Vysoká škola ekonomická v Praze

Národohospodářská fakulta

Hlavní specializace: Ekonomická analýza

IMPACT OF VAT CHANGES ON DIFFERENT TYPES OF CONSUMPTION GOODS AND PRODUCER PRICES

diplomová práce

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Rok: 2019

Prohlašuji na svou čest, že jsem diplomovou práci vypracoval samostatně a s použitím uvedené literatury.

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V Praze, dne 10. 5. 2019

Abstract

Existing literature examining behavior of prices as a response to changes in VAT rate are somewhat ambiguous as to whether prices react before the implementation, after the implementation or both. This thesis analyzes response of consumer prices of different category goods in the Czech Republic and Slovakia between 2001 and 2018, and producer prices in CZE between 2004 and 2018. The chosen identification strategy uses linear regress model with specified control variables - fixed effects. The results show different outcomes across categories. Consumer prices of pork meat and meat products respond both before and after the implementation cumulatively. While consumer prices of poultry, beef meat, animal products, and legumes react only after the implementation of new VAT rate, consumer prices of dairy products only show preadoption effect. Almost the whole tax increase is reflected in consumer prices in CZE. Producer prices of cereal products and feed mixtures show only preadoption effect. Producers transferred 27 percent of the tax burden into their prices. In Slovakia, consumer prices of dairy products and pork meat are affected only in the first month after implementation of a VAT rate change. 22 percent of the new tax burden is transferred on consumers though consumer prices.

Keywords: Value Added Tax, consumer prices, producer prices, price elasticity, tax burden, pass-through

JEL Classification: H22, D12, D22

Abstrakt

Dosavadní existující literatura na téma reakce cen na změny DPH se do určité míry rozchází, zda-li ceny reagují již před změnou DPH, až po implementaci nové sazby DPH či kumulativně před i po. Tato práce zkoumá reakce spotřebitelských cen statků různých kategorií v České Republice a na Slovensku mezi lety 2001 a 2018 a cen výrobců v ČR mezi lety 2004 a 2018. Zvolená identifikační strategie využívá lineární regresní model s bohatou specifikací kontrolních proměnných - fixních efektů. Výsledky ukazují různé reakce jednotlivých kategorií. Spotřebitelské ceny vepřového masa a masných výrobků reagují v České Republice kumulativně před i po zavedení nové sazby DPH. Zatímco spotřebitelské ceny drůbežího a hovězího masa, živočišných výrobků a luštěnin reagují v ČR až po zavedení nové sazby DPH, spotřebitelské ceny mléčných produktů vykazují změnu pouze před zavedním nové sazby. U spotřebitelských cen v ČR je téměř celé zvýšení sazby DPH promítnuto v cenách a přeneseno na spotřebitele. Ceny výrobců obilných produktů a krmných směsí reagují na změnu DPH ještě před jejím zavedením. Výrobci přenesli na odběratele 27 procent z celkové změny daňové zátěže. Na Slovensku spotřebitelské ceny mléčných produktů a vepřového masa reagují na změnu sazby DPH pouze v prvním měsíci po změně sazby. 22 procent nové daňové zátěže je přeneseno na spotřebitele.

Keywords: Daň z přidané hodnoty, spotřebitelské ceny, ceny výrobců, cenová elasticita, daňové břemeno, přenos daňové zátěže

JEL Classification: H22, D12, D22

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Introduction

In the first decade of the 21st century, changes in the VAT rate became more frequent than ever before in the majority of European countries. The Czech Republic, on which I'm going to test my hypothesis, is a great example of a country with steady VAT rate in the 90's, and many changes after the country joined the EU on May 1st 2004. Since January 1993, the VAT has replaced the turnover tax in the Czech tax system. The rate has only changed once in the first 11 years of its existence. However, between 2004 and 2015, the tax rates were manipulated by the government six times. These frequent changes in the VAT rates created an excellent environment for an academic paper examining the impact of the changes on the prices of both consumer and producer prices.

There should be at least a pre-adoptive effect of a VAT rate change, according to the available literature. Carrare and Damminger (2008) found that one third of the total burden transfer happens before the VAT rate change is implemented. Two thirds of the pass-through happens after the implementation with cumulative transfer of 73 percent on the consumer. Buettner and Madzharova (2017) found higher numbers with nearly full transfer to the consumer price. According to their research, the burden on the supply side of the market is transferred through lower sales. Benkovskis and Fadejeva (2013) estimated the burden transfer at 84 percent.

The interesting fact about this issue is the ambiguity of papers on this topic. Even though most of the papers agree on a certain amount of pre-adoptive effect of a VAT rate change, there are papers disproving this fact. Kaufman (2009) finds no significant pre-adoptive change before the VAT policy is implemented. The rationale behind this fact is due to the extremely sticky prices in Switzerland.

There are many available papers on this topic examining other European countries. To the extent of my knowledge, there has not been a paper published examining data in the Czech Republic. It might be interesting to compare my results with results from other European countries. Using eatables for my analysis provides me with enough heterogeneity as price elasticities of demand for different eatables can range between 0.27 and 0.79, according to Andreyeva, Long, and Brownell (2010).

The purpose of this thesis is to estimate whether there is pre-adoption, post-adoption or both present in the behavior of price changes in the Czech Republic and Slovakia. I do not expect the results to be too different from the reviewed literature; however, this thesis will provide quantitative evidence of these phenomena. To estimate these effects, there will be the use of three data sets. The first panel data set covers consumer prices in the Czech Republic, second covers producer prices in the Czech Republic, and finally, the third panel data set uses consumer prices from Slovakia. Identification strategy employs specifying linear regression model with dummy variables for pre-adoption and post-adoption (treatment) effects and controlling for fixed effects.

This thesis is organized into two parts: The first part (theoretical) sets the theoretical framework and reviews published literature on this topic. The second part (practical) describes the used data in detail, formulates a formal hypothesis, describes the used method, estimates models, and interprets results.

Theoretical Part

Changes in the VAT rate

Table 1 shows standard and reduced rates' changes in time, as well as, the introduction of the 2nd reduced rate which can be imposed on products such as: infant formula, books, newspapers, some pharmaceutical products, and/or some agriculture product. The 2nd reduced rate is relatively marginal compared to the other two rates. In the consumption basket for the year 2018, the Czech Statistical Office (2019d) valued the whole section of Books and Newspapers at 0.832% and infant formula at 0.032%. Other goods that are taxed by the 2nd reduced rate are even more marginal. The reduced rate which I will focus on in this thesis is applied on plants, flowers, medical equipment, car safety seats for children, wood sold as fuel and any food not served in a restaurant. Food consumed in restaurants is taxed by the standard rate while take-away food by the reduced rate. The reasoning behind this distinction is that it's the service you are paying for in a restaurant and not the food itself which represents just a fraction of the total cost of the meal.

