Much Ado about Nothing?
Yes and No.

VAT Pass-through to Consumer Prices

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Abstract

Slovakia experienced significant changes in value-added taxation since 2003. This happened in line with the government's strategy of shifting towards indirect taxation, widely believed to have less harmful effects on economic growth, as well as the need for fiscal consolidation in the aftermath of the crisis. In this study we examine the impact of tax changes on consumer prices. Our findings suggest that the pass-through was strong in the events of tax increases, while the impact on prices was insignificant in cases of VAT reductions. However, the identified absence of the pass-through in the events of tax cuts may be linked to the nature of the studied events including the concurrent VAT increase and reduction in 2003 and 2004 and the narrow item-specific VAT cut in 2008. Going further, we find that the prolonged announcement period of the tax measure before its actual implementation helps smooth out the inflation profile as anticipatory effects are present in the case of VAT increases.

Acknowledgement:

Authors

Lucia Šrámková   lucia.sramkova@mfsr.sk
Libor Melioris   libor.melioris@mfsr.sk

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1   Introduction

The question of the impact of VAT rate changes on inflation played an important role during the debate regarding the composition of the fiscal consolidation package in the aftermath of the crisis from 2008. As literature has documented less harmful effects of indirect taxation on the economic growth, many governments in the advanced economies have adopted the strategies towards the increase of indirect taxation[1]. The evaluation of the transmission of the VAT changes to consumer inflation is key when assessing the tax burden of implemented tax measures taken by different economic agents in economy. Many research papers have explored this issue in recent years, addressing the country-specific results. In general, a strong pass-through to consumers is estimated in the events of VAT rate increases, while a modest transmission occurs in cases of VAT reductions. In this paper we study the Slovak experience related to VAT changes and quantify the pass-through to consumer prices in all relevant tax changes since 2003.

Since 2003 Slovak VAT rates have undergone two major changes. First, a two-step unification of reduced and standard VAT rates took place in 2003 and 2004. This tax rate unification was publicly discussed for a long time during 2002, alongside with the government's strategy of shifting towards higher indirect taxation. This resulted in a long-lasting announcement period regarding the 2004 tax change. In the first step, the reduced VAT rate was raised from 10% to 14%, while the standard VAT rate was cut from 23% to 20% in January 2003. Second, the tax rates were unified at 19% in May 2004. At the same time, there was a small change in terms of reducing the range of non-VAT items. Studying this concurrent event of VAT rate increase and reduction is a unique opportunity as the empirical literature quantified the impact on inflation in cases of non-concurrent VAT hikes and cuts. A second major policy change in VAT followed in the aftermath of the crisis, as a result of a sizeable fiscal consolidation. The VAT rate was increased by 1 p.p. to 20% in January 2011. In the meantime, two minor item-specific VAT reductions were introduced: a tax rate on (selected) medicines was reduced to 10% in January 2007, followed by a VAT rate cut on books in January 2008 (from 19% to 10%). In this paper we study the impact on prices in all of the abovementioned episodes except for the one concerning the tax reduction on medicines. The latter are determined by the regulatory body suggesting that full pass-through should be anticipated in that tax policy change[2].

Besides giving the first quantitative-based evidence on the pass-through in Slovakia, the goal of this research paper is twofold. First, we aim to study the presence of asymmetry in the transmission with respect to the tax rate increases and decreases, in line with the literature. Second, we examine the timing of the transmission to consumers. Anticipatory price adjustments prior to the actual tax change implementation are assumed to be present in the case of long announcement periods. We adopt the methodology of Carrare and Danniger (2008) who quantified the pass-through of a VAT rate hike in Germany in 2007. Using the disaggregated HICP panel data, we explore whether the price dynamics of items liable to VAT rate(s) differ significantly from the inflation profile of non-VAT items while other important factors such as global and domestic price pressures are controlled.

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[1] According to OECD (2011), an increase of taxes on consumption, extra excise duties and environmental taxes were dominant measures on the revenue side of the budgets in OECD countries.

[2] The modelling framework used in this paper is not fully applicable for a quantification of VAT pass-through to pharmaceutical products as consumer prices of prescribed medicines represent only a part of price paid by households, while the second part of final price is covered by health insurers. We analysed the impact on final pharmaceutical prices (incl. the payment by health insurers) on dataset by the Ministry of Health, which contain individual final prices of medicines (circa 5 000). The hypothesis that full VAT pass-through took place was confirmed in a simple regression model without controlling for individual foreign prices.

The rest of the paper is organised as follows. Section 2 introduces the stylised facts and theoretical models of transmission of indirect tax changes on consumer prices. The role of price elasticities is discussed as well as the asymmetry in tax shifting. Empirical evidence from other countries is summarized in Section 3. The framework of the empirical analysis, including a selection of the method, a description of the dataset and a discussion of the results are included in Section 4. Section 5 concludes.

2   Theoretical Framework of VAT Transmission to Consumer Prices

The theoretical part examines and describes the reaction of the price level to the change in VAT rate. The crucial point is to identify the key factors which play role in the price setting behaviour with respect to VAT change. The change in VAT affects two mutually interconnected variables: the profitability of the firms and the final price of the goods paid by consumers. This problem can be analytically reformulated as the distribution of tax burden between producers and consumers.

The tax burden paid by consumers can be expressed as the difference between the price of the product after and before the change in VAT. Burden carried by producers can be calculated as the difference between hypothetical full pass-through of VAT hike and real pass-through observed form the price dynamics. There are several factors which determine the degree to which changes in the VAT rate are divided between producers and consumers.

