence the macroeconomic variables. Figure 2 shows the contributions of the exogenous shocks onto the price differential between the non-tradable and tradable sectors through time. It is evident that the inflation differential between the non-tradable and tradable sectors has been influenced by productivity components. As the financial crisis lingered on in the second wave after 2010, the difference between the non-tradable and tradable dynamics turned to be negative, implying a slowdown in the tradable sector productivity. Only with the start of the recovery of the Slovene economy in 2015, the difference between the inflation of both sectors returned to positive figures and has continued the pattern from before the financial crisis in 2008 by being affected with positive tradable sector productivity shocks.

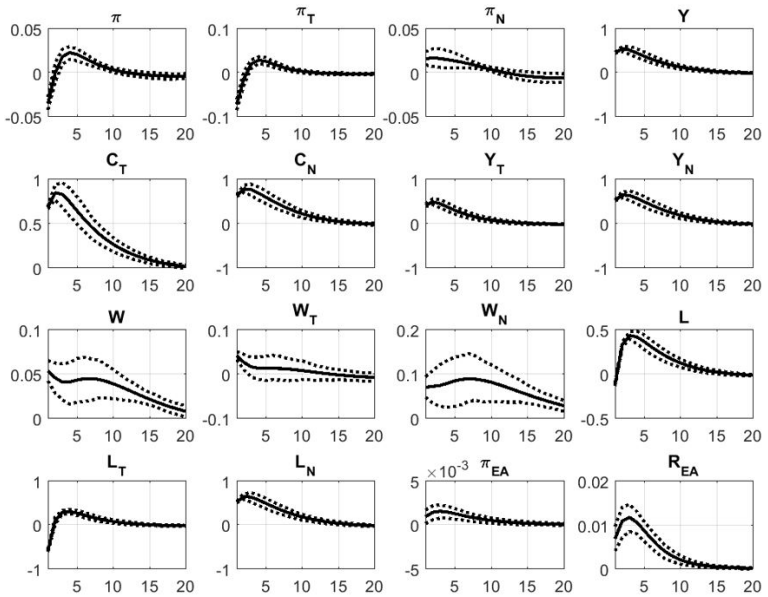
Figure 2: *Historical shock decomposition in the inflation differential between the non-tradable and the tradable sector (deviations from steady state, in p.p.)*



*Note: Tradable productivity shocks are the sum of the contributions of the country-specific domestic tradable sector shocks $\varepsilon_{Z,T}$ and $\varepsilon_{Z,T,*}$ and the common productivity shock ε_{Z}. The non-tradable sector productivity shocks $\varepsilon_{Z,N}$ and $\varepsilon_{Z,N,*}$ are depicted separately. Other shocks are the sum of the contributions of the government spending shocks ($\varepsilon_{G,T,}$ $\varepsilon_{G,T,*,}$ $\varepsilon_{G,N}$ and $\varepsilon_{G,N,*}$) and the monetary policy shock ε_{MP}. Source: Author's calculations.

It is more intuitive to look at the impulse response functions in order to understand the effects of productivity shocks. Figures (3-6) show the responses of the main macroeconomic variables to different exogenous shocks and depict a 20-period horizon. In studying the impulse responses, we will only consider the productivity shocks that hit the two economies. Figure 3 displays the impulse responses of the main variables to a 1 p.p. domestic tradable sector productivity shock $\varepsilon_{Z,T}$. When a positive productivity shock hits the tradable sector, tradable and non-tradable inflation increases in Slovenia, causing the overall inflation to increase. This is due to a wage increase in the tradable sector via quality improvement mechanism that increases the need for more demanding inputs in the production process, thus increasing the marginal costs, as wages increase the marginal costs increase, causing the inflation to increase. The Harrod-Balassa-Samuelson type productivity shock causes the increase of output and consumption as well. Under the implementation of quality improvement mechanism and under the price and wage frictions the HBS effect seems to hold, based on the impulse responses, the effects on the euro area macroeconomic variables are small.

Figure 3: *Impulse responses of the main variables to a 1 p.p. domestic tradable sector productivity shock (deviations from steady state, in p.p.)*



The same pattern is observed when we analyse a 1 p.p. common tradable sector technology shock ε_{Z}, shown in Figure 4. Similar effects happen when a 1 p.p. foreign tradable sector productivity shock $\varepsilon_{Z,T,*}$ hits the rest of the euro area (Figure 5). The difference is that this time the quality mechanism works abroad, so that spillovers come with a lag and in smaller magnitude. As a consequence, marginal costs do not increase in the domestic country, but positive effects from the price increase abroad make the tradable sector more profitable, increasing production, consumption, price and wages in the domestic country.

Figure 4: *Impulse responses of the main variables to a 1 p.p. common euro area tradable sector productivity shock (deviations from steady state, in p.p.)*

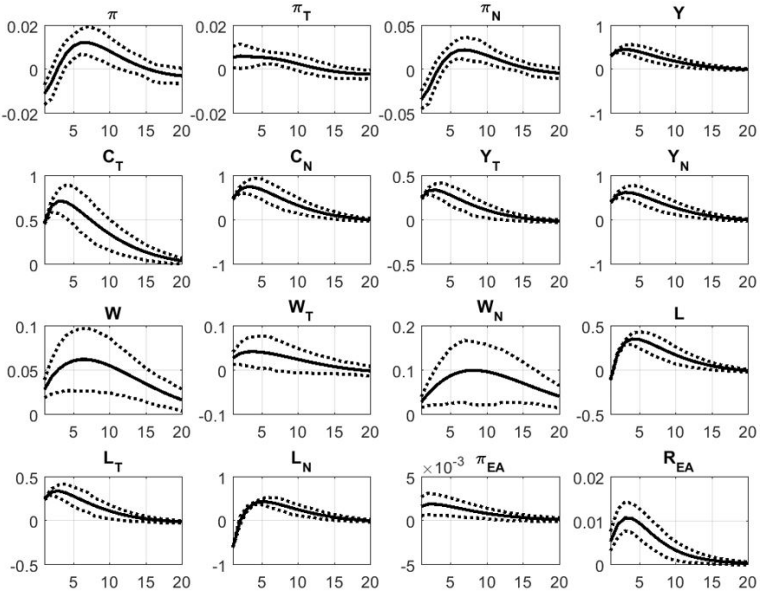
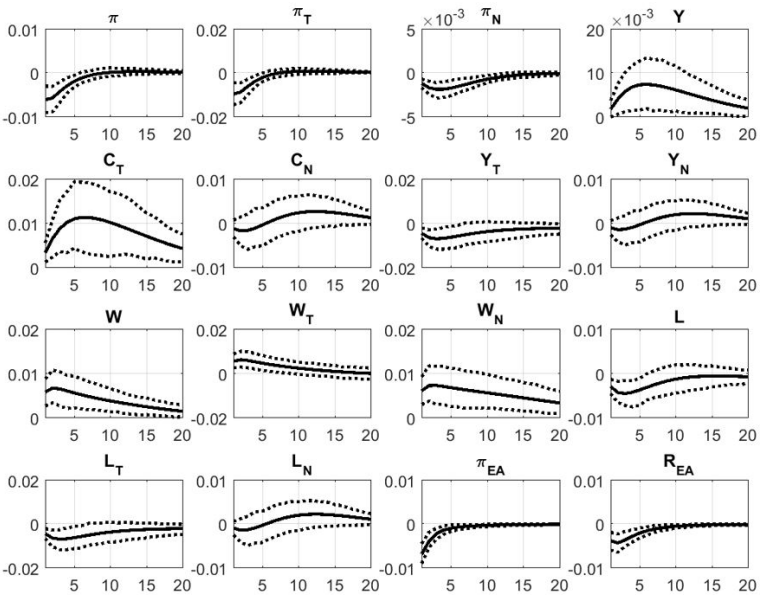
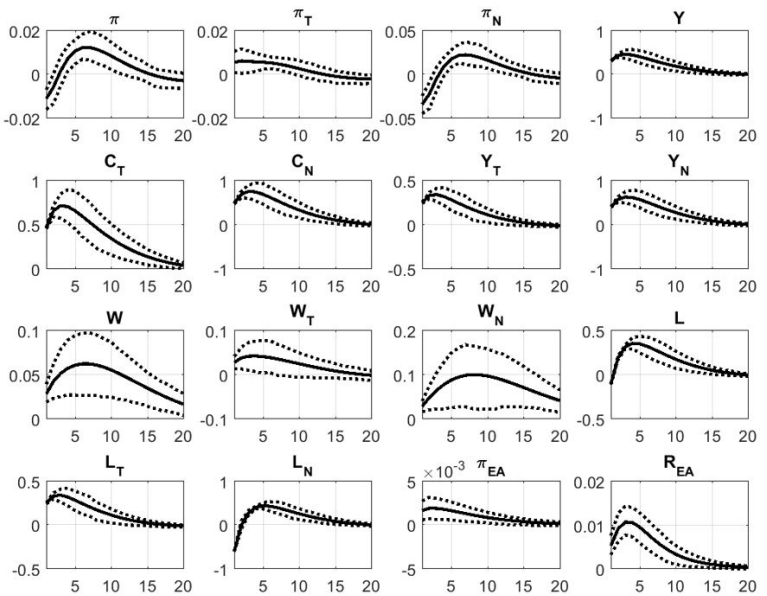


Figure 5: *Impulse responses of the main variables to a 1 p.p. foreign tradable sector productivity shock (in p.p. deviations from steady state)*



We are left to study the effects of the non-tradable sector productivity shocks, as they are depicted in Figure 6. In contrast to the tradable sector productivity shocks, the domestic non-tradable sector productivity shock $\varepsilon_{Z,N}$ does not enter the quality improvement mechanism. Consequently, it acts more as a (classical productivity) shock that decreases marginal costs and lowers non-tradable sector inflation, while the tradable sector marginally increases since the labour supply moves from the non-tradable sector to the tradable sector. The sectoral and the overall output, as well as the consumption, increase.