Table 1 – Changes in VAT Rate in the Czech Republic

Time Period	Standard	Reduced	2nd Reduced
January 1993 - December 1994	23%	5%	–
January 1995 - April 2004	22%	5%	–
April 2004 - December 2007	19%	5%	–
January 2008 - December 2009	19%	9%	–
January 2010 - December 2011	20%	10%	–
January 2012 - December 2012	20%	14%	–
January 2013 – December 2014	21%	15%	–
January 2015 - present	21%	15%	10%

Source: Daňový portál (2019)

Table 2 – Percentage Change of VAT in the Czech Republic

Time Period	Standard	Reduced
January 1993 - December 1994	-	-
January 1995 - April 2004	-4,35%	-
April 2004 - December 2007	-13,64%	-
January 2008 - December 2009	-	+80%
January 2010 - December 2011	+5,26%	+11,11%
January 2012 - December 2012	-	+40%
January 2013 – December 2014	+5%	+7,14%
January 2015 - present	-	-

Note: Author's calculations

Source: Daňový portál (2019)

The story is very similar in Slovakia. The countries that separated in 1993 have each experienced seven changes in VAT rates. Both countries have not changed the standard rate by much. The Czech Republic kept the rate in 4 percentage points and Slovakia's difference between the historically lowest and the highest rate was 6 percentage points. The more rapid change occurred in the reduced rates. The burden in the Czech Republic tripled from 5% to 15%. In Slovakia, the reduced rate almost quadrupled between the dissolution of Czechoslovakia in 1993, and 2004 when Slovakia joined the EU. The reduced rate had been abolished in 2004 so all products were taxed with the standard rate until 2007 when the reduced rate was re-introduced again at 10%. Slovakia had also introduced a second reduced rate at 6% in 2010. This rate was soon after the implementation cancelled. The second reduced rate applied mostly just on medical supplies, books and eatables sold from a yard. The fraction of food sold from private yards is so marginal there is no need to take it into consideration and this thesis will assume all the eatables were taxed by the reduced rate. (Bánociová, 2009)

Table 3 – Changes in VAT rate in Slovakia

Time Period	Standard	Reduced	2nd Reduced
01.01.1993	23%	5%	-
01.08.1994	25%	6%	-
01.01.1996	23%	6%	-
01.07.1999	23%	10%	-
01.01.2003	20%	14%	-
01.01.2004	19%	19%	-
01.01.2007	19%	10%	-
01.05.2010	19%	10%	6%
01.01.2011	20%	10%	-

Source: Jarošová (2007) and Portal Podnikajte.sk (2019)

The EU's highest standard rate is in Hungary where the tax burden is 27% and the lowest is in Luxembourg where the rate is set at 17%. The vast majority of the EU countries now have the standard rate between 19% and 23%. The reduced rates vary between 2.1% up to the standard rate in the country. The actual rates, especially the reduced rates, cannot really be compared as every country has its own legislation splitting goods into different rates. (European Commision, 2019)

Theoretical Framework

In the Czech Republic, a company or an entrepreneur becomes the payer of the VAT when their revenues exceed one million Czech crowns in 12 consecutive months period. The seller is the one obligated to pay the VAT from every product or service they sold while deducting the total amount of VAT they had paid for the input. Prices on shelves in stores in the whole European Union are written tax included. In the United States, sellers are not obligated to include the sales tax to the prices presented to customers; however, the tax is also technically paid to the government by the seller.

In basic economic theory, it makes no difference who physically pays the tax. The focus of economics and my thesis is to see who bears the cost. The cost is distributed based on elasticities of demand and supply curves. The price elasticity tells us the percentage change in quantity with a 1% change in price. If any of the curves is perfectly inelastic (the curve is vertical), the quantity traded on the market does not change; therefore, there is no dead weight loss and the whole burden goes to the side with the perfectly inelastic curve. If the supply curve is perfectly elastic (the curve is horizontal), the whole burden is transferred forward as the price will rise by the value of the tax. With perfectly elastic demand curve, the price cannot change so the burden of the tax is fully taken by the supply side through lower quantity sold.

The conventional assumption outside of general public and media is that a higher VAT rate will be fully transferred to the price and the burden passed onto consumers. As both perfectly elastic and perfectly inelastic supply and demand curves are only a theoretical concept, not present in the real world, it is reasonable to assume at least some elasticity of both curves. Both sides will then bear at least a small fraction of the cost imposed by the tax. The core problem of this thesis is how much of the burden caused by higher VAT can be transferred forward from the producer through distribution channels to the final consumer. The burden of any tax, according to economic theory, depends on the elasticity of supply relative to the elasticity of demand (Fullerton and Metcalf, 2002).

Announcement Period

Inflation-Smoothing Effect

The empiric studies show that there is a significant change in prices before the implementation of a VAT rate change. This means that even though there might be sharp increase in prices right after the implementation, a longer period between announcement and implementation of the policy can help smoothen the final effect. The main idea behind this concept is that both form and especially time of the announcement matter. According to Carrare and Danninger (2008), this pre-adoptive behavior might have two reasons on both sides of the market:

Firstly, price adjustments can be staggered due to sticky information. Price adjusting and information gathering is costly; therefore, firms which do not change prices often and plan to adjust their prices in the period before the implementation of the price change might make the price change larger than otherwise. This approach is consistent with Time Dependent Pricing (TDP) models described below and discussed in more detail.

The second reason, is a demand shift after the announcement of the tax policy. Firms operating on markets with limited competition and downwards sloping demand curve can experience a temporary shift in demand caused by consumers' anticipating the tax burden being passed on them. This effect will temporarily increase the demand curve (and prices) before the implementation and decrease the demand curve (and prices) in the period after the implementation as consumers already bought the desired product before the tax change. The less competitive the markets the more exploited this effect can be by the companies operating there.

Anticipated and Unanticipated Tax Shock

Mertens and Ravn (2012) also emphasize the importance of the announcement period before a tax policy change. Their study analyzed direct tax changes in post-war United States between 1947 and 2003. They did not focus on VAT nor sales tax which is the main focus of this thesis. However, they found interesting results of a significant difference between tax policy changes that were implemented within 90 days after announcement (unanticipated) and those implemented after more than 90 days (anticipated). Unanticipated tax cuts give significantly higher stimulus to the economy persistently increasing output, consumption, investment, and worked hours right after the announcement. Stimulus caused by anticipated tax policy change occurs after the implementation but during the pre-implementation period the output, investment, and hours worked all drop. Consumption remained unchanged which is consistent with most of the studies published on this topic.