Demand and supply elasticities are by the far the most important factors which affect the pass-through to consumer prices. The microeconomic analysis examines the impact of taxation of particular goods via the reactions of supply and demand functions. Other important factors are the level and the structure of the market competition, the properties of supply and demand functions and some other factors such as menu costs, consumer behaviour, phase of the business cycle etc.

Graph 1: The analysis of effect of VAT rate change using supply and demand curve
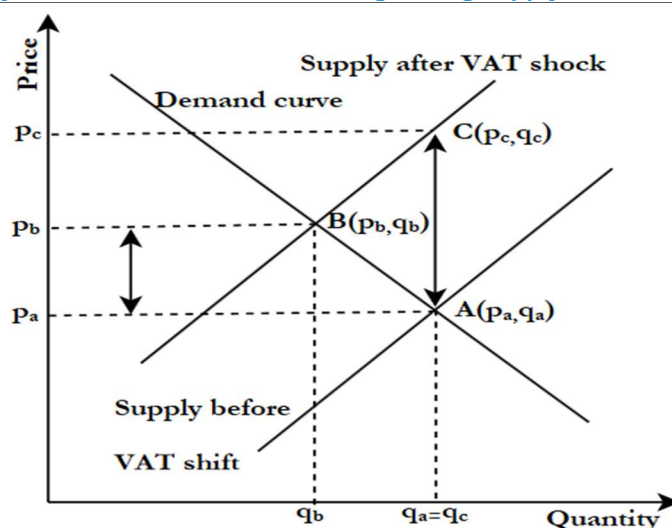
Where: A(p_a,q_a) – equilibrium before VAT shift, B(p_b,q_b) – equilibrium after VAT shift, C(p_c,q_c) – hypothetical equilibrium with full VAT pass-though and same quantity as in equilibrium before VAT shift, p_a – equilibrium price of the good before VAT shift, p_b – equilibrium price of the good after VAT shift, p_c – equilibrium price of the good with full VAT pass-through, q_a – equilibrium quantity of the good before VAT shift, q_b – equilibrium quantity of the good after VAT shift, q_c – equilibrium quantity of the good with full VAT pass-through, ($p_c - p_a$) – hypothetical increase in price level under full transmission of VAT shift, ($p_b - p_a$) – real increase in price level with respect to shift in VAT, ($p_b - p_a$)/($p_c - p_a$) – share of the tax burden carried by consumers, ($p_c - p_b$)/($p_c - p_a$) – share of the tax burden carried by producers.

Source: IFP

The reaction of price level with respect to the change in VAT depends on the price elasticities of supply and demand. Low price elasticity of supply suggests that change in VAT which can be expressed as additional cost for producers is not transmitted into a significant change of the amount of goods supplied. When the supplied amount of goods does not react strongly to the VAT hike, the equilibrium price, which is a situation when supply meets demand, will not differ significantly from the period before the VAT hike. Therefore the pass-through of change in VAT would be low if supply elasticity was also low. Vice-versa the pass-through will be higher if, everything else being equal, the price elasticity of supply is higher.

The relation between pass-through and demand elasticity is different. Consider two extreme scenarios. In the first case demand is perfectly inelastic. Under such conditions the consumers will buy only a set quantity of goods for any price given. There is no price incentive which would change their preferences with regard to the amount of goods demanded. If the VAT hike occurs under such conditions then it is completely passed into consumer prices. In second scenario the demand curve is perfectly elastic. Consumers will not accept any change in price of goods demanded. The result is that the shift in the supply curve corresponding to the hike in VAT is completely transmitted into the amount of goods demanded while the consumer price remains the same. Therefore the pass-through of shock in VAT will be equal to zero.

Figure 1: Pass-through of VAT rate change to consumer prices with respect to demand and supply function characteristics

Supply function elasticity		Demand function elasticity			
		Perfectly elastic	Elastic	Inelastic	Completely inelastic
	Perfectly elastic	N/A	Full	Full	Full
	Elastic	None	Medium	Strong	Full
	Inelastic	None	Weak	Medium	Full
	Completely inelastic	None	None	None	N/A

Source: IFP

2.1   Asymmetric Tax Shifting Reaction

There is a relatively broad stream of theories which advocate for the existence of an asymmetric reaction of price level with respect to the change in VAT rate. Asymmetric price dynamics are present when the price level does not react identically to the decrease and the increase of VAT rate of equivalent size. The asymmetric reaction means that the price level dynamics is determined not only by the size but also by the sign of tax change. Carbonier (2005) proposed microeconomic explanation for the existence of asymmetric reactions for price changes. The argument is built on the asymmetric properties of the production function and on the assumption about psychological effects of shadow pricing scheme.

Asymmetric properties of the production function arise from the observation which concludes that it is much harder for the producers to increase production than to decrease it. Increase in production would require additional human and capital investments, while it is much easier to decrease production. Following the VAT decrease firms would need to expand the production to satisfy an increase in demand arising from lower prices. Facing high marginal costs of production expansion firms may otherwise choose not to increase production substantially which will result in low pass-through of VAT decrease to consumer prices. This

channel can be detrimental for asymmetric response of price level if the capacity utilization of industries is high.

According to Carbonier (2005), consumers' reaction is disproportionally stronger to important price variations compared to small or mild ones. This framework would require significant price decrease which would lead to a corresponding response in the behaviour of consumers and an increase of goods demanded. On the other hand low variations in prices would not create a significant change in consumer behaviour. These propositions would mechanically imply steeper reaction of price level to a tax cut and only mild reaction to an increase of the VAT rate. Optimal pricing strategy and response might thus depend on the direction of the VAT change.