Figure 6: *Impulse responses of the main variables to a 1 p.p. domestic non-tradable sector productivity shock (deviations from steady state, in p.p.)*



6.2 Policy implications and way forward

The HBS effect is typically used to explain inflation differentials for countries experiencing a catching-up process. As the relatively poorer countries adopt new technologies in those sectors that are open to international trade (i.e., the tradable sector), they will experience higher productivity growth in the tradable sector, increased wages via quality mechanism, and consequently a higher inflation in sectors that are not open to international trade, as is the non-tradable sector. Therefore, the HBS effect hypothesis could help to explain higher inflation rates in the non-tradable sector than in the tradable sector, hence leading to higher overall inflation.

Another important issue to point out is that the HBS effect theory does not explain the possible sources of productivity differentials between different sectors and countries. As

the HBS is often associated with catching-up and convergence phases of less developed countries, there is a possibility that a catching-up process could take place without the HBS effect. This happens if productivity growth in both sectors (i.e., tradable and non-tradable) is equally high. Additionally, some countries that already experience high productivity levels may for various reasons (i.e., economic policies that are conducive to technological innovation) also experience relatively high productivity growth in the tradable sector. Importantly, in those countries structural rigidities and different degrees of competition[8] can affect productivity growth differentials between sectors and overall productivity growth in a way that favours either positive or negative inflation differentials.

Despite wage setting being typical for the DSGE model setting, following Calvo (1983) and later on Christiano (2005) labour market frictions, some issues could still arise in that respect. The wage setting in the non-tradable sector could be to a large extent governed by the non-market forces and other structural rigidities since a large part of the non-tradeable sector is comprised of the public sector. In our case, the model does not structurally distinguish between the private and the public sector and would consequently not be able to consider various types of non-market forces. However, it does provide some distinction in a sense of having two different (estimated) rigidity parameters of the wage setting equation for the non-tradable and the tradable sector. Based on the estimation figures the non-tradable sector wages seem to be more rigid than those in the tradable sector. They are slower in responding to exogenous shocks, which would to some extent simulate the differences between the private and the public sector. This issue could go beyond the scope of the present paper, but it could represent an additional way forward to extend the model into a more complex one by additionally restricting and dividing the modelled labour market, as well as the government sector.

Nonetheless, the continued process of convergence processes in the euro area should lead to a decline in inflation dispersion amongst the euro area countries due to a price level and income convergence in the long-run. On the other hand, other structural factors such as differences in the degrees of wage and price rigidities and divergent degree of competition in domestic markets may have also contributed to the observed inflation differentials and their persistence. In this respect, the relative degree of market competition seems to be an important parameter in explaining the size and volatility of relative price responses to symmetric shocks across euro area countries.

7 CONCLUSION

This paper draws conclusions based on a construction of a theoretical two-country two-sector DSGE model with both economies operating in a common monetary union. We were able to produce and show the existence of the HBS effect in a calibrated and estimated structural dynamic setting of the DSGE model by introducing a quality improvement mechanism that helps to explain why prices grow when productivity increases, especially in

8 i.e., the private vs. the public sector.

catching-up economies like the new EU member states in 2000. The quality improvement mechanism affects marginal costs by requiring the use of more advanced inputs in the production process. Quality improvement of goods overcomes a typical open economy theoretical specification that reduces the relative prices of domestic tradable goods relative to the foreign prices, and consequently worsens the terms of trade for the domestic economy. Despite showing the presence of the HBS effect, the effect *per se* is not large enough to pose significant risks to central banks in their quest for price stability.

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APPENDICES

Appendix A: Prior and posterior distribution

Figure A1: *Prior (dashed line) and posterior distribution (solid line) of the estimated shocks*

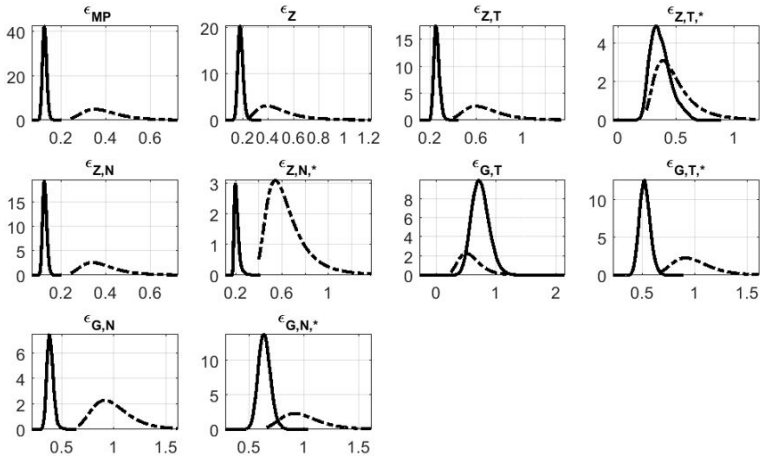
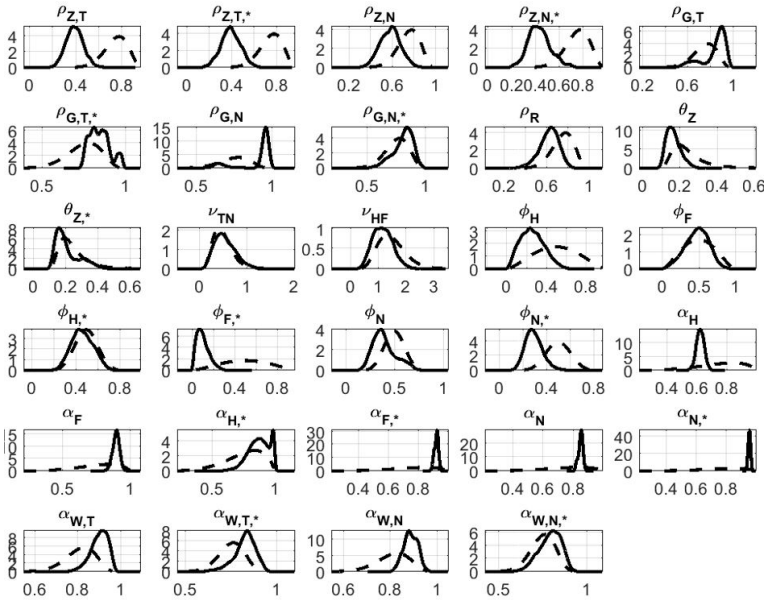
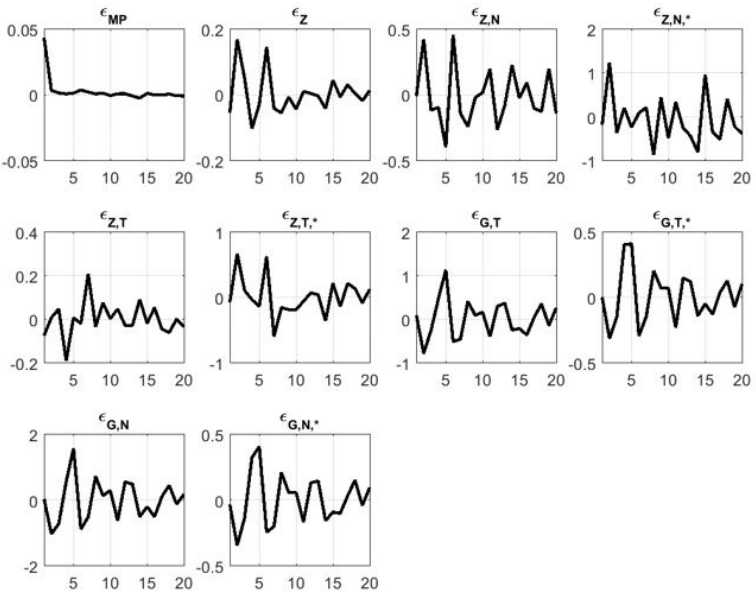


Figure A2: *Prior (dashed line) and posterior distribution (solid line) of the estimated parameters*



Appendix B: Exogenous shocks

Figure B1: *Exogenous shocks*



Change Ready, Resistant, or Both? Exploring the Concepts of Individual Change Readiness and Resistance to Organizational Change

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ABSTRACT: *This paper is a qualitative review of two concepts: change readiness and resistance to change. We review their use, clarify their conceptual underpinnings, and address the assumption of them being the opposite poles of the same continuum. We juxtapose the two concepts and analyze their dimensions which commonly represent a source of ambiguity about their meaning, review their evolution, and compare them to similar concepts. We argue that resistance to change addresses two important aspects: resistance as behavior and resistance as attitude. We argue that because resistance to change and change readiness share attitudinal roots, they should be looked at in conjunction – not on a bipolar continuum but as coexisting orthogonal dimensions – to grasp the full complexity of change-related attitudes. We discuss implications and offer guidance for future research.*

Key words: *change readiness, resistance to change, review, framework, orthogonal*

JEL classification: O15

DOI: 10.15458/85451.82

1 INTORDUCTION

Employee attitudes toward change are a key factor that determines the success of an organization's change efforts (Elias, 2009). Identified as critical for implementing planned change (e.g., Miller, Johnson, & Grau, 1994) the concept of change readiness strongly permeates the organizational change literature. Presumably presenting the same phenomenon from the opposite perspective (Armenakis, Harris, & Mossholder, 1993), resistance to change has been one of the most frequently cited reasons for why firms fail to implement change (Anuradha & Kelloway, 2004). According to Bouckenooghe (2010),

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more than 90% of the conceptual work on change attitudes has been done either on change readiness or resistance to change.