Profit Maximizing Price

Time Dependent Pricing and State Dependent

Changing prices implies some fixed costs. Changing the menu in restaurants, price tags on clothes or just changing prices on a web-shop impose costs on the seller. Therefore, it is only profitable for a firm to change prices when the benefits of a price change exceed the cost. Existing literature distinguish between two types of price stickiness: Time Dependent Pricing (TDP) and State Dependent Pricing (SDP). (Devereux and Henry, 2007)

TDP models assume that firms are given exogenous possibility to change prices with respect to time since the last change of that particular price. If the VAT rate is changed, the companies do not react by changing their prices immediately and stick to their fixed timing. The size of the price adjustment will be larger. In SDP models, a firm's decision to change prices depends on specific endogenous shocks. Firms react to a change in the VAT rate by adjusting the prices immediately. Monetary shocks last longer in time-dependent pricing models as in state-dependent pricing models where (in SDP) the monetary stimulus is met with faster price adjustment and the total effect on the real product is smaller. (Klenow and Oleksiy, 2008)

Pricing Practices in Large Business

It is important to mention that the goal of a business of any scale is to maximize profit in the long run. The main short-term goal of pricing might not be to maximize profit in that particular time period. A company might set lower price for a new product for marketing reasons. Getting their innovative product on the market and increasing their market share or building new brands. It might also be a marketing strategy to set prices too high and establish the brand as something luxurious. Dolgui and Proth (2010) puts Apple and Mercedes-Benz as an example. Apple's mp3 players and Mercedes' A-class cars were put on the market at higher prices to demonstrate the exclusiveness of their brand. These strategies are costly for the company in the short-term but might pay off in the long run.

The pricing strategies will differ based on the type of market on which the company operates. If it is possible and feasible, the company will exercise price discrimination. Selling

different versions of the product in terms of quality, changing price over time, discounts for different groups of people (students, seniors, veterans), or discounts with higher quantity purchased (Anderson and Dana, 2009). If the discrimination is profitable, the pricing gets more complicated as it requires estimating demand curves for different quality of the product, for multiple groups of customers, or for the same type of customer in different time periods.

$$Y_{jhmt} = f(X, D, p)'\beta + \zeta_{hm} + \eta_{mt} + \epsilon_{jmt}$$

With technology and software being more and more affordable, it might get profitable for even some smaller companies to analyze the demand curve through econometric models if the companies acquire the desired data. The equation above represents a typical specification of a demand curve for product **j** on market **m** at time **t**. The function **f** stands for an interaction between the observables, demographics and prices. $\boldsymbol{\zeta}$ represent dummy variables and $\boldsymbol{\eta}$ adjusts for seasonality. The total number of variables depends on the data available to the company and the method used. If the data set is big enough there might be thousands of them. Google is a great example of a company with nearly infinite amount of data and more than enough resources to build a high quality model. Google takes advantage of this fact and estimates the demand curve for a web page using billions of other web pages on the right-hand side of the equation. (Bajari, 2015)

Pricing Practices in Small Business

Estimating shape of a demand curve for a certain good might still be costly and small businesses cannot afford to do such research. The demand curve is abstract and it changes constantly. Large companies or corporations with high revenues can invest money to accurately estimate the demand curve for their product. Smaller firms usually prefer simple pricing methods. This action reduces their revenue because the price they set probably differs from the revenue-maximizing price. On the other hand this decrease in revenue is lower than cost of high-quality market research and menu costs. Professor Haynes (1964) identified a few different pricing techniques.

Initially, Haynes (1964) presents full-cost pricing. The problem with this method is the ambiguous definition of costs. Are the costs equal to expected costs or costs of a previous time period? Do they also include opportunity costs? A certain mark-up is added to these

"costs." The mark-up times the number of products sold equals the profit of a firm. Another problem with this method is various sizes of mark-ups that firms add to their costs. Third, the insufficiency in this method is the fact that firms, according to Haynes (1964), change their mark-up according to changes on markets. If this was true, it would contradict the whole concept of full-cost pricing as explained earlier. If the mark-ups changed as a result of changes in demand, a firm would simply be trying to find a profit-maximizing price of their product. The size of a mark-up might also be affected by ethics and morality. Some producers do not set their mark-up higher than what they consider to be "fair" or "reasonable".

Almost half of the responders in Haynes's (1964) survey do not take costs into account at all. In some industries, it is hard or even impossible to quantify the costs, which is the reason for such an action. Among the firms that do not take costs into account, there are a few which do a systematic market research. However, a more common pricing method is trial-and-error and is dependent on the instinct of the person who is setting the price.

The last technique Haynes (1964, p. 322) mentions is profit-targeting. A company sets a goal of a certain height of their profit, and sets prices just as high to get to the desired profit. This technique seems probable just in case of considering ethics and morality, similar to a method that is mentioned above. Firms set their prices based on their previous experiences or based on prices of a successful competition in the field which has a similar size. Interestingly, not a single enterprise in this research has tried to quantify their marginal revenue or elasticity of a demand curve for their product.