2.2 Other Factors

The transmission of VAT changes to prices may be also influenced by a group of other factors. For example, a presence of menu costs introduces a threshold for price setting decisions. According to the microeconomic theory, firms will adjust prices only when the scale of the VAT hike is larger than the threshold determined by menu costs. Otherwise prices will not react and remain sticky despite the change in fundaments.

Another factor may arise from a company's strategy when the short-term profits are sacrificed in an attempt to push competitors out of the market. Under these conditions firms would not increase prices immediately in reaction to a VAT rate hike. Carlton (1986) pointed out the strong correlation between concentration of industry and price stickiness. The more concentrated the industry, the higher price rigidity persistence. Therefore the pass-through of VAT hike will be lower. The price setting would also differ when firms somehow coordinate their behaviour with other market participants or they are part of a vertically integrated company.

Heidhues (2006) stated that price variability is also reduced, when the price distribution of the product is heavy-tailed. Heavy-tailed distribution creates additional costs for consumers in order to obtain information related to the demanded good and reduces potential pass-through of tax shifts. Similar pattern was observed with respect to the frequency of exchange. Prices of the goods that are demanded regularly and frequently tend to be more flexible.

The behavioural concept of consumer behaviour underline the importance of initial endowment together with empirical observation that consumers are willing to give up an good only at a higher price than is the price at which they are willing to buy. Behavioural literature describes such consumer preferences as a loss aversive behaviour. Loss aversive consumer would react mildly with respect to price increase. Departing from Kahnemann (1990) we can conclude that loss aversive consumer behaviour would imply asymmetric pass-through with high pass-through with respect to increase of VAT rate and lower transmission of the decrease of tax rate.

From the perspective of small, open and converging economy there are also few additional factors which may influence the transmission of a VAT shift to price level. There is strong evidence that competitiveness among retailers gradually increased in the domestic economy over the past two decades. Increasing competitiveness reduces mark-ups and partially curbs the price level response to an increase in the VAT rate, while possibly amplifies the price reaction in the case of VAT cut. The EU accession and euro adoption could have been events which led to significant changes in the price decisions of economic agents and the degree of competitiveness on various markets. The occurrence and aftermath of financial crisis from 2009 was also an important factor having prolonged impact on demand of consumers, particularly in case of durable goods.

3   Empirical Evidence from Other Countries

Most of empirical research studies that examined the pass-through of changes in VAT rates to consumer prices has been published over the past decade. There are several analyses which evaluated the impact of the changes in the VAT rates using the micro data. In general, we can conclude that the studies identified a significant pass-through to consumer prices in the episodes of VAT rate hikes (Djikstra (2014), Bundesbank (2008), Jonker (2004)). On the other hand, results of research studying the effect of VAT rate cuts are far less conclusive, mostly identifying lower pass-through compared with case studies on VAT rate hikes. At the same time, there is a high variability in timing of a VAT transmission to consumers. In general, research studies found that there is substantial adjustment of prices if the commitment to VAT change is reliably announced and anticipated. Under such circumstances, transmission into prices usually occurs prior to the actual implementation of the tax change because of the anticipatory behaviour of suppliers and retailers.

Another stream of literature examined price effects of VAT changes with respect to the structure of market. Carbonnier (2005) found that in competitive markets the reaction to a VAT change is higher when VAT is increased rather than decreased, confirming the asymmetry in tax shifting. The opposite conclusion was found while studying more collusive and monopolistic markets. Chirakijja (2008) studied the impact of changes in VAT rates with respect to the use of the products. They divided consumer items into non-durable goods (necessities) and durable goods (luxuries) and tested the theoretical hypothesis that in case of durables retailers manage to benefit from consumption shifting driven by anticipatory behaviour. However, their results failed to support this premise. The summary of empirical literature is listed in Figure 2.

Figure 2: Overview of empirical literature

Author	Country	Results	Dataset
Jonker (2004)	Netherlands	VAT increase almost completely passed through consumer prices. Asymmetric reaction identified	80% of CPI basket
Bundesbank (2008)	Germany	VAT increase passed through by approx. 87%.	Full HICP basket
Carare and Danniger (2008)	Germany	Estimated pass-through of 73% as a response to increase of VAT rate	80% of CPI basket
Dijkstra (2014)	The Netherland	Hypothesis of a full pass-through of tax increase not rejected	93% of HICP basket
Chirakijja (2009)	United Kingdom	VAT cut was passed through by approx. 75%	55% of consumer basket
Pike (2009)	United Kingdom	VAT cut pass through below 50% with gradual increase of price level in later periods	55% of consumer basket
Gabriel (2006)	Hungary	Fast reaction to VAT increase with 70% pass-through over a period of 3 months. Gradual reaction to VAT cut with pass-through below 25%.	76% of CPI basket
Benkovskis (2013)	Latvia	VAT hike passed through by approx. 84%. The reaction of prices on decrease in VAT only at 45%	42% of CPI basket

Source: IFP

4   Empirical Analysis

The empirical strategy is aimed at answering two key questions. First, we are interested in investigating whether the pass-through to prices is asymmetric regarding the tax rate increases and decreases, in line with the literature. Second, we have the ambition to identify the timing of the transmission on consumers. Inflation smoothing hypothesis would suggest that price increases prior to the legislation implementation are dominant. Alternatively, the price increases are concentrated at the date of the implementation or the delayed effects prevail. The latter effect is partly explained in the literature by flexible prices.