Indeed, the two concepts frequently appear in conjunction[4] in the literature, mostly represented as two opposite poles of a continuum (e.g., Salleh et al., 2011). However, calls for the clarifications of both concepts that have been raised many times (e.g., Dent & Goldberg, 1999) suggest this might have been an unnecessary simplification. Moreover, as the interest in employee attitudes toward change has grown, so has the number of other concepts that appear along the change process, such as openness to change, change cynicism, and others. Depending on their positive or negative valence toward change, they have interfered or have been used as synonyms for either change readiness or resistance to change. This process resulted in the proliferation of concepts and confusion. Stevens (2013), for example, borrowed Block's (1995) expression of "jingle and jangle fallacies" to capture the pool of change readiness conceptualizations.

The goal of our review paper is twofold. First, we aim to clarify the concepts of resistance to change and change readiness along with interactions among them in order to facilitate further development of this interesting body of knowledge. Only a clear understanding of the concepts' meanings provides firm ground for sound theorizing and clarifies incommensurability issues. Second, our goal is to show that resistance to change and change readiness need to be inspected simultaneously to grasp the full complexity of change-related attitudes. We argue that employee attitudes toward organizational change are not as black-and-white as originally assumed.

We confront the concepts of resistance to change and change readiness, and simultaneously analyze their dimensions to clarify ambiguity about what these concepts are and what they are not. We first review the evolution of both concepts through time by (a) inspecting their cognitive, affective, intentional, and behavioral aspects, and (b) presenting the evolution of theoretical approaches regarding the origin of the concepts. Next, we clarify the focal concepts by (a) further exploring the dimensions of an attitude, (b) applying both focal concepts to stages of change, and (c) comparing them to other, similar concepts. We conclude with a discussion and directions for future research.

2 THE EVOLUTION OF THE USES OF BOTH CONCEPTS THROUGH TIME

The first observation regarding organizational change literature is that resistance to change began to appear much earlier than change readiness and also trumps change readiness in the number of total publications (123 vs. 462) (see Figure 1 in Appendix). This is not surprising because people naturally resist change as it concerns moving from the known to the unknown (Coghlan, 1993). The introduction of the term *resistance to change* is

4 Change readiness and resistance to change have largely been used interchangeably, depending on which valence was more convenient (resistance for negative and readiness for positive valence).

credited to Kurt Lewin (1947). The term appeared in the first stage of his three-stage change model: the "unfreezing" stage, referring to the application of an additional force to break employees' social habits (Burnes & Bargal, 2017), current mental models, and behavior. However, Lewin "introduced the term as a systems concept, as a force affecting managers and employees equally" that could be found and rooted anywhere within the system of roles, norms, attitudes, and other factors—the psychology of the humans being just one element of it (Dent & Goldberg, 1999, p. 25). Interestingly, the first reference to resistance to change was made by McMurry (1947), with "The problem of Resistance to Change in Industry," and the second by Coch and French (1948) in a paper titled "Overcoming Resistance to Change," followed by other works all offering prescriptions to fight against resistance (Dent & Goldberg, 1999). It seems that authors aimed to prevent or overcome resistance to change as soon as it was recognized to exist. Despite resistance to change being the longest-present and probably the best-known attitude toward change in the literature (Bouckenooghe, 2010), Dent and Goldberg (1999) observed in their comprehensive review it was not well-defined and frequently lacked definition.

The concept of *change readiness*, on the other hand, was introduced more recently. Armenakis, Harris, and Mossholder (1993) define it and propose a model for creating change readiness at the individual level in 1993. In earlier literature, change readiness was not conceptually differentiated from resistance and can be traced in discussions with regard to reducing change resistance (Armenakis, Harris, & Mossholder, 1993).

In search of ways to prevent resistance, calls for the retirement of resistance to change have been raised; however, resistance to change perseveres, together with the growing body of literature on change readiness from 1993 on. A review of publications published in the year 2017 reveals that 24 publications dealt with resistance to change compared to only eight dealing with change readiness.

Despite the popularity of both concepts and their interconnectedness, a search[5] for publications dealing with both concepts simultaneously resulted in a surprisingly low number of publications. Only three publications[6] address the two concepts at the same time: the Armenakis, Harris, and Mossholder paper from 1993 aiming to differentiate

5 We searched the Social Sciences Citation Index edition of the Web of Science Core Collection database. Publications of document types article, review, proceedings paper, and book chapter, written in English between 1900 and 2018 (June) were included. We searched the database for works with the words "change readiness" or "readiness for change" in their abstracts, titles, or keywords for the first concept of our interest, and "change resistance", "resistance to change", or "resistance toward* change" for the second. The search was undertaken using the Web of Science categories, namely Management, Psychology Applied, Psychology Multidisciplinary, Psychology, Business, Social Sciences Interdisciplinary, Psychology Social, and Behavioral Sciences.

6 These three publications are: (1) Armenakis, A. A., Harris, S. G., & Mossholder, K. W. (1993). Creating readiness for organizational change. *Human relations, 46*(6), 681-703; (2) Michel, A., Todnem By, R., & Burnes, B. (2013). The limitations of dispositional resistance in relation to organizational change. *Management Decision, 51*(4), 761-780; (3) Salleh, H., Alshawi, M., Sabli, N. A. M., Zolkafli, U. K., & Judi, S. S. (2011). Measuring readiness for successful information technology/information system (IT/IS) project implementation: A conceptual model. *African Journal of Business Management, 5*(23), 9770-9778. 3).

change readiness from resistance, and two empirical papers which do not attempt to differentiate or consolidate the two concepts. This observation, in addition to the pivotal role the two concepts have in the broader change management literature, supports the need for our review.

2.1 A review of conceptualizations

As we dig into conceptualizations of resistance to change and change readiness, different paths in their evolutions can be detected. Below, we list (see Tables 1 and 2) and review their conceptualizations. We discuss their evolution addressing the four different dimensions of employee responses toward change: cognitive, affective, intentional, and behavioral.

With the *behavioral dimension* we denote actual behavior. For the *intentional dimension,* we follow Piderit's (2000, p. 787) understanding of "an intention" in his debate on attitudes toward an organizational change that denotes "a plan or resolution to take some action, rather than a plan to try to achieve some goal (Bagozzi, 1992)". This understanding is in line with the theory of planned behavior (Ajzen, 1985) and the tripartite attitude model (Smith, 1947), on which our theorizing is based on. Moreover, our aim is not to observe what the goal of a dimension is. We draw on the assumption that humans as rational beings will always act rationally - with an intention.[7] The *cognitive dimension* refers to beliefs, thoughts, perceptual responses, and knowledge structures about change (Breckler, 1984). The *affective dimension* refers to feelings about change. Eagly and Chaiken (1998, p. 272) define this dimension as "feelings, moods, emotions, and sympathetic nervous-system activity that people have experienced in relation to an attitude object and subsequently associate with it."

Table 1: *An overview of resistance to change definitions*

Source	Definition	Dimension
Zander (1950, p. 9)	"Behavior which is intended to protect an individual from the effects of real or imagined change."	Behavioral
Argyris (1985, p. 5)	"Thoughts and actions used to protect individuals', groups', and organizations' usual way of dealing with reality."	Cognitive, and behavioral
Brower & Abolafia (1995, p. 151)	A particular kind of "action or intentional inaction."	Behavioral

7 Acting "rationally" in the social sciences usually means "acting with instrumental rationality – doing what will get you whatever ends you wish to achieve, whether they are in your best interest or not (Korsgaard, n.d.).

Source	Definition	Dimension
Ashforth & Mael (1998, p. 90)	"Intentional acts of commission or omission that defy the wishes of others."	Behavioral
Folger & Skarlicki (1999, p. 36)	"Employees' behaviour that seeks to challenge, or disrupt the prevailing assumptions, discourses, and power relations."	Behavioral
Herscovitch (2003, p. 14)	"Employee action or inaction that is intended to avoid a change and/ or interfere with the successful implementation of a change in its current form."	Behavioral
del Val & Fuentes (2003)	"Any set of intentions and actions that slows down or hinders the implementation of change."	Intentional, and behavioral
Oreg (2006, p. 76)	"Tri-dimensional (negative) attitude towards change, which includes affective, behavioural, and cognitive components."	Affective, cognitive, and behavioral or intentional[8]

The literature focusing on resistance to change departed from the behavioral dimension (see Table 1). Researchers describe resistance to change as behavior intended to protect recipients from change (e.g., Zander, 1950), and to avoid change (e.g., Herscovitch, 2003). Coch and French (1948), the authors who made one of the first references to resistance to change, as well use desirable (compliant) behavior as a criterion in their quasi-experiment on resistance to change (Piderit, 2000).