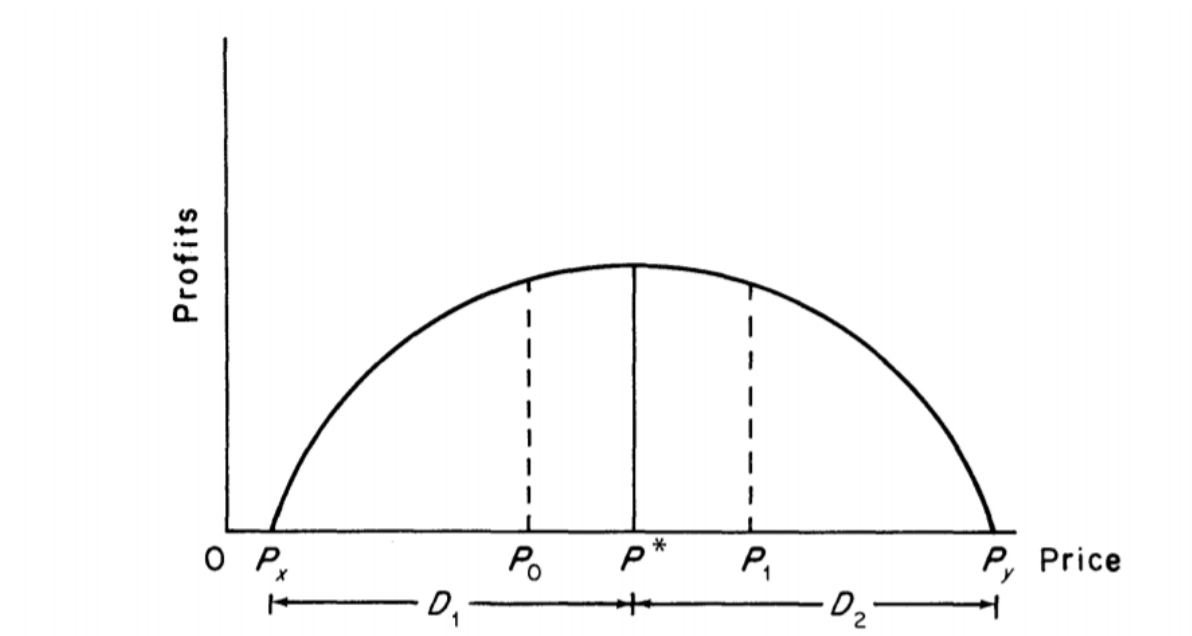
Deviations from the profit maximizing price

Besides finding profit-maximizing price, it is worth examining deviations in price from this profit-maximizing price and its effect on profits. The profit-maximizing price is a theoretical concept which cannot be permanently perfectly achieved. Individual demand curves for any product might change every second due to an infinite number of reasons.

Flat-Maximum Profit

Pricing decisions are imperfect due to incomplete information. The main question a pricing decision-maker faces is whether the marginal product of additional information is greater than its marginal cost. In other words, the closer a company gets to the profit-maximizing price, the more expensive it gets to obtain information leading to higher profits through better pricing. The effect of a price change on profits depends on the flatness of the profit curve. As seen on Graph 1, the change in profits caused by deviating from P* to P_0 or P_1 might not be that big based on the shape of the curve. The curve on this graph is based on linear demand and cost functions. The curve in the real world will most likely not be symmetrical. (Silver and Tull, 1987)

Graph 1 – Flat-Maximum Profit



source: Silver and Tull (1987)

$$\mu = \frac{d\pi}{dp} * \frac{p}{\pi}$$

If the elasticity of profit with respect to price is equal to one, the proportional change in price will result in the same change in profits. If the elasticity is smaller than one, the change in profits will be proportionally smaller, and vice versa. It is crucial for the price decision-maker to estimate the elasticity of profit with respect to price near P* to decide how close the company wants to approach the profit-maximizing price. The higher the elasticity, the higher marginal product of additional information leading to the optimal price. The lower the elasticity, the more flat the profit curve gets meaning lower marginal product of additional information. Based on this Flat-maximum principle, Silver and Tull (1987) propose that firms do not necessarily need to find the pure profit-maximizing price. Companies might have some flexibility when deciding the price of their product without any significant change of their profits.

Price Flexibility

The price flexibility, as a classical macroeconomic term, explains how markets adjust to shortages and surpluses via changes in prices in the long-run. In the context of this thesis, we examine the micro-economic meaning of the price flexibility. The actual ability of companies to change prices of their products is based on changes in demand or supply curves of those products. In this context, we can measure the price flexibility.

The value of price flexibility represents a percentage of consumer goods which are on average changed during one month. For example, the price flexibility of 100% can be observed on stock markets or in auction halls where prices can change every minute. On the other side, the frequency of 0% can be observed in acupuncture treatments, for example (Benkovskis and Fadejeva, 2013).

Empirical Papers On This Topic

Price Elasticity Estimates

Andreyeva, Long, and Brownell (2010) identified 464 relevant citations on estimating price elasticities of different types of food and non-alcoholic beverages. After retrieving and reviewing them, they were left with 160 papers published between 1938 and 2007. 62% of the studies were time-series data, 21% household survey data, and 17% scanner data. Only 24% of the researches included were published before 1970. All the elasticities complied with basic economic theory and ranged between 0.27 and 0.81. Food served outside of home has relatively very high elasticity at 0.81. Food brought home to consume 0.59. Different types of food and its elasticities are shown in table below:

Table 4 – Elasticities of Different Eatables

Product	**Mean Price Elasticity**	**Number of Estimates**
Soft Drinks	0.79	14
Juice	0.76	14
Beef	0.75	51
Pork	0.72	49
Fruit	0.70	20
Poultry	0.68	23
Dairy	0.65	13
Cereals	0.60	24
Milk	0.59	26
Vegetables	0.58	20
Fish	0.50	18

Fats and Oils	0.48	13
Cheese	0.44	20
Sweets	0.34	13
Eggs	0.27	14

Source: Andreyeva, Long, and Brownell (2010)

Studies on the Impact of VAT on Prices in EU countries

Study from Latvia

Benkovskis and Fadejeva (2013) explore impact of the VAT rates changes on CPI in Latvia. This analysis is to some extent similar to the one presented later in this paper using data from the Czech Republic. The main focus point in Benkovskis's and Fedejeva's (2013) paper is the CPI and macroeconomic data. This thesis analyzes Czech micro data. Latvia, like the Czech Republic, has experienced a significant rise in the VAT rates in the last decade. Changes in the VAT rates are shown in Table 3:

Table 5 – Changes in VAT Rate in Latvia

	Standard	**Reduced**	**Change in CPI**
Before 01.01.2009	18%	5%	
01.01.2009	21%	10%	3.81 pp
01.01.2011	22%	12%	1.27 pp
30.06.2012	21%	12%	0.67 pp

Source: Benkovskis and Fadejeva (2013)

The Table 3 does not express movement of goods and services between the two rates. For example, water, housing, and theaters started to be taxed by the standard rate instead of the reduced rate after 01/01/2009. The last column represents the change in CPI in percentage points, assuming that the whole burden of the tax was transferred onto a consumer (perfectly inelastic demand curve). Latvia's price flexibility was relatively high in the observed period as it was estimated to 24.7% which means the average duration of a is approximately four months.

The average change in prices was 2.2% in the observed period. On average, a change in the VAT rate caused the frequency of price changes to be higher in the following month. However, there was a big difference between different types of goods and services. The frequency of food price changes was significantly higher as a result of the VAT change, apart from fruits and vegetables which seemed not to be affected by the VAT rate change at all (Benkovskis and Fadejeva, 2013). This was probably caused by very inelastic demand for food and very inelastic supply of nondurable fruits and vegetables.