4.1   Methodology

The estimation method is based on the study of Carrare and Danniger (2008) who analysed the impact of a large-scale VAT rate hike held in Germany in 2007. As this tax measure was introduced after the long-lasting announcement period, they focused on estimating the inflation smoothing effects prior to the implementation of a VAT rate hike. They developed the modelling framework which enables to identify whether the dynamics of CPI items liable to VAT change differ from non-VAT items while controlling for the systematic factors that influence all consumer items. Among these, global inflation trends are captured by including euro area wide inflation (excl. Germany). Going further, they included trend, seasonal monthly dummies and idiosyncratic shocks.

Proposed model is designed to work with monthly panel data of the annual inflation rates of items included in HICP at two-digit level[3]. The dependent variable is an annual inflation rate of item (i). It is modelled as a function of time-varying, individual and cross-sectional fixed factors. In general, the model representation takes the form:

$$p_i^t = f\big(p_i^{t-1}, X_i^t, Y_i, Z^t, G_{\sum j}\big) \qquad \textbf{(1)}$$

where the annual inflation rate p_i^t of commodity (i) at time (t) is a function of item-specific time varying factors (X_i^t), individual-fixed factors (Y_i) and time-fixed factors (Z^t). If the lagged dependent variable p_i^{t-1} is included, then it is referred to as the dynamic panel framework where a traditional OLS estimator is not applicable. Group-specific factors related to a change in VAT tax rates ($G_{\sum j}$) enable to identify the differences between the dynamics of VAT and non-VAT items and separate the items in regard to the application of reduced and standard tax rates. Rewriting the general formula to linear regression, we get:

$$p_i^t = c + \alpha_0 trend + \alpha_i + \alpha_2 p_{i,\,EA}^t + \alpha_3(y^t - y^{*t}) + \sum_k \alpha_{4,k} VAT_{i,k}^t + \varepsilon_i^t \qquad \textbf{(2)}$$

- where c denotes constant;
- *trend* represents a linear trend which is included to capture the disinflation trend witnessed at the national level emanating from the economic transition of the country;
- α_i is item-specific cross-sectional effect of HICP COICOP item (i);

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[3] More disaggregated approach is also applicable; however, it would lead to demanding work on dataset. Two-digit level is perceived as the sufficient disaggregation in terms of items specification (type of tax rate, durability of good, market price setting behavior) , while being aggregated enough to give robust estimates of pass-through on aggregate price level.

- $p_{i,EA}^t$ controls for the imported inflation by applying SKK/EUR bilateral exchange rate to a weighted annual inflation rate of item (i) at time (t) in the Eurozone excluding Slovakia;

- $(y^t - y^{*t})$ is the output gap of Slovak economy aimed at controlling for domestic demand pressures[4];

- $VAT_{i,k}^t$ represents a group of dummies specifying whether VAT rate change at time (t) is liable to item (i)

VAT dummies include different subgroups vis-à-vis time of the measure implementation: prior to the implementation, at the time of implementation and post-implementation periods. Since inflation-smoothing hypothesis captured by prior to the implementation set of dummies relates particularly to markets with durable goods or imperfect competition, we introduced additional dummies that restricts the range of items affected by the tax change to these goods and markets.

More importantly, as HICP is the weighted Laspeyres index, the model needs to be appropriately specified to satisfy the aggregation method. Hence, the model works with weighted inflation rates, where each HICP item at two-digit COICOP level is weighted by its individual weight in the HICP basket. As a result, the model identifies an average VAT group effect on inflation, while avoiding the overestimation of the impact of small-weight items if they experience significant trends.

4.2   Data

Data on annual inflation rates of HICP items at two digit COICOP level were obtained from the ECB data warehouse. Our dataset covers the annual rate of inflation items from January 2001 to May 2014. We narrowed the estimation of the effect on core inflation[5] rather than measuring the impact on headline inflation. This is motivated by the fact that the price dynamics of the regulated prices (8 HICP items) is distorted by the decisions of a regulatory body. In addition, these are typically held in January, similarly to most of the implemented tax measures. At the same time, core inflation is a more useful indicator when assessing the underlying inflation trends. In addition to the exclusion of regulated prices, we identified three major reasons for dropping further data from the analysis:

- high volatility and instable seasonal patterns (9 HICP items such as fruit, vegetables, clothing materials or recording media);
- liability to other indirect taxes (5 HICP items including alcoholic drinks, tobacco and fuels);
- inconsistency between euro area wide and national data which disable from controlling of global inflation trends (1 HICP item – other personal effects);

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[4] Output gap estimate by MF SR methodology is adopted. Quarterly data are interpolated to monthly frequency with cubic splines. Results are not sensitive to the choice of interpolation method, constant and linear method were used alternatively. Original paper disregarded this variable as the length of analyzed time sample was shorter than one usual business cycle.

[5] Core inflation in our analysis is not identical with the definition of core inflation as defined by the Slovak Statistical Office / Eurostat. We use this label as it analytically fits the notion of core or underlying inflation, in line with the empirical literature.

As a result we ended up with 65 HICP items (out of total 88), covering approximately two thirds of the consumer basket over the course of whole time sample. Final list of HICP items included in the analysis with corresponding weights is reported in Annex, Tab. A2. Table also reports the following classification per item:

- VAT dummies according to the VAT change episode: dummies take value 0 if the analysed tax event is not applicable to the item; value 1 if it applies to all goods and services within this item; or the value between 0 and 1 if it applies only to a part of goods and services incl. in the item, which is calibrated based on an exhaustive consumer basket;
- durability of goods – values were assigned by the expert judgement;
- price setting power – indicator for the structure of the corresponding markets was derived from the euro changeover effect in January 2009, in line with Carare and Danninger (2008) methodology[6]

Definition of the VAT dummies with respect to the time of implementation of the tax change is reported in Annex, Tab A1. In general, we follow the rule that effects prior to the implementation are limited to the period between the final approval of the tax change by the government and its actual implementation. Lagged effects are restricted to last six months in all events of VAT changes, which is assumed to be a period long enough to capture the price adjustments on flexible markets.