In later stages of evolution of resistance to change we spot the intentional dimension was added (see del Val and Fuentes, 2003) and finally we arrive to the contemporary definition that describes it as a multidimensional attitude (Oreg, 2006).

The cognitive dimension can as well be identified in early definitions (see Argyris, 1985). Also, when advising on how to overcome resistance, a "cognitive realignment of resistors' espoused theories and their theories-in-use" is recommended (Diamond, 1986, as cited in Dent & Goldberg, 1999, p. 786). Also, among the causes of resistance Dent and Goldberg (1999) find misunderstanding to be a common cause, exposing its cognitive component. Zander (1950), for example, notes that resistance may surface "if the change is open to variety of interpretations" or "if the nature of the change is not made clear to the people who are going to be influenced by the change" (Dent & Goldberg, 1999, p. 34-35). Lawrence (1954) also emphasized management should use understandable terms so that the change makes sense to employees. Cognition as a part of the phenomenon can as well be found

8 To Oreg (2006) the behavioral dimension denotes action or intention to act.

in the early work of Coch and French (1948) discussing participation that might have motivational and cognitive effects (Piderit, 2000).

The affective dimension can be found in early descriptions of resistance to change, but not in its definitions. Shimoni (2017) notices that Dent and Goldberg (1999) list terms such as *fear*, *frustration*, *emotionality*, and *innate aggression* when discussing resistance to change, all of which expose the emotional or affective nature of the concept. Notions of aggression can be traced back to the work of Coch and French (1948). In Diamond's (1986) view, the underlying nature of resistance to change is highly emotional (Piderit, 2000), even though not explicitly noted in its earlier definitions, as opposed to more recent definitions, where the affective component is included (e.g., Oreg, 2006). Oreg et al. (2018) describe resistors' responses to change with underlying core affects, such as stressed, angry, and upset.

Table 2: *An overview of change readiness definitions*

Source	Definition	Dimension
Armenakis Harris, & Mossholder (1993, p. 681)	"Organizational members' beliefs, attitudes, and intentions regarding the extent to which changes are needed and the organization's capacity to successfully make those changes."	Cognitive, affective, and intentional
Cunningham et al. (2002, p. 377)	It involves "a demonstrable need for change, a sense of one's ability to successfully accomplish change (self-efficacy) and an opportunity to participate in the change process."	Cognitive[9]
Holt, Armenakis, Feild, & Harris (2007, p. 235)	"The extent to which an individual or individuals are cognitively and emotionally inclined to accept, embrace, and adopt a particular plan to purposefully alter the status quo."	Cognitive, and affective
Weiner (2009, p. 68)	"Organizational readiness for change refers to organizational members' change commitment and self-efficacy to implement organizational change."	Cognitive[9]
Holt & Vardaman (2013, p. 9)	"The degree to which the organization and those involved are individually and collectively primed, motivated and capable of executing change."	Cognitive[9]

9 Perhaps not explicitly stated, the definitions of Cunningham et al. (2002), Weiner (2009), and Holt & Vardaman (2013) describe the cognitive dimension. The concept of self-efficacy is even entailed in the operationalization of change readiness discussed in more detail in Section 3.

In contrast with the beginnings of resistance to change, Armenakis, Harris, and Mossholder (1993) explicitly position the core of creating change readiness in changing individuals' cognitions, the latter representing a precursor to behaviors regarding change efforts. In their view, readiness is "reflected in organizational members' beliefs, attitudes, and intentions regarding the extent to which changes are needed and the organization's capacity to successfully make those changes" (p. 681). Thus, the change readiness concept puts cognitions in the focus of attention from its beginnings.

Armenakis, Harris, and Mossholder (1993) do not explicitly mention affect in their conception of change readiness, but it can be traced in the notion of readiness being an attitude because an attitude is comprised of "qualitatively different types of information (e.g., affective and cognitive)" (Crites, Fabrigar, & Petty, 1994, p. 621). In more recent conceptualizations, we can find readiness explicitly defined as consisting of cognition, as well as affect. Nevertheless, affect still remains an understudied dimension in change readiness research (Rafferty et al., 2013). Some definitions also note intentions but not behaviors. Rafferty et al. (2013) conclude intentions should be excluded from the conceptualization, since they are indications of how hard one is willing to try and how much energy one is willing to invest in order to perform the behavior (Ajzen, 1991) concerning employees' *motivation*.

2.2 Theoretical approaches to studying resistance and readiness to change

Besides dimensions of the focal change concepts, the literature has also put a lot of emphasis on the sources of change readiness and change resistance. We draw on Shimoni's (2017) grouping of approaches to resistance to change and identify the following evolutional lines of the sources of both concepts: (a) deriving from an individual's psychological disposition, (b) arising from the change context, (c) being a product of interplay between disposition and context, and (d) arising from habitus.

The first, and the earliest one — deriving from the individual's psychological disposition, has only been discussed in connection to the concept of resistance to change. This approach is also called the traditional approach to resistance to change. The other three approaches listed above are relevant for both concepts, thus we adopt them to discuss change readiness as well.

2.2.1 An individual's psychological disposition as a source: The traditional approach

Traditionally, scholars approached resistance to change as something rooted exclusively within individuals. What people actually resist is not change per se, but letting go of something that is familiar. They fear to lose status, pay, or comfort (Dent & Goldberg, 1999), or even their identity (Karp & Tveteraas Helgø, 2009), seeing change in organizations as shifting of identities. Neuroscience complements biologists' findings that the human brain is wired against loss (e.g., Cozolino, 2006) – loss aversion – and our brains tell us to

resist change and save energy if change is not necessary for our survival (Csikszentmihalyi, 1996).

In his review, Shimoni (2017) notes that organization development scholars and practitioners often see resistance to change as pathological — a defensive routine that change creators need to defeat. Being something that organizations need to overcome also implies the position of the concept in the four-phase reaction process to change that individuals go through, according to Scott and Jaffe (1988, as cited by Bovey & Hede, 2001, p. 534), being: "initial denial, resistance, gradual exploration, and eventual commitment". The traditional view assumes employees' resistance can be turned into more supportive orientation if employees do the best they can (Illouz, 2007) and has been, in Krantz's (1999, p. 42) opinion, "transformed over the years into a not-so-disguised way of blaming the less powerful for unsatisfactory results of change efforts".

Ford, Ford, and D'Amelio (2008, p. 362) emphasize that the "change agent-centric" view that sees change agents as unbiased observers (who do the right thing to overcome the objective reality of change recipients who are seen as obstacles resisting the change) should be discarded. We should realize that resistance is a result of interactions and relationships between change agents and recipients and does not reside completely "over there, in them (i.e., in change recipients)" (Ford, Ford, & D'Amelio, 2008, p. 362).

2.2.2 Change context as a source: The social context approach

Recognizing there is more to it than just individuals, scholars began to see resistance as a product of the social context. Contextual factors are the circumstances under which change occurs and can inhibit or accelerate the effectiveness of change implementation (Self, Armenakis, & Schraeder, 2007). Lewin's field theory argues an individual's behavior needs to be understood within the context, taking into account all the forces of the life space that affect it (Lewin, 1947).

Ford, Ford, and D' Amelio (2008) advocate for the importance of change agents' role and their relationships with employees. Change agents need to be able to restore trust and establish fairness, call to action, and communicate effectively to avoid misinterpretation that could cause resistance. This factor belongs to the process factors of the change process, which include strategies and tactics, justifying organizational change, communicating a shared vision, and executive visibility (Self et al., 2007; Armenakis & Bedeian, 1999). Supporters of this approach see inappropriate organizational cultures as obstacles to or enablers of reducing resistance by guiding their members on how to act, perceive, and feel (Shimoni, 2017). Often, the organizations' structures are sources of resistance (e.g., narrow job categories can force employees to choose between new perspectives and their self-interests; Burnes, 2015, Kotter, 1995). Holt and Vardaman (2013) add encouraging climate, and reward or incentive systems as relevant structural factors. Kotter (1995) finds

individual resistance to be rare and states employees usually understand the new vision and desire its realization but are restrained by the system.

The social context approach was used by Armenakis, Harris, and Mossholder (1993) to build foundations of the concept of change readiness on. They acknowledge the contextual factors influencing the creation of change readiness, especially the role of change agents through influence strategies, such as persuasive communication, management of external information, and enabling active participation. Change managers should take the role of proactive players instead of trying just to "reactively monitor the workplace for signs of resistance" (p. 682), thereby taking the role of proactive change agents as coaches and champions of change. Second, they emphasize change readiness is a social phenomenon influenced by other peoples' readiness, another factor showing the context-dependency of change readiness.

2.2.3 Interplay between an individual's psychological disposition and change context as a source: The social construction approach

While the first two approaches view the personal and the social aspects as relatively separated (Shimoni, 2017), the social construction approach integrates both. This approach returns to Lewin's roots. This time, the whole content, not just the nomenclature, has been adopted because Lewin saw the behavior of individuals, groups, and organizations as a function of a totality of a life space entailing both — the individual and the environment (Burnes & Bargal, 2017). According to Burnes (2015), contextual factors moderate the level of dispositional resistance, and organizations being social systems, resistance should be seen as emerging from the mutual effects of individuals' and organizations' characteristics.