The Benkovskis and Fedejeva (2013) results do not show any statistically significant delayed effect of the VAT rates changes; therefore, their paper focuses only on the following month after the VAT rates changes. After a big increase in both VAT rates in January 2009, the immediate transfer of the burden of the tax on consumers was 83.9%. This raise in the VAT rates itself caused higher inflation by 3.2 percentage points. The immediate transfer in 2011, even though smaller in absolute numbers, surpassed the 100% boundary and caused additional inflation of 1.4 percentage points. "Positive" transfer of the tax burden in 2012, when the VAT rate was lowered, was estimated to be 36%. Therefore, there is a clear asymmetric reaction of Latvian companies.

Study from Hungary

Very similar research was conducted by Gabriel and Reiff (2008) using data from Hungary which experienced one of the highest and most fluctuating inflation rates in the developed world in the last two decades. However, the price flexibility is smaller than in Latvia despite the highly fluctuating inflation rate. Although, estimated 21.5% is still more

than the Eurozone average. In the observed period, 40% of all changes in prices were reductions. This implies prices in Hungary are not sticky.

The average size of the price change was 12.25%, which is a very high number relative to Latvia, where the size was 10 percentage points smaller. The average duration of one price of a good or a service was 6.14 months. This value is probably underestimated, and Gabriel and Reiff (2008, p. 12) assume that the number is closer to 8 months. In the period examined by Gabriel and Reiff (2008), the Hungarian government changed the VAT rates three times. The standard rate was raised in January 2004 from 12% to 15% and in September 2006 from 15% to 20%. In January 2006, the higher VAT rate was reduced from 25% to 20%. The results of the model show that a VAT rate change significantly affects goods which do not fall into the changed VAT rate.

The core question Gabriel and Reiff (2008) ask is whether the inflation change, as a result of a rate change, is caused by larger price changes or higher frequency of price changes. According to empirical data in the observed period, TDP dominates with 75.2% of firms' decisions; however, the results of the model are very heterogeneous among different categories of goods. In general, changes in inflation are caused more by larger price changes rather than by changes in frequency.

Study from Switzerland

An interesting comparison to the Hungarian paper is a paper published by Daniel Kaufman (2009) analyzing Switzerland. Hungary has experienced volatile and unstable inflation rate in the last 25 years. The inflation rate in Switzerland, on the other hand, has been very stable and very low in that time period. Switzerland even experienced long time-period in deflation when the consumer price index was decreasing. For almost the whole 2015 and 2016, the inflation rate was below zero with minimum at -1.4% at the end of 2015. In the last 10 years, the inflation rate was not further from zero than 1.5 percentage points which is lower than most central banks inflation target. (Trading Economics, 2019)

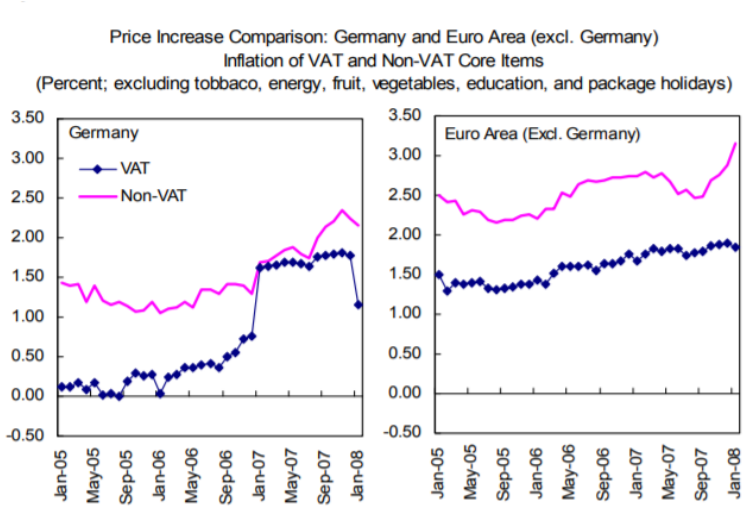
Kaufman's (2009) paper analyzed data from 1993 to 2005. The results show that VAT rate changes do not cause pre-adoptive changes in prices and prices adjust in the quarter

after the changes take effect. Prices in Switzerland are sticky. The average duration of a price was almost 14 months which is 3,5 times longer than in Latvia. However, price flexibility differs significantly across different consumer goods. The average price change was estimated at 9,4% which is more than four times the number in Latvia. The distribution of price changes is relatively symmetrical around zero. About 41,3% of all price changes were price decreases. Even in periods with positive inflation, significant share of price changes were price decreases. Inflation rate and other macroeconomic factors seems to affect the frequency of the price changes rather than its size which is consistent with the state-dependent pricing model. However, Kaufman (2009) admits that very low and stable inflation rate limits deeper examination of the pricing models.

Study from Germany

In January 2007, Germany experienced 3 percentage point increase in the VAT rate. Even though, Carrare and Danninger (2008, p. 3) argue it was "one of the largest such hikes in industrial coutries", looking at other EU countries like the Czech Republic, Slovakia, or Latvia, this increase in nothing unusual. What is unusual and worth examining is the announcement period before the change which was 13 months.

Graph 2 – Price Increase in Germany



Source: Carrare and Danninger (2008)

Time trend in the model is positive and significant showing accelerating inflation. The inflation rate among VAT items increased more than among non-VAT items even before the implementation of the tax change in period between 2005 and January 1st 2007. The total increase in core inflation after the increase was implemented was smaller than expected by the authorities. This implies that the early announcement effect is inflation smoothing. The pre-adoptive increase in consumer prices added 0,36 percentage points to the core inflation. The effect of the tax increase after the implementation contributed to the core inflation by 0,73 percentage points. The cumulative pass-through of the tax into the consumer prices was 73 percent. (Carrare and Danninger, 2008)

Study From France

Carbonnier's (2006) paper focused on quantifying the amount of burden passed-through on the final consumer. His paper examined prices of cars and housing repair services. In 1987, the VAT rate imposed on cars bought in France went down from massive 33,33 percent to 18,6 percent. In 1999, the VAT rate on housing repair services also decreased massively from 20,6 percent to almost one fourth (5,5 percent). The markets are very

different as the new car market is a closed oligopoly and the housing repair market is approaching perfect competition. Carbonnier (2006) concludes that the total amount of tax burden transferred forward was estimated at 52 percent on car market and 77 percent on the market with housing repair services. Interestingly, there is a higher percentage transferred forward on less competitive market which might go against economic intuition and Carrare's and Danninger's (2008) thesis that firms on less competitive markets can transfer larger fraction of the tax. The reason these two papers contradict is that on strongly competitive markets, like housing rapair market, with no or little entry cost, the competition lowers the margins to minimum which force the workers to reflect any change in their costs into the price of their serveices.