4.3 Results

Table 1 summarizes the results of the estimated models. All specifications include euro area wide inflation excluding Slovakia and national output gap as explanatory variables, significant in all models[7]. In contrast, monthly dummies as used in the original paper turned out insignificant. Model (1) reports the results of **fixed effects estimator**[8]. In addition to cross-section fixed effects, model (2) includes **period random effects** , while dropping deterministic trend used in model (1)[9]. However, this does not lead to more satisfactory results. It must emphasized here that both these models give relatively low R-squared statistics. More importantly, results of residual tests for serial autocorrelation suggest the presence of autocorrelation in residuals in both of the models. This caveat is overcome by using **GMM estimator** reported in model (3) of Table 1[10]. Introduction of lagged dependent variable proves that inflation is a highly persistent process in Slovakia.

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[6] The method is based on the assumption that monopolistic or competitive characteristics of the markets may be identified from variation of upward and downward adjustment in the month of cash change over. However, construction of the variable relies on the expert´s assumption that price increases which are higher than 75th percentile indicate the lack of competitive conditions. However, as shown later, alternating the definition (to median) did not alter results of our analysis.

[7] These estimates are not reported as they are out of the scope of the analysis. Estimates are available by authors upon the request.

[8] Likelihood ratio test rejects the restricted model in which there is only a single intercept.

[9] A central assumption of random effects estimation is that the random effects are uncorrelated with the explanatory variables. Hausman test provides little evidence against the null hypothesis that there is no misspecification in the model.

[10] GMM estimator includes cross-section fixed effects and uses 2SLS for GLS weighting.

Tab 1. Determinants of core-HICP Inflation: Identification of VAT impact on prices

	(1) FE		(2) PRE		(3) GMM		(4) Durables		(5) Price setting power	
Constant	0.080***		0.050***		0.002***		0.002***		0.002***	
	(31.424)		(38.413)		(5.289)		(5.600)		(5.468)	
Lagged Dep. Var.	N		N		0.926***		0.928***		0.927***	
					(273.959)		(277.653)		(276.648)	
Trend	-0.0003***		N		N		N		N	
	(-14.769)									
EA inflation	0.376***		0.448***		0.023***		0.022***		0.022***	
	(29.115)		(30.670)		(4.770)		(4.600)		(4.654)	
Output gap	0.010***		0.010***		0.010***		0.010***		0.010***	
	(13.021)		(7.553)		(5.889)		(5.879)		(5.890)	

VAT effect dummies

2003

	Reduced	Standard	Reduced	Standard	Reduced	Standard	Reduced	Standard	Reduced	Standard
Before	-0.027	0.010	0.016	0.050***	0.001	0.004	0.000	0.004	0.006	-0.001
	(-1.533)	(0.689)	(0.756)	(2.654)	(0.214)	(0,803)	(0.017)	(0.552)	(0.698)	(-0.100)
At	0.034	0.014	0.069**	0.047*	0.073***	0.013*	0.072***	0,013*	0.073***	0.013*
	(1.413)	(0.479)	(2.322)	(1.776)	(9.074)	(1,891)	(8,975)	(1,905)	(9,010)	(1,903)
After	0.045***	0.022**	0.060***	0.036***	0.011***	0.001	0.012***	0,000	0.011***	0,000
	(4.010)	(2.341)	(4.415)	(2.997)	(2.881)	(0,165)	(3,205)	(0,000)	(3,094)	(0,003)

2004

	Reduced	Standard	Reduced	Standard	Reduced	Standard	Reduced	Standard	Reduced	Standard
Before	0.093***	-0.013**	0.085***	-0.022***	0.011***	-0.003	0.002	0.000	0.010**	-0.001
	(11.890)	(-1.978)	(9.052)	(2.604)	(4.176)	(-1.456)	(0.136)	(0.150)	(2.378)	(-0.159)
At	0.086***	-0.019	0.080***	-0.026	0.014*	-0.001	0.013	-0.001	0.013*	0.000
	(3.505)	(-0.951)	(2.691)	(-0.966)	(1.731)	(-0.155)	(1.608)	(-0.130)	(1.652)	(0.135)
After	0.097***	-0.010	0.084***	-0.024**	0.008**	-0.001	0.007**	-0.001	0.007**	-0.001
	(9.498)	(-.150)	(6.756)	(-2.173)	(2.266)	(-0.498)	(1.967)	(-0.446)	(2.074)	(-0.456)

2008 (books)

Before	-0.010		-0.008		0.000		0.000		-0.003	
	(-0.166)		(-0.131)		(0.022)		(0.012)		(-0.127)	
At	-0.022		-0.010		-0.002		-0.003		-0.002	
	(-0.207)		(-0.088)		(-0.055)		(-0.074)		(-0.057)	
After	-0.009		-0.014		-0.003		-0.003		-0.003	
	(-0.188)		(-0.028)		(-0.165)		(-0.208)		(-0.170)	

2011

Before	-0.037***		-0.033***		0.000		0.000		-0.002	
	(-4.014)		(-2.468)		(0.127)		(0.143)		(-0.466)	
At	-0.021		-0.021		0.010*		0.010*		0.010*	
	(-1.333)		(-0.911)		(1.870)		(1.845)		(1.856)	
After	-0.003		-0.005		0.005**		0.005**		0.005**	
	(-0.469)		(-0.437)		(2.268)		(2.199)		(2.228)	