In the evolution of the concept of change readiness, the social construction approach was adopted as well, recognizing the importance of individual and contextual mutual effects. Holt and Vardaman (2013) named them *individual factors* (psychological) and *structural factors* (the circumstances under which change occurs).

2.2.4 The habitus-oriented approach

Shimoni (2017) acknowledges the advantage of the social construction approach and returns to the original Lewin's idea, but criticizes it for ignoring the dynamic nature of resistance. Thus, he proposes a habitus-oriented approach to resistance to change. He argues that "resistance is a social practice built into the system, produced by social agents' habitus, historically developed in constant interactions between human agents and social structures in a given social field" (Shimoni, 2017, p. 263). In line with the concept of habitus, social agents' behavior is not a direct reaction to external conditions (Swartz, 2002) but an improvisation of action strategies within structural constraints, also in terms of deeply rooted past experiences (Shimoni, 2017). For Shimoni, individuals or groups (social agents) are active producers of meaning. Bourdieu (1989) explains that by adopting

the social structure of organization through the process of socialization, the social structure becomes a part of individuals' habitus or social disposition, which influences their thoughts and behaviors, including resistance to change (Shimoni, 2017). The habitus approach emphasizes the mirroring of organizations' material and symbolic social structures in an individual's cognition. As Shimoni (2017, p. 264) notes, it is "something people learn, and once it is learned it 'naturally' affects the way they think and behave."

Holt and Vardaman (2013) propose an expanded conceptualization of change readiness by incorporating the factor of awareness. They draw on Gondo, Patterson, and Palacios's (2013) research on mindfulness, which points out the uselessness of willingness and capability of employees in the absence of awareness of the need for change and of their routinized or automatic behaviors. With this, we are rapidly approaching the habitus-oriented approach to resistance, as discussed by Shimoni (2017), incorporating the social disposition that influences our thoughts and behaviors, meaning that we are not (fully) aware of our routinized behavior.

3 CLARIFYING THE CONCEPTS

As the review of the evolution of the concepts has shown, the contemporary definitions describe change readiness as well as resistance to change as having an attitudinal core. However, this still leaves some ambiguity about the entailment of intentions and behavior in these two concepts. We discuss the dilemma of whether they should be included or excluded from the conception of an attitude and address some other aspects in the following subsections to improve the understanding of the focal concepts.

The tripartite attitude model (Smith, 1947) that led the development of attitude research constitutes of three attitude components: the cognitive, the affective, and the conative. While the cognitive component clearly denotes the beliefs (e.g., believing the change is beneficial), and the affective refers to feelings (e.g., being angry about change) about the attitude object (a specific change), the conative component is the most complex of all. In some cases also named intentional, in others behavioral, this dimension created substantial conceptual confusion. It denotes future intentions to act based on past behaviors or experiences with the attitude object. Some studies place more emphasis on past experiences and behaviors to reflect evaluations of an attitude object, while others criticize this, and focus on intentions, saying that one might not have past experiences when responding to a novel event (Piderit, 2000).

However, some researchers (e.g., Oreg, 2006), understand this component as entailing both, intentions to act as well as actions (e.g., verbally expressing intentions concerning change adoption, trying to convince others that the change is not beneficial). Thus, we identify the first source of conceptual confusion, especially concerning resistance to change, in different interpretations of the conative component. We need to understand that attitudes are a psychological phenomenon and higher-order classes of response to stimuli that

cannot be observed directly. Thus, Breckler (1984) sees overt actions as expressions of the behavioral dimension. Behavior in a sense of action or intentional inaction was often the only dimension in earlier stages of resistance to change definitions, as our review reveals.

However, intentions, and attitudes in general, do not necessarily end in behavior consistent with them (Fazio & Olson, 2007). This brings us to the second important issue in need of attention in order to understand our focal concepts better – the attitude-behavior gap. Drawing from critiques of attitude-behavior consistency of the tripartite model and consistent with the theory of planned behavior (Ajzen, 1985), behavioral intention does not always lead to actual behavior because the individual's control over the behavior is incomplete.

The third issue is the absence of agreement on whether to omit the conative component (intentions) from conceptualizations of an attitude altogether. Because the findings of the existence of the conative dimension are mixed (some advocates of the multidimensional view find evidence of only affective and cognitive dimensions in an attitude structure and some find all three), Eagly and Chaiken (1993, p. 13) in their review of the literature on the tripartite model conclude that "evidence supports the empirical separability of three classes of evaluative responses under some but certainly not all circumstances."

Based on our discussion, we propose behavior should be excluded from conceptualizations of change readiness and resistance to change that are defined in attitudinal terms, and should be seen as their possible outcome. Furthermore, we call for an agreement on the entailment of the conative component in attitudes that should be followed in both concepts consistently. The gap regarding the conative component is clearly visible in the operationalization of the concepts.

The constitutive definition of change readiness does not entail intentions or behavior. To comprise the concept of individual change readiness at lower levels of abstraction, Armenakis, Harris, and Mossholder (1993) proposed two factors that change agents need to cover through communication: (a) *discrepancy* between the desired state and the current state the employees need to realize (i.e., the need for change), and (b) *self-efficacy* (i.e., perceived ability of individuals and collective to change). Later, other factors were added, and today, the most popular and frequently used manner to operationalize change readiness at the individual level features the five dimensions by Holt and colleagues (2007). These include additional questions of (c) the *appropriateness* of the proposed change for addressing the discrepancy; (d) *principal support* being the degree to which organizational leaders support the change; and (e) *personal valence* (e.g., Is the change beneficial for the individual?). Finding positive answers to these questions will form an attitude of change readiness. This operationalization is referred to in the literature as "the message" and shows how salient cognition or individuals' beliefs are in the conceptualization of readiness.

On the other hand, the operationalization of individual resistance to change includes all three dimensions: cognitive, affective, and conative. Oreg (2006) followed Piderit's (1999) work and designed the Change Attitude Scale based on a conceptualization of resistance to change as a multidimensional, which previous studies did not consider (Oreg, 2006). The items measuring affect question (positive and negative) feelings one has toward a specific change. The cognitive dimension involves items about the employees' evaluations of the worthiness and potential benefit of the change. The last, conative dimension (also called *behavioral* and *intentional* in Oreg's [2006] in Piderit's [1999] nomenclature, respectively) addresses intentions to act and actions against the change (Oreg, 2006). At this point, we need to mention the Resistance to Change Scale (Oreg, 2003) that has been widely used and accepted the operationalization of change resistance. This instrument was designed to measure an individual's dispositional resistance to change. It includes items measuring emotional reactions to imposed change, routine seeking, and cognitive rigidity. As such, it can be understood as an antecedent to a change-resistant attitude (Oreg, 2006) and must not be confused with change resistance conceptualized as an attitude.

3.1 The coexistence of change readiness and resistance to change

An important underlying assumption of the tripartite model is the consistency of all dimensions of an attitude because they are part of the same underlying construct experienced by an individual. However, besides the attitude-behavior consistency, this is one of the significant critiques of the tripartite model because numerous studies show the existence of inconsistencies (Fazio & Olson, 2007). With new research advocating a reconceptualization of individual responses to change as multidimensional attitudes, it is becoming clear that attitude toward change is not all black-and-white. One can foster a positive attitude toward change, yet at the same time resist it. In other words, resistance to change and change readiness can coexist.

Individual's "simultaneously oppositional positive and negative orientations toward an object" including cognition ("I think about X") and/or affect ("I feel about X") is defined as ambivalent (Ashforth et al., 2014, p. 1455) and is perhaps the most prevalent type of response toward change that has been ignored for a long time (Piderit, 2000).

3.2 Using time to improve understanding of the concepts

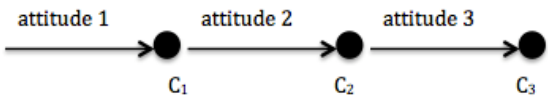
It is important to note that change readiness and resistance to change are, as attitudes, situational and time sensitive. If the situation or the context within which change occurs changes, attitudes can change as well.

Referring to change readiness, Armenakis, Harris, and Mossholder (1993, p. 700) noted that "the creation of readiness is not necessarily a pre-change concern only." They posited readiness should be maintained throughout the duration of the change process because

change is composed of smaller, ongoing changes and thus initial change readiness will not suffice.

We illustrate this in Figure 2 and add that the focal change stays the same, however, with each new piece of information from the external or individual's internal environment (the changing of the context) becoming available, the focal change subjectively changes for the individual, and thus the attitude toward it can change, too. The issue of time and context changes that it brings is especially significant to our discussion of change-related attitudes, since attitudes form before change takes action. For the formation of an attitude toward future events that we can never possess complete information on, every new piece of information we obtain can importantly change our attitude. Thus, we can see change readiness and resistance to change must be seen as fluid.

Figure 2: *The role of time and change of context in attitude change*



Note. C1 means change 1, C2 change 2, and C3 change 3. We are talking about the same change (e.g., a merger), however, as the context changes, the change is not the same for the individual anymore because with time new information that changes the context of the change is obtained.

Stevens (2013) offered clarification of change readiness by applying stages of change. Drawing on Lewin's three-stage model of unfreeze–change–refreeze, there is a consensus that change readiness applies to the phase of unfreezing and "equates to the preparation stage" (Holt & Vardaman, 2013). However, as Stevens (2013) noted when applying it to the phases of the transtheoretical model (Prochaska & DiClemente, 1983), it is not clear where to apply it. Thus, he proposed conceptualizing change readiness as a process referring to the transitions between the phases of precontemplation to contemplation and contemplation to preparation, reflecting the shifts in an individual's decisional balance rather than positioning it in a particular phase. We propose this approach could be applied to resistance to change as well.