VAT and Data Across EU Countries

A research paper with similar data as those presented later in this thesis was published by Thiess Buettner and Boryana Madzharova (2017). They based their price and sales analysis on micro data of durable "white goods" like cookers, refrigerators, dishwashers, freezers, cooktops, hoods, tumble driers, and washing machines. The observed time period was 117 months between years 2004 and 2013. The data set used is massive with approximately 110,000 products, 62 million units sold each year and annual market size of 26 billion Euro in 22 EU countries.

The paper disproves the idea that the tax can be immediately transferred to the customer fully showing that one percentage point increase in the VAT rate results in contemporaneous prices increase by about 0,22 percent. Pre-adoptive transfer of higher VAT rate show significantly positive coefficient. The same results are shown in the following month after the rate hike. Buettner and Madzharova (2017, p. 27) state that "the magnitude and statistical significance of the leading and lagged terms indicate that the pass-through for major domestic appliances starts before a reform becomes effective and continues for some time after implementation".

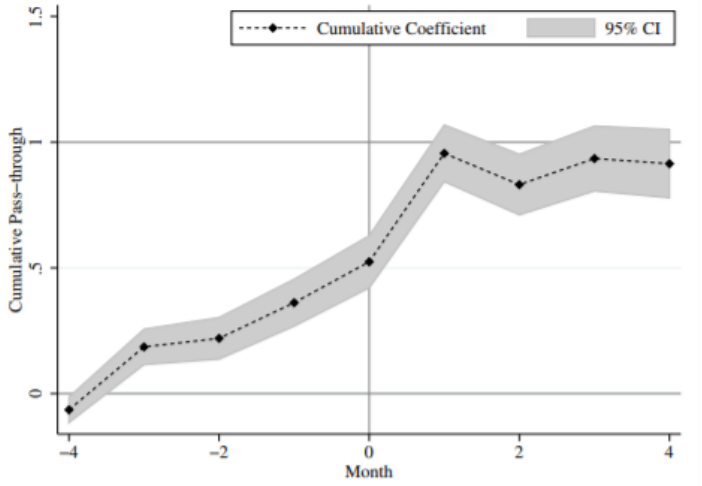
The total sum of pre-adoptive, contemporaneous, and following affects (3 months in total) is about 75% meaning that sellers were able to transfer three quarters of the tax on the consumer though higher prices. If the treated period is 6 months around the tax hike (3

months before and 3 months after the change), the results are higher approaching full transfer on the consumer. There are clear differences in pre-adoption behavior based on the time of announcement of the tax change. In general, if the announcements is soon enough the pass-through starts 3 months before implementation and is completed by the second month after; therefore, we can state that an average VAT rate increase takes 5 months to be fully reflected in consumer prices.

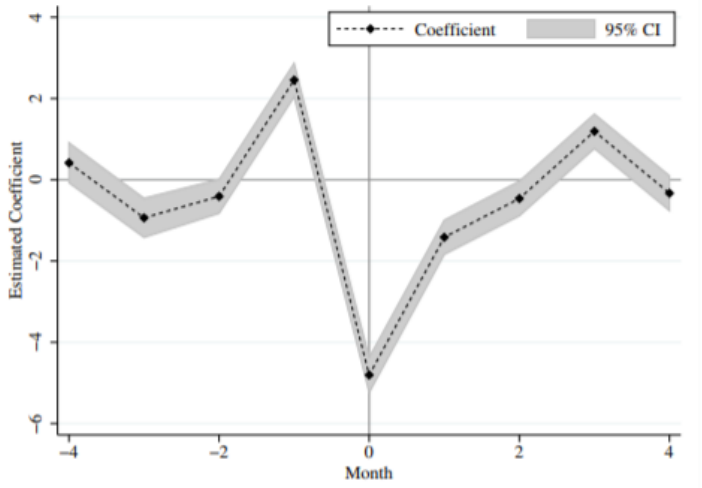
Even if a VAT rate increase was fully reflected in the consumer prices that does not mean that the whole burden of the tax was passed-through on the consumer. It would be true if the sales remained unchanged implying perfectly inelastic demand curve. Results show that a VAT rate hike by one percentage point increases consumption temporarily by 2,6 percent in the last month before the rate hike. In the long-term one percentage point tax increase results in 2,4 percent shift in consumption. The results are shown on Graph 3 shown below:

Graph 3 – Price and Sales Changes

A. Cumulative Pass-through



B. Tax Effects on Sales



Source: Buettner and Madzharova (2017)

Practical Part

Data

Three data sets are used in later analysis. All panel data sets are perfectly balanced. The first data set is monthly prices of 49 different products. The panel data consists of 214 observations for each product from January 2001 to October 2018. This means the total of 10486 observations in the whole data set. This data is available in limited version on the website of the Czech Statistical office (CZSO, 2019c). I used data I received from the office upon request via e-mail conversation.

I also received data for producer prices through e-mail. Some products match products from the first data set perfectly. Unfortunately, Czech Statistical Office does not gather the same data for both producer and consumer prices so the second data set is slightly smaller in terms of the amount of products and also the time period. I only obtained data for 178 months from January 2004 to October 2018. There are 24 different products so the total number of observations in this data set is 4272.

The third data set contains consumer prices in Slovakia. The time period is identical with Czech consumer data. I obtained data online from the Slovak Statistical Office as there are not any more detailed data available upon request. Slovak data set in unfortunately also smaller than the first one as methodology of measuring prices of many products changed leaving many products discontinuous (without missing observations) and unfit to be analyzed. The third data set consists of 31 products and with 214 observations for each one of them totaling at 6634 observations.