Estimation	FE	FE	GMM	GMM	GMM
Time effects	N	Y	N	N	N
Test for res. Autocorrel.	Rej.	Rej.	Not Rej.	Not Rej.	Not Rej.
R-squared	0.39	0.38	0.93	0.93	0.93

* significant at 10%, ** significant at 5%, significant at 1% „Reduced" refers to reduced VAT rate, „Standard" refers to standard VAT rate, „Before" captures impact prior to the implementation, „At" at time of tax measure, „After" measures delayed impact on inflation. Number of cross-sections: 65 in all models, no of observations: 10 335 in models (1)-(2), 9880 in models (3)-(5). Source: IFP calculations

Results based on our model (3) can be summarised as follows:

- We find evidence that **inflation of items liable to the reduced VAT significantly increased at the time of VAT rate hike implementation in January 2003, as well as after its implementation**;
- In contrast, **inflation smoothing effect was significant in case of May 2004 VAT rate hike** (of reduced VAT rate);
- **Downward adjustments of prices in case of VAT cut of standard rate in 2003 and 2004 were found insignificant** and there is even a weak evidence of price increases of related items in January 2003;
- Item-specific VAT rate cut on books in 2008 was found having no impact on their prices;
- **As to 2011 VAT rate hike, price increases related to VAT items took place at the time of hike implementation and after it, similarly to 2003;**

The empirical evidence confirms the theoretical asymmetry in the VAT pass-through to consumers. Tax hikes are found to have significant pass-through to consumer prices, while there is no evidence of curbing effects on inflation in case of VAT cuts. There is even a weak evidence of price increases related to standard VAT items in January 2003, implying that firms managed to widen mark-ups on these goods. This finding lies outside the conclusions found in the literature as most of the studies identifies moderate pass-through on prices in case of VAT cuts. However, none of the empirical papers investigated the concurrent VAT increase of reduced rate accompanied by the cut of the standard rate. The concurrence may possibly produce some noisy information in regards to the pricing of products on various markets, thus opening the room for muted downward price adjustments of items liable to VAT cut. Based on the model results, this appear being the case prior the implementation of 2004 VAT cut.

Insignificant impact on prices in case of item-specific VAT cut on books in 2008 suggest that **the concentration and the structure of the market plays a significant role in the transmission of legislation event to consumers even in the case of large-scale change of tax rate.**

Lagged effects on inflation prevailed in case of tax measures with short announcement periods of three months. On the other hand, pass-through to prices prior to the implementation of tax measure dominated in case of May 2004 hike of reduced VAT rate, when the announcement period lasted eleven months. This finding is in line with Carare and Danninger (2008) who identified **the presence of significant effects on inflation prior to the implementation in the case of long announcement period.**

As the presence of anticipatory effects on inflation is assumed to be linked to demand-shifting which may predominantly occur only in case of durable goods, we modified the model (3) further by restricting the prior-implementation effects to the subset of durable goods within the HICP items liable to the VAT rate change. As column (4) suggests, this does not improve the properties of the model at all. That said, inflation-smoothing effect in case of May 2004 tax change is found insignificant when limiting its impact to durables. Going further, in model (5) we investigated whether the variation in inflation prior to the implementation of the tax change may be explained by the suppliers' price setting power on various markets as derived from euro currency changeover effect. Results only negligibly change the conclusions drawn from model (3). The presence of anticipatory effects is identified only in case of 2004 VAT rate hike and its impact on inflation is estimated at a comparable size.

In the next step, we derived the pass-through of the tax change to our definition of core inflation as estimated by the model. For this purpose, we used the results of model (3) as it appears to have the best statistical properties. As the models estimate the average group VAT effects on inflation, the units of the coefficients need to be multiplied by the number of

HICP items liable to the respective tax change[11]. Implied pass-through per legislation events is reported in Tab 2.

The estimated pass-through differs among the legislation events. Almost full immediate pass-through is identified in case of VAT rate hike in January 2003. Additional price adjustments of 14% materialised in the period of six months following the tax increase. This technically implies more than full transmission to consumer prices, which may be interpreted in two ways. First, as Benkovskis and Fadejeva (2013) suggests when discussing results for Latvia, tax increase combined with improving demand conditions may provide some firms the opportunity to widen the mark-ups. However, this does not appear to be satisfactory explanation in this case as household consumption slowed down significantly in 2003 and the output gap was negative. Second, it may have been the case that economic agents viewed 2003 and 2004 two-step VAT rate unification as one policy event. The government´s strategy to unify the reduced and standard tax rates was publicly communicated already in 2002. That said, group of VAT dummies capturing delayed effects with regards to 2003 VAT increase may also seize some anticipatory effects related to 2004 VAT hike[12]. Going further, it is also difficult to interpret subsequent low pass-through in 2004 as shown in Tab 2. These arguments would speak in favour of **assessing the VAT rate unification as one policy event.** As a consequence, **the medium-size pass-through to consumer prices of 69% is estimated as for the VAT increase.** Our finding is broadly in line with the related literature. In contrast, this cannot be concluded when examining the impact of VAT cut of standard rate. As we had already suggested above, the statistically marginal evidence of price increases of the standard-VAT rate items in January 2003[13] could have been triggered by the concurrence of VAT hike of the reduced rate.