3.3 Confusion with similar concepts

While the majority of definitions of change readiness draw on Armenakis, Harris, and Mossholder (1993), some definitions are closer to other concepts and some even contain them in the definitions of readiness, such as change commitment (e.g., Weiner, 2009). For this reason, we review some of the concepts most often used in conjunction with change readiness or as its synonym in Table 3.

Table 3: *Concepts similar to change readiness*

Construct	Source	Definition
Openness to change	Miller, Johnson, & Grau (1994, p. 66)	"Willingness to support organizational change and positive affect toward change."
Commitment to change	Herscovitch & Meyer (2002, p. 475)	"A force (mind-set) that binds an individual to a course of action deemed necessary for the successful implementation of a change initiative."
Coping with change	Folkman, Lazarus, Gruen, & DeLongis (1986, p. 572)	"A person's cognitive and intentional/ behavioral efforts to manage (reduce, minimize or tolerate) the internal or external demands of the person-environment transaction when it is appraised as taxing or exceeding a person's resources."

The confusion can be partly resolved by considering the stages of change. Readiness, in comparison to commitment, refers to the stages prior to the action stage, while commitment is in Armenakis, Harris, and Feild's (1999) view typical of Lewin's freezing stage. However, it may apply to any of the change stages, and thus in the earlier stages of the change process these two concepts can indeed be indistinguishable, since they are both described as precursors to change-supportive behaviors (Armenakis & Harris, 2009) and entail cognitive and affective dimensions (Hersovitch & Meyer [2002] suggest the force might also be classified as affective).

Some authors distinguish openness from readiness, saying it is a prior condition to it (Wanberg & Banas, 2000), while others (e.g., Herold, Fedor, & Caldwell, 2007) treat the two concepts as nearly synonyms. Since openness does not entail the intentional component, the similarity of the two depends upon whether we include intentions into conceptualization of readiness (Stevens, 2013). Thus in the early stages when it is not clear what type of behaviors will change require to form intentions readiness may indeed take the form of openness (Stevens, 2013).

Coping with change differs from change readiness by involving behavioral effort to manage change. Moreover, it implies change is already occurring, as opposed to readiness that happens before change occurs.

The problem of differentiating between similar concepts deriving from stages of change is not that salient with resistance to change. An issue that seemingly needs to be clarified is activation. Coetsee (1999) places resistance on a continuum of intensity ranging from apathy (i.e., indifference) to aggression (i.e., destructive opposition), positing that

resistance can be passive when forms of opposition are weak, expressed for example by voicing opposition, or active when blocking or impeding change. We agree with Coetsee (1999) that a more nuanced approach is needed. However, we share the views building on Lewin's (1947) and other behavior-oriented conceptualizations, as well as affect-focused conceptualizations describing change resistance with core affects high in activation (e.g., Oreg et al., 2018), implying resistance to be high in activation.

Change readiness or resistance happens when individuals foster psychological attachment to change. Change entails psychological involvement for them and triggers psychological arousal (Baek, 2010). The psychological arousal can be in a form of cognition or affect. Arousal of cognition and activation of an individual's cognitive resources show through answering questions, such as "Is the change needed? Am I capable of change? Is the change beneficial for me?" and others explained in Section 3. In other words, we speak of change resistance and change readiness when employees care for the change. In terms of affect, emotions high in activation are felt, such as excitement, fear, or anger (Oreg et al., 2018). Coghlan (1993) for example describes resistance as a dynamic energy and emphasizes it is not passive.

We posit other concepts are more appropriate for capturing low levels of psychological activation, such as disengagement (Oreg et al., 2018) or indifference, as mentioned by Coetsee (1999) himself. Jermier, Knights, and Nord (1994, p. 9) observe that seeing resistance as "a reactive process where agents embedded in power relations *actively* oppose initiatives by other agents" is the most prevalent view in the literature and this is also the view advocated in our paper as the most appropriate. We present the concepts of psychological disengagement and indifference, together with another concept similar to resistance to change – change cynicism in Table 4.

Table 4: *Concepts similar to resistance to change*

Construct	**Source**	**Definition**
Psychological (change) disengagement	Major et al. (1998, p. 35)	"A defensive detachment of self-esteem from outcomes in a particular domain, such that feelings of self-worth are not dependent on successes or failures in that domain."
Indifference	Ben-Ze'ev (2000)	Perceiving something as unimportant, thus feeling no emotion in response.
Change cynicism	Wanous, Reichers, & Austin (2000, p. 135)	"A construct that has two elements: a pessimistic outlook for successful change and blame placed on "those responsible" for lacking the motivation and/or the ability to effect successful change."

Cynicism about change can be found on the negative side of attitudes toward change. Bommer, Rich, and Rubin (2005) see it as a complex attitude comprised of cognitive, affective, and behavioral aspects. However, as Reichers, Wanous, and Austin (1997) observe, cynicism does not necessarily result in change-resistant behaviors, which is compliant with our discussion on the behavioral component of attitude in Section 3. Cynicism is distinct from resistance in that it arises from a loss of faith in change leaders and the history of unsuccessful change attempts, whereas resistance as a negative attitude toward change is based on self-interest, misunderstanding, or inherently limited tolerance for change (Reichers, Wanous, & Austin, 1997). Thus, being cynical about change will not aim to seek answers to questions such as "Is change needed and beneficial for me?" because a cynic fosters feelings of distrust or unfairness toward those responsible for change (Bommer, Rich, & Rubin, 2005).

4 DISCUSSION

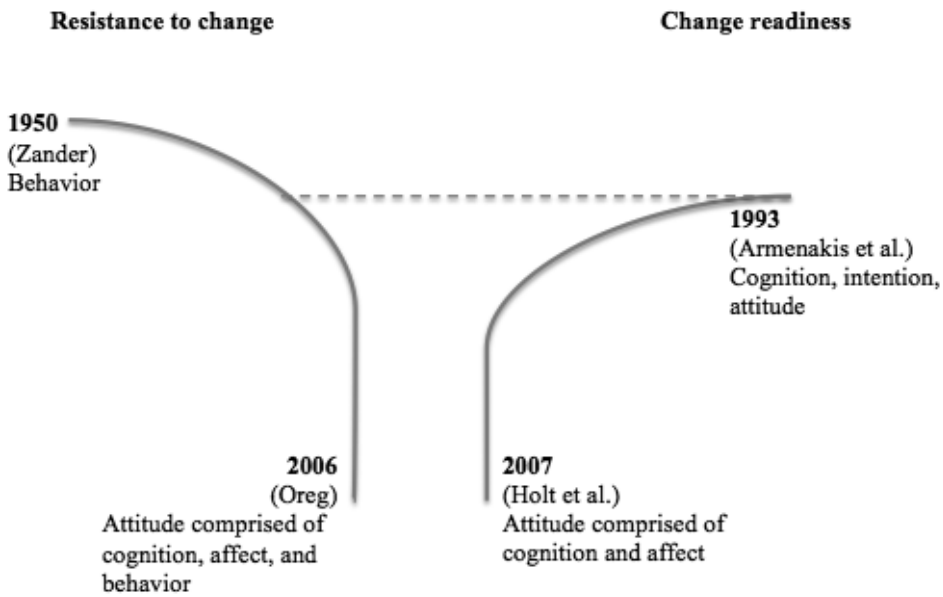
Armenakis et al. (1993) tried to differentiate the concept of change readiness from resistance to change, however, they were not as successful in resolving the confusion as in preventing further calls for clarifications after their publication (e.g., Dent & Goldberg, 1999). Their differentiation draws on the majority of past definitions of resistance to change defining the concept in behavioral terms. Armenakis et al. (1993, p. 681) differentiate readiness from resistance by defining change readiness as "a cognitive precursor to the behaviors". They leave resistance to change conceptualized as behavior solely. In their view, the behavior could be of either support for change or resistance towards change, despite the term "resistance" being usually associated with a negative orientation toward change. Similarly, their view allows for assigning the possible negative valence to the change readiness attitude, meaning a sort of change readiness (i.e., negative change readiness) could be a precursor to the change resistance (the behavior). However, what seemed a clear differentiation between the two focal concepts opens new questions, one of them being "What was their basis for defining resistance as behavior?", while the cognitive component is present in some definitions and literature preceding their paper (e.g, Argyris, 1985), as revealed in our review.

Based on our review and discussion in Section 3, we claim that the ambiguity and therefore calls for clarifications were justified. Resistance to change cannot simply be conceptualized as behavior, as Armenakis et al. (1993) proposed. The two concepts share attitudinal roots. When we speak of resistance to change as behavior (as the majority of early definitions do), we know today that we should be speaking of a different concept. We are witnessing a polysemy, meaning using the same phrase (resistance to change) to denote two different meanings and thus two concepts: (a) resistance to change: the attitude, and (b) resistance to change: the behavior. However, back in 1950, when Zander defined resistance to change, behaviors were assumed to be visual expressions of attitudes – the directly unobservable psychological phenomena.