Summary Statistics
Consumer Prices in the Czech Republic

Table 6 - Summary Statistics of Consumer Prices in the Czech Republic by Categories

Category	Mean	Sd	Min	Max
	PricePct	PricePct	PricePct	PricePct
Animal Products (4%)	0.3	4.9	-19.7	66.6
Beef (8%)	0.2	1.2	-5.1	6.1
Cereal Products (8%)	0.3	3.8	-12.8	35
Dairy Products (14%)	0.2	2.9	-11.4	18.7
Fruits (10%)	1	13	-43.7	82.4
Legumes (4%)	0.3	1.9	-4.6	11.7
Meat Products (14%)	0.1	1.6	-7.2	10.2
Pork (10%)	0	2.1	-6.3	8.5
Poultry (4%)	0.1	3	-9	15.1
Sugar (4%)	-0.2	3.7	-16.5	20.8
Vegetables (18%)	1.5	17.7	-54.2	232.9
Total (100%)	0.5	9	-54.2	232.9

Note: Author's calculations in Stata

Source: CZSO (2019d)

The summary statistics for each category does not include absolute values as the measuring unit of each product might be different. Products in category *Beef* are measured consistently in kilos but the category *Animal products*, for example, consists of honey and eggs. The price of eggs is displayed for a package of 10. The consumer price of honey is measured in kilos. Every category is marked with a percentage stating its share on the examined goods basket. The largest one (*Vegetables*) consists of nine different products, the smallest ones (*Animal Products*, *Legumes*, *Poultry*, and *Sugar*) contain two products each.

Two categories *Fruits* and *Vegetables* show the highest monthly flexibility. The highest downwards price percentage change was -43,7 for *Fruits* and -54,2 for *Vegetables*. The highest upwards percentage change in the price was 82,4 percent for fruits and

suspiciously high number of 232,9 percent for *Vegetables*. The price of potatoes was 7,29 CZK per kilo in May 2001 and it rose to 24,27 in June 2001 in order to return to 7,84 in September 2001. *Potatoes* show quite high volatility at the end of spring in other years also.

This relatively very high volatility compared to other categories can be easily explained by the elasticity of the supply curve of fruits and vegetables. The total supply is decided months in advance when farmers plant the eatables. Plus there are many environmental factors affecting the harvest (weather, climate, pest) and also political (artificially lowered supply by agriculture policy). After harvesting eatables, the supply is fixed and the inelasticity of the fixed and limited supply is enhanced by the time factor as the victuals spoil.

The most stable prices are in categories including meat. *Beef, Pork, Meat Products* and *Poultry*. Even though, the same applies to meat as it does to fruits and vegetables when it comes to spoiling, the supply of meat is way more elastic. Farmers can decide whether to slaughter the cattle now or in a few months. Once the animal is dead the clock is ticking; however, there is still a possibility of turning the meat into durable meat products like salami or sausages which can last for months or even years.

Table 7 - Summary Statistics for Consumer Prices in the Czech Republic by Products

Product	Mean	Sd	Min	Max	Mean	Sd	Min	Max
	PriceAbs	PriceAbs	PriceAbs	PriceAbs	PricePct	PricePct	PricePct	PricePct
Apples (2%)	28.5	5.2	16.4	43.3	0.5	7.1	-24.6	20.8
Bananas (2%)	30.1	3.8	21.7	41.8	0.4	8.9	-22.7	26.1
Beef Front Boneless (2%)	141.8	16.2	119.1	173.2	0.1	1.2	-3.2	4.7
Beef Front With Bone (2%)	90.4	17.7	68.3	125.5	0.2	1.1	-3.4	6.1
Beef Rear Boneless (2%)	179.9	25.4	139.8	225.7	0.2	1.3	-4	4.6
Beef Tenderloin (2%)	547.2	107.9	336.4	671.7	0.2	1.3	-5.1	5.6
Butter (2%)	130.1	33.7	89.1	241.8	0.5	3.4	-11.4	15.1
Cabbage (2%)	11.3	3.9	4.7	26.1	1.6	16	-47.1	79.4
Caraway Bread (2%)	19.6	3.7	13.9	24.8	0.3	2.8	-8.3	16.5
Carrots (2%)	16.6	4.4	8.7	34.2	1	13.2	-37.9	45.5
Cauliflower (2%)	31.5	9.2	12.7	55.7	3.5	27.9	-54.2	154
Chicken (2%)	59.8	8.2	44.3	74.1	0.1	2.6	-7.1	7.4

Coarse Flour (2%)	10.4	2.1	6.7	14.1	0.3	4.3	-12.8	20
Crystal Sugar (2%)	20.7	2.6	12.5	26.1	-0.2	3.5	-14.4	20.8
Cucumbers (2%)	38.3	12.4	15.2	94	2.7	25.5	-40.4	92.3
Duck (2%)	86.3	5.8	74.4	96.9	0.1	3.3	-9	15.1
Durable Milk (2%)	15.6	1.9	12.7	20.6	0.1	2.9	-8.1	18.7
Edam Cheese (2%)	122.5	15.6	92.4	165.4	0.2	3.3	-8.3	14.6
Eggs (2%)	28.1	5.4	21.2	50.9	0.3	6.8	-19.7	66.6
Fruit Yoghurt (2%)	9.5	1.4	7.4	12.9	0.2	3.6	-10.8	12.9
Ham Salami (2%)	122.9	9.2	109.9	151.3	0.1	1.9	-7.2	6.5
Honey (2%)	148.6	30.6	117.4	216.7	0.2	1.5	-5	8.5
Icing Sugar (2%)	23.3	2.4	16.3	27.7	-0.2	3.9	-16.5	11.1
Lemons (2%)	38.8	13.3	24.8	92	0.9	11.4	-37.7	55
Lentils (2%)	47.1	9.6	30.8	60.4	0.3	1.9	-4.6	10
Liver Pate (2%)	100.1	10.6	88	122.4	0.1	1.3	-3.4	5.5
Luncheon Meat (2%)	84.6	21.4	58.6	119.1	0.3	1.7	-6.7	6.3
Onions (2%)	13.5	3.1	5.8	20.3	0.8	10.3	-24.9	50.7
Oranges (2%)	31.1	4.8	23.9	47.1	0.6	8.6	-27.7	30.1
Pasta (2%)	34.3	7.9	25.5	49.8	0.3	2.3	-8.2	8.6
Pasteurized Milk (2%)	16.7	2.5	12.6	21.2	0.2	2.4	-6.5	9
Peppers (2%)	61.7	15	34	102	1.2	16.9	-43.5	56.6
Pickled Cabbage (2%)	29.4	6.4	22.5	47.4	0.3	2.1	-6.9	7.8
Pickles (2%)	43	7.5	33.1	57.9	0.2	2.4	-9.3	6.9
Pork Belly (2%)	72.9	10.6	56.6	97.6	0.1	2.1	-6.1	7.9
Pork Ham (2%)	169.6	19.8	147.3	212.9	0.1	1.6	-5	10.2
Pork Lard (2%)	57.3	6.3	47.8	68.5	0.1	1.5	-3.9	8.7
Pork Liver (2%)	58.9	2.2	53.3	65.3	0	1.7	-5.3	5.2
Pork Neck (2%)	105.9	9.1	89.8	126.1	0.1	2.2	-5.9	8.5
Pork Roast (2%)	109.6	8	95	133.9	0	2	-6.3	6.3
Pork Shoulder (2%)	104.6	9.7	91.5	132.4	0	2.3	-6	7.2
Potatoes (2%)	12.5	3.8	6.3	26.2	2.3	23.6	-53.8	232.9
Rice (2%)	29.4	7.4	18.1	38.5	0.3	1.9	-3.7	11.7
Salami (2%)	182	11.5	166.6	208.5	0	1.6	-4.6	6
Sausages (2%)	105.9	22.3	75.5	149.2	0.3	1.4	-3.6	5.8
Smooth Flour (2%)	10.3	2	7	13.7	0.2	3.5	-8.5	13
Tomatoes (2%)	38.7	9.2	17.6	70.2	2.5	22.8	-43.7	82.4
Wheat Bread (2%)	38.5	7.7	25.2	55.9	0.3	4.3	-11.6	35

White Yoghurt (2%)	6.9	1.2	5.7	9.5	0.2	1.9	-5.7	8.1
Total (100%)	71.8	86.6	4.7	671.7	0.5	9	-54.2	232.9

Note: Author's calculations in Stata

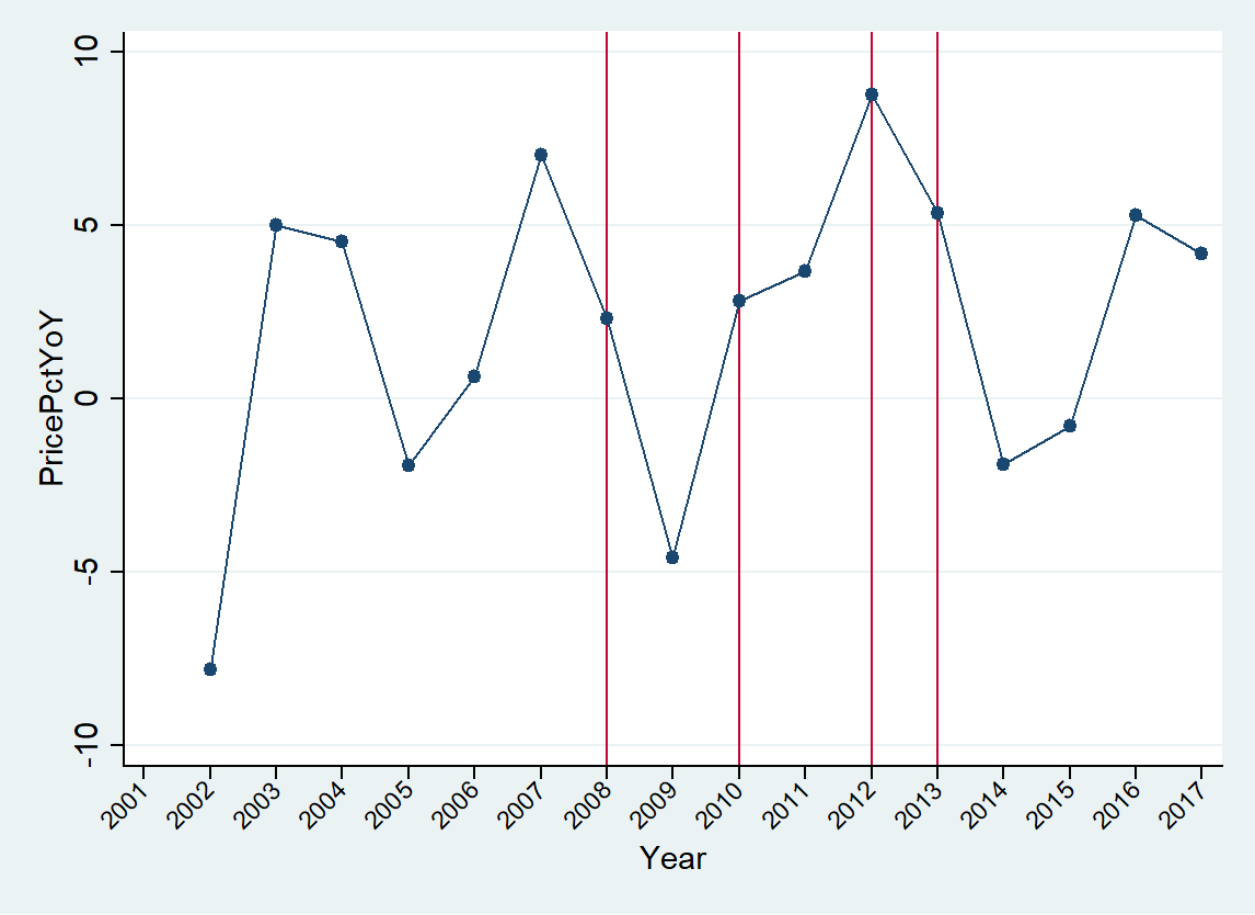
Source: CZSO (2019d)

In Table 7, we can also see the absolute values for each product. All products displayed in the table are eatables and are subject to the reduced VAT rate. The share on the total examined basket is again shown in the table for every product, even though they are all the same size with 178 observations. There are 49 products analyzed so the share of eacah product is slightly over 2% of the examined basket and all consist of 178 observation

Again, the product that is the most volatile and unstable is *Potatoes* as stated above. Looking at the absolute values, we see similar story as in the Table 6. Prices of meat, pork especially, are the most stable. The minimal price for *Pork Neck* was 89,8 CZK per kilo which is approximately 71 percent of the maximum price of 126.1. For *Salami* the number is even higher at 80 percent and the smallest price range can be observed for *Pork Liver* (81,6 percent). On the other side, the biggest difference between the maximum and minimum prices is not to see for potatoes as expected by the sharp increase described above but rather for *Cucumbers* which has its maximum price more than six times higher than its minimum. The most stable prices in terms of monthly percentage increase or decrease was *Beef Rear Boneless* with maximum increase of just 4,6 percent.

The average percentage change of all but two products is positive. Two out of 49 product are showing average decrease in price between January 2001 and October 2018. This means that the nominal consumer price for sugar is lower in 2018 than it was in early 2001. Price of *Icing Sugar* reached three peeks since January 2001. Price of *Crystal Sugar*, even though the overall trend is very similar, has been much more stable without any significant increase or decrease.

Graph 4 – Annual Percentage Consumer Price Change