Tab 2. VAT change pass-through to core inflation as estimated by model

	2003		2004	2011
	Reduced VAT	Standard VAT	Reduced VAT	
		Inflation smoothing Effect		
Estimated effect (in p.p.)			0.24	
Full effect (in p.p.)			2.06	
Pass-through (in %)			11.7	
		At-the-implementation Effect		
Estimated effect (in p.p.)	1.64	0.36	0.31	0.49
Full effect (in p.p.)	1.71	-0.89	2.05	0.68
Pass-through (in %)	96.0	-40.7	15.3	70.9
		Delayed Effect		
Estimated effect (in p.p.)	0.24		0.17	0.25
Full effect (in p.p.)	1.71		2.05	0.68
Pass-through (in %)	13.9		8.4	36.4
Cumulative pass-through (in %)	109.9	-40.7	35.4	107.3
*Full impact on headline inflation (in p.p.)**	*1.65*		*2.00*	*0.54*

*as significantly estimated by specification (3) GMM, Source: *SUSR, IFP calculations*

[11] Speaking more precisely, the coefficients are multiplied by the sum of components of corresponding VAT dummy vector, as reported in Tab A2 in Appendix.
[12] Actually, as reported in Tab A1 in Appendix, periods capturing delayed effects with regards to 2003 VAT change and anticipatory effects related to 2004 VAT change do overlap in June 2003.
[13] Significant only at 10%.

As to the 2011 VAT increase, we estimated the full pass-through to core inflation with the occurrence of increasing mark-ups[14]. Price increases were concentrated at the time of the tax change implementation when 70% pass-through materialised, while additional upward adjustments totalling to 36% pass-through after the implementation. The evidence of increasing mark-ups is surprising in the light of weak private consumption in the aftermath of the crisis and the demand restrictions. Yet, the mark-ups had been squeezed immediately after the crisis exploded in 2009, so some firms could take the 2011 VAT hike as the opportunity for their increase.

5   Conclusion

In this study we have quantified the pass-through of VAT rate changes to core inflation in different periods using the dynamic panel estimate on two digit COICOP HICP data. Overall, **the finding suggests that the pass-through is strong in case of increasing tax rates, while the impact on prices is insignificant for cases of VAT reductions.** While the former conclusion is robustly identified in both pre- and post-crisis policy events, the latter finding is limited to the VAT cuts experienced in 2003-2004 and 2008. That said, the evidence of the pass-through absence in the case of VAT cuts has the limitation in the nature of the studied tax changes: the concurrent VAT hike of the reduced rate in 2003-2004 as a part of the VAT rate unification and the narrow item-specific cut in 2008.

The results related to the experienced two-step VAT rate unification in 2003 and 2004 have two major implications. First, **the concurrence of a VAT rate increase and a reduction of different tax rates may halt the transmission on prices liable to the VAT rate cut.** We even found a weak evidence of price increases of these items in 2003 despite the delivered tax cut. Second, **the prolonged announcement period of the tax measure before its actual implementation helps smooth out the inflation profile.** This was the case of 2004 when the announcement period lasted eleven months and the intention to unify tax rates was in fact communicated more than one year in advance. Anticipatory effects thus help dampen the kinks in inflation trajectory.

With respect to item-specific VAT cuts usually aimed at supporting item-specific demand, we found insignificant pass-through on book prices in 2008 despite the large-scale cut from 19% to 10%. This implies that **attention should be drawn to studying the related level and structure of the market competition before acceding to this kind of policy measure.**

However, the identified absence of the pass-through in the events of tax reductions should be taken carefully when considering future policy changes. Our results are in contrast with the literature on "ordinary" VAT reductions suggesting the presence of moderate pass-through. In addition, it is widely believed that the structure of markets (both in wholesale and retail segment) has become more competitive in Slovakia over the past decade. This may lead to significantly different transmission to prices in case of future policy changes.

Possible future research may include methodological alternatives such as the use of sample selection models, which require fully disaggregated data on consumer basket. This framework also enables to examine the price formation in more detail and might have benefits for calibrating comprehensive DSGE models in respect to Calvo sticky prices assumptions.

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[14] Though the reported model estimates the impact on prices at the time of tax change implementation only at 10% significance, we stick to this estimate as shortening of the modelling time sample to post-crisis period confirms the significance of the impact at 1% level at a comparable size.

Appendix

Tab A1. VAT rates´ changes: specification of time periods having the impact on inflation

Effect	VAT Dummy			
	2003	2004	2008	2011
Pre-implementation "Inflation-smoothing effect"[1]	Nov - Dec 2002	Jun 2003 - Apr 2004	Oct - Dec 2007	Oct - Dec 2010
Actual implementation Effect	Jan 2003	May 2004	Jan 2008	Jan 2011
Post-Implementation effect[2]	Jan - Jun 2003	Jun - November 2004	Feb - Jun 2008	Feb - Jun 2008

Note: (1) Pre-implementation periods start at the date of the tax measure approval by the government and end the month before its actual implementation (2) Post-implementation effects are set to last six months in all events of VAT rates´ changes. Source: IFP