Figure 3 illustrates our understanding of how the two concepts grew more together through their evolution. According to clarification, our proposal for resistance to change as a behavior should be seen as a separate concept from resistance to change as an attitude, we could assume the resistance to change "curve" presents two different concepts. But knowing the background and the development of attitude-behavior consistency literature, it becomes clear it depicts the evolution of one concept.

Nowadays, resistance to change and change readiness are conceptualized as attitudes. However, due to the different evolutions of our focal concepts, and the issues raised in Section 3, the conative or behavioral component is still present in the operationalization of resistance to change but not in the operationalization of change readiness.

Figure 3: *The evolution of resistance to change and change readiness conceptualization*



As for their use, resistance to change nowadays is still operationalized in research in different ways. While the majority of research acknowledges the multidimensionality of the concept and uses Oreg's (2006) definition (e.g., Rafferty & Jimmieson, 2017; Moutousi & May, 2018), some authors still use it exclusively in behavioral terms (e.g., Furst & Cable, 2008), and do not recognize it as an attitude. Change readiness, on the other hand, is consistently used as an attitude. Its possible consequent behavior is discussed as change-supportive behavior.

We conclude that the concepts do represent the opposite poles of a continuum. They share the core property of being attitudes, readiness being the positive, and resistance the negative orientation toward change. However, both concepts should be operationalized along the same dimensions to enable complete alignment. Thus, we call for a unified approach to the operationalization of both concepts to facilitate commensurability. More specifically, we suggest that an agreement on the entailment of intentions in the conceptualization of an attitude should be reached and consistently implemented into both concepts. Furthermore, the behavior should be excluded from the resistance to change concept, and change-resistant or change-supportive behaviors seen as possible outcomes of resistance to change and change readiness, respectively.

To ensure commensurability, an important property of the concepts, as well as their similarity by involving activity and not passivity of change recipients, is deriving from psychological attachment to a specific change. With activity we refer to a form of psychological arousal, the activation of recipients' cognitive resources and/or emotions. In other words, employees will experience resistance or readiness when they care for the change, and the criterion of activation importantly separates them from other change-related attitudes.

Another criterion that we propose to help clarify the two concepts is the role of time and change context. Resistance to change and change readiness concern the pre-change phase, however, as attitudes they are situational and are as such ongoing processes. As the context changes constantly with time, the attitude can change as well and should not be treated as a pre-change concern only because every change is composed of many other smaller changes. In line with this finding, the two concepts should be seen as continuous and measured accordingly.

The situational property of change attitudes should not be lost or the terms confused with trait-like concepts. Resistance especially, is often seen as a psychological disposition of individuals and has been measured in many studies, using Oreg's (2003) Resistance to Change Scale. An individual's dispositional inclination to resist change is a possible source or antecedent of a change-resistant attitude. The same could be applied to readiness.

Despite the finding that change readiness and resistance to change can be put on a bipolar continuum, the question is, should they be. Change is one of the major triggers of ambivalence (Piderit, 1999), and an individual can simultaneously hold positive and negative orientations toward change. Moving beyond the seminal work of Thurstone (1928), who saw attitudes on a bipolar continuum ranging from positive to negative, with a neutral point in the middle, we draw on social psychologists' work (e.g., Kaplan, 1972; Breckler, 1994) to suggest that a more nuanced approach is needed by separating the positive and negative components of an attitude and placing them in a two-dimensional space. According to the traditional bipolar attitude approach, individuals who have mixed feelings, as well as the ones who are indifferent, would report the same neutral attitude

(Baek, 2010). We note that change readiness and resistance indeed can and should be looked at in conjunction, however, not in the sense of a bipolar continuum but rather as simultaneously present orthogonal concepts, as depicted in Figure 4. Within the spectrum of attitudes, which arises from the orthogonality of the two concepts, there are many nuances of attitudes that need to be further researched in the future.

Figure 4: *Resistance to change and change readiness: From bipolar to orthogonal concepts*

With our review, we contribute to the clarification of the change readiness and resistance to change concepts. Our findings bear insights for future research on the integration of the two concepts. Moreover, we see our results as building blocks to help align and integrate existing measures or develop new ones. Drawing from our clarification of the focal properties of the concepts, we propose a new measurement instrument should be developed in the future that would improve the validity of resistance to change and change readiness and better reflect the realities of change-related attitudes.

In Table 5, we summarize the proposed building blocks for a potential new measurement instrument.

Table 5: *Building blocks for a potential new measurement instrument*

Building block	**Description**
Catching ambivalence and attitudinal nuances	The new measurement instrument should be able to measure resistance to change and change readiness simultaneously (i.e., as orthogonal concepts) to be able to capture the realities of change-related attitudes that are often ambivalent.
Aligning the attitude components	An agreement on the entailment of the conative component in the conceptualization of an attitude should be achieved and followed in both focal concepts consistently. This would facilitate the commensurability of change readiness and resistance to change and establish the condition to treat the two concepts as orthogonal to one another.

Building block	Description
Separation of the behavioral dimension from conceptualization of resistance to change	Behavior should be excluded from the resistance to change concept and seen as a possible outcome (change-resistant behavior) of the attitude. This would also establish a condition for orthogonality of the concepts.
Psychological activation	We speak of resistance to change and change readiness when change triggers psychological (cognitive and/or emotional) arousal and an individual cares for the change. Activation in a sense of behavior is a possible outcome of the focal concepts.
Continuance of measurement	Despite concerning the pre-change phase, resistance to change and change readiness are situational, and should be understood and measured as an ongoing process, as the context changes constantly with time. One-time pre-change measurement will not suffice.

Based on Holt and Vardaman's (2013) definition of change readiness, which entails the capability of executing change, and following the ordinary meaning of the term *readiness* (i.e., to be fully prepared for something; *New Oxford American Dictionary)*, we find another interesting avenue for future research and conceptualization of change readiness. A question appears of whether the self-perceived capability (self-efficacy) captured in existing definitions of change readiness should be expanded to capability in more objective terms as well. Drawing on the plain readiness definition, Weiner (2009) noted that change readiness means being willing and able to change. The issue of actual ability should receive attention in future research, especially because change readiness is used as a tool by practitioners to predict the success of future change implementations. By expanding the definition in such a way, we would radically redefine change readiness, making it more than an attitude and moving it away from the concept of resistance to change. An alternative would be to define a new concept that entails both, readiness and ability.

5 CONCLUSION

In our paper, we juxtaposed the concepts of resistance to change and change readiness, and reviewed their evolution through time. This allowed us to explore the sources of ambiguity in their conceptualizations that is still present in the literature today. The originality of our approach stems from the simultaneous review of resistance to change and change readiness.

Examining the two concepts simultaneously is important for two reasons. First, change readiness has been in prior literature assumed as the opposite pole of resistance. To validate this assumption, we should first explore common grounds for comparing both concepts. A major finding of our study suggests that the two concepts can be compared because they share being an attitude. Moreover, they both include activation of an individual's cognitive

resources and/or emotions and are thus not passive attitudes. Drawing from this evidence, we confirm that the two concepts can be treated as opposite poles of each other.

However, the attitudes toward change should not be put on a bipolar continuum. Theorists and practitioners alike should realize change is one of the major triggers of ambivalence (Piderit, 1999), and the orientations of attitude dimensions will not always be aligned. We suggest that future researchers pay more attention to understand the spectrum of ambivalence toward change given that an individual's attitude toward change is rarely bipolar. We advocate that a more nuanced categorization of attitudes toward change is needed in the future and propose more precision and richness should be added by combining the orientation toward change (positive or negative) with the level of activation (activation of positivity and/or negativity that arises from the psychological attachment to change) and by acknowledging multiple dimensions of an attitude that will not always be aligned in terms of orientation toward change.

Last but not least, our study does not come without limitations. It is a qualitative review of the concepts of change readiness and resistance to change that was driven by a goal to clarify them to be able to understand them better and answer the question of whether or not they are representing opposite poles of the same continuum. A combination with a quantitative review of the concepts in terms of bibliometric analyses might reveal some interesting additional insights. We present only a brief quantitative review of the number of publications to show the popularity of the concepts through time.

Second, as a result of our review, we propose some building blocks for a potential new measurement instrument. We do discuss the existing operationalization of the concepts, however, with a more thorough review of the measures of both concepts we would be able to better examine the downsides of the existing measures and provide more practical suggestions to improve future measures of our focal concepts.

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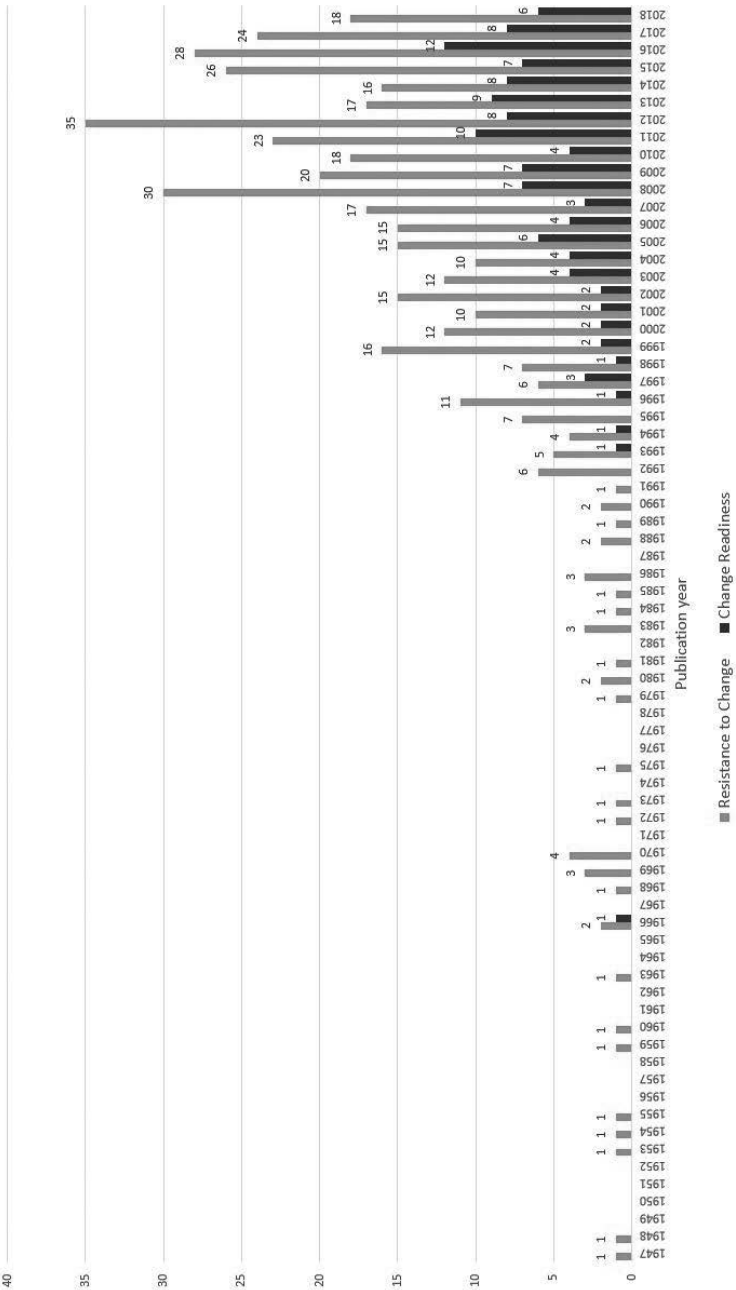
APPENDIX

Figure 1: *Total publications per year on resistance to change and change readiness*



NOTE. The figure was produced based on the Social Sciences Citation Index edition of the Web of Science Core Collection database. Document types "article," "review," "proceedings paper," and "book chapter," in English and from 1900 to 2018 (June), were included. We have searched the database for works with the words "change readiness" or "readiness for change" in their abstracts, titles, or keywords for the first concept of our interest, and "change resistance" or "resistance to change" or "resistance toward* change" for the second. The search was undertaken using the Web of Science categories "Management," "Psychology Applied," " Psychology Multidisciplinary," "Psychology," "Business," " Social Sciences Interdisciplinary," " Psychology Social," and " Behavioral Sciences."

E/B/R

POVZETKI V SLOVENSKEM JEZIKU

A Dsge model for the Slovenian Economy: Model Estimates and Application

Dsge Model Slovenskega Gospodarstva: Ocene in Njegova Praktična Uporaba

Andrej Kuštrin

Članek vsebuje ocene dinamičnega stohastičnega modela splošnega ravnotežja (DSGE) za Slovenijo in prikaz njegove uporabe na primeru analize strukturnih dejavnikov poslovnega cikla. V ta namen so predstavljeni rezultati historične dekompozicije gibanja realne rasti slovenskega BDP-ja (in njegovih komponent) v obdobju 1995–2014 , s posebnim poudarkom na obdobjih recesije. Rezultati kažejo, da so v obdobju prve recesije (2008–2009) pomemben dejavnik negativne gospodarske rasti predstavljali investicijski šoki, ki so se odražali v padcu investicij kot posledica zmanjšanja tujih in domačih naročil kot tudi povečane negotovosti glede prihodnjih ekonomskih obetov. Pomemben negativen vpliv na gospodarsko rast so imeli tudi potrošno-preferenčni šoki in šoki v pribitkih izvoznega sektorja, kar lahko v prvem primeru povezujemo s padcem dohodkov gospodinjstev (v povezavi s povečanim previdnostnim varčevanjem), v drugem primeru pa s padcem izvoznega povpraševanja zaradi poslabšanja konkurenčnosti domačega gospodarstva, ki je nastala zaradi hitrejše rasti plač od rasti produktivnosti v obdobju pred krizo. V času druge recesije (2012–2013) se je negativni vpliv investicijskih šokov nadaljeval, predvsem kot posledica slabih kreditov, ki so ne nakopičili v slovenskem bančnem sistemu. Vse to je vplivalo na zmanjšanje posojilne aktivnosti in investicij ter zaviralo gospodarsko rast. Poleg tega so na gospodarsko rast negativno vplivali tudi permanentni tehnološki šoki, ki jih lahko povezujemo predvsem z odsotnostjo ustreznih strukturnih reform v času pred začetkom krize. Po drugi strani pa so imeli stacionarni tehnološki šoki pozitiven vpliv na gospodarsko rast, posebej v času druge recesije, kar lahko odraža težnjo podjetij po sprejemanju ukrepov za izboljšanje svojega konkurenčnega položaja. Nazadnje rezultati kažejo, da je okrevanje gospodarske aktivnosti na koncu proučevanega obdobja izhajalo predvsem iz pozitivnega vpliva potrošno-preferenčnih šokov, ki jih lahko povezujemo z večjim zaupanjem potrošnikov, izvedeno sanacijo bančnega sistema in izboljšanjem razmer na trgu dela.

Ključne besede: *DSGE model, Bayesovks metoda, poslovni cikel*

The Influence of Socio-Demographic Characteristics on Environmental Concern and Ecologically Conscious Consumer Behaviour Among Macedonian Consumers

Vpliv Socio-Demografskih Značilnosti na Skrb za Okolje in Ekološko Zavedno Vedenje Makedonskih Porabnikov

Barbara Čater, Julijana Serafimova

Države zahodnega Balkana se soočajo z odločilnim trenutkom v razvoju svojih gospodarstev, družb in okolja. Po podatkih Evropske agencije za okolje se vzorci porabe gospodinjstev v teh državah v zadnjih letih hitro spreminjajo in so ključnega pomena zaradi dejstva, da so netrajnostni vzorci porabe pomemben vzrok za okoljske težave. Glavni namen tega članka je prispevati k bazi znanja o okoljskem profiliranju porabnikov, zlasti v kontekstu post-tranzicijskih gospodarstev. Predstavljamo rezultate raziskave na vzorcu 323 makedonskih porabnikov, ki povezuje njihov odnos in vzorce porabe s socio-demografskimi značilnostmi.

Ključne besede: *skrb za okolje, vedenje porabnikov, ekologija, Severna Makedonija*

Inflation – the Harrod-Balassa-Samuelson Effect in a DSGE Model setting

Inflacija – Harrod-Balassa-Samuelsonov Učinek v DSGE Modelu

Črt Lenarčič

V članku je predstavljen dvosektorski in dvodržavni dinamični stohastični model splošnega ravnotežja. V model so vpeljani različni sektorski produktivnostni šoki, ki so izpostavljeni mehanizmu izboljšanja kvalitete proizvodov. Na ta način se v teoretični strukturi omogoči nastanek Harrod-Balassa-Samuelsonovega učinka, ki v teoriji pojasnjuje povezavo med stopnjo rasti produktivnosti in stopnje inflacije med različnimi sektorji v nekem gospodarstvu. Rezultati ocenjenega modela DSGE na slovenskih podatkih pokažejo možnost obstoja Harrod-Balassa-Samuelsonovega učinka, saj ob produktivnostnem šoku v trgovalnem sektorju porasteta inflaciji trgovalnega in netrgovalnega sektorja.

Ključne besede: *Harrod-Balassa-Samuelsonov učinek, model DSGE, inflacija, produktivnost, mehanizem izboljšanja kakovosti*

Change Ready, Resistant, or Both? Exploring the Concepts of Individual Change Readiness and Resistance to Organizational Change

Pripravljeni na spremembo ali ne - ali oboje? Raziskovanje konceptov pripravljenosti na spremembo in odpora do organizacijske spremembe

Eva Repovš, Mateja Drnovšek, Robert Kaše

Prispevek je kvalitativni pregled dveh konceptov: pripravljenosti na spremembo in odpora do spremembe. V prispevku pregledamo njuno uporabo, razjasnimo njune idejne podlage in preverimo resničnost predpostavke, da predstavljata nasprotna pola istega kontinuuma. V primerjavi konceptov analiziramo njune dimenzije, ki pogosto predstavljajo izvor nejasnosti o njunem pomenu, pregledamo njuno evolucijo ter sorodne koncepte. Ugotavljamo, da odpor do spremembe predstavlja dva pomembna vidika: odpor kot vedenje in odpor kot odnos. Ker pa koncepta pripravljenosti na spremembo in odpora do spremembe v svojem bistvu opisujeta odnos do spremembe trdimo, da ju je potrebno proučevati kot povezana koncepta. Vendar ne v smislu nasprotnih polov bipolarnega kontinuuma, pač pa kot soobstoječi ortogonalni dimenziji – da lahko razumemo kompleksnost odnosa do spremembe. Prispevek zaključimo z razpravo o implikacijah ter smernicami za prihodje raziskave.

Ključne besede: *pripravljenost na spremembe, organizacijske spremembe, kvalitativni pregled, ortogonalna dimenzija*

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