Tab A2. HICP commodity items, weights and classfication related to VAT dummies

		Weight[1]	VAT Dummy (Cross-sectional dimension)					
			2003 / 2004 lower rate	2003 / 2004 upper rate	2008	2011	Durables	Price setting power[2]
1	Bread and cereals	31.3	1	0	0	1	0	0
2	Meat	49.5	1	0	0	1	0	0
3	Fish	4.5	1	0	0	1	0	0
4	Milk, cheese and eggs	34.4	1	0	0	1	0	0
5	Oils and fats	9.8	1	0	0	1	0	0
6	Sugar, jam, honey, chocolate and confectionery	14.1	1	0	0	1	0	1
7	Food products n.e.c.	4.7	1	0	0	1	0	0
8	Coffee, tea and cocoa	7.3	0	1	0	1	0	1
9	Mineral waters, soft drinks, fruit and vegetable juices	11.7	1	0	0	1	0	0
10	Cleaning, repair and hire of clothing	1.0	1	0	0	1	0	1
11	Actual rentals for housing	13.4	0	0	0	0	0	1
12	Materials for the maintenance and repair of the dwelling	14.7	0	1	0	1	0	0
13	Services for the maintenance and repair of the dwelling	12.1	1	0	0	1	0	1
14	Other services relating to the dwelling n.e.c.	7.2	1	0	0	1	0	1
15	Solid fuels	3.9	0.060	0.940	0	1	0	1
16	Furniture and furnishings	12.5	0	1	0	1	1	0
17	Household textiles	4.8	0	1	0	1	1	0
18	Major household appliances, small electric hous. appl.	9.7	0	1	0	1	1	0
19	Repair of household appliances	1.8	1	0	0	1	0	0
20	Glassware, tableware and household utensils	5.7	0	1	0	1	1	1
21	Tools and equipment for house and garden	4.8	0	1	0	1	1	0
22	Non-durable household goods	16.7	0	1	0	1	0	0

		Weight[1]	VAT Dummy (Cross-sectional dimension)					Price setting power[2]
			2003 / 2004 lower rate	2003 / 2004 upper rate	2008	2011	Durables	
23	Domestic services and household services	2.2	1	0	0	1	0	1
24	Pharmaceutical products	15.3	0	0	0	0.447	0	1
25	Other medical products, therapeutic appliances and equipment	8.3	0.054	0	0	0.054	0	1
26	Medical and paramedical services	6.8	0	0	0	0	0	1
27	Dental services	6.0	0	0	0	0	0	1
28	Motor cars	22.4	0	1	0	1	1	0
29	Motor cycles, bicycles and animal drawn vehicles	3.2	0	1	0	1	1	0
30	Spare parts and accessories for personal transport equipment	3.8	0	1	0	1	1	0
31	Maintenance and repair of personal transport equipment	7.9	0	1	0	1	0	0
32	Other services in respect of personal transport equipment	3.9	0	1	0	1	0	1
33	Passenger transport by road	16.4	1	0	0	1	0	0
34	Passenger transport by air	0.4	1	0	0	1	0	0
35	Other purchased transport services	1.0	1	0	0	1	0	1
36	Postal services	2.0	0	0	0	0	0	0
37	Telephone and telefax equipment and tel. and telefax services	39.8	0	1	0	1	0	0
38	Equip. for reception, recording and reprod. of sound and pictures	6.4	0	1	0	1	1	0
39	Photographic and cinematographic equip. and optical instruments	1.6	0	1	0	1	1	0
40	Information processing equipment	3.6	0	1	0	1	0	0
41	Repair of audio-visual, photographic, info. processing equip.	1.4	0	1	0	1	0	1
42	Other major durables for recreation and culture	0.3	0	1	0	1	1	0
43	Games, toys and hobbies	2.5	0	1	0	1	1	0
44	Equipment for sport, camping and open-air recreation	1.7	0	1	0	1	1	1
45	Gardens, plants and flowers	5.9	0	1	0	1	0	1
46	Pets and related prod. incl. veterinary and other serv. for pets	3.7	0	1	0	1	0	1
47	Recreational and sporting services	5.8	0.453	0	0	0.453	0	1
48	Cultural services	13.6	0.749	0	0	0.749	0	0

		Weight[1]	VAT Dummy (Cross-sectional dimension)					
			2003 / 2004 lower rate	2003 / 2004 upper rate	2008	2011	Durables	Price setting power[2]
49	Books	5.6	1	0	1	0	1	1
50	Newspapers and periodicals	10.7	1	0	0	1	0	0
51	Misc. printed matter and stationery and drawing materials	6.7	1	0	0	1	0	0
52	Package holidays	15.1	0,1	0	0	0,1	0	1
53	Education	14.7	0.0724	0	0	0.0724	0	1
54	Restaurants, cafes and the like	32.7	0	1	0	1	0	1
55	Canteens	43.2	0.783	0	0	0.783	0	1
56	Accommodation services	8.3	0.290	0	0	0.290	0	1
57	Hairdressing salons and personal grooming establishments	13.6	0	1	0	1	0	1
58	Electric appliances and other appliances etc. for pers. Care	30.3	0	1	0	1	1	0
59	Jewellery, clocks and watches	3.2	0	1	0	1	1	0
60	Social protection (124000)	2.8	0	0	0	0	0	1
61	Insurance connected with the dwelling	1.2	0	0	0	0	0	0
62	Insurance connected with health	1.8	0	0	0	0	0	0
63	Insurance connected with transport	3.6	0	0	0	0	0	0
64	Financial services n.e.c.	8.5	0	0	0	0	0	0
65	Other services n.e.c.	3.3	0.807	0	0	0.807	0	0
	TOTAL (incl. non-VAT items)	667.0						
	TOTAL Weight attributed to VAT rate change[3]		314.2 / 306.3	245 / 236.8	5.5	545.1		

Note: (1) Average weights over the modelled time sample 2001:1 to 20014:5 are reported. In panel data, time-varying HICP weights based on annual time series are allowed. (3) Price setting power dummy is based in line with the methodology of Carare and Danninger (2008), applied to 2009 euro currency introduction in Slovakia. The value gets the value of 1 if the inflation rate between December 2008 and January 2009 achieved more than the median price increase. (2) HICP weights related VAT rate change at the time of implementation (T) are reported. For the purpose of pass-through calculations, the weights corresponding to T-1 year are taken for pre-implementation effect and weights in year T in regards to implementation and lagged effects. Source: IFP

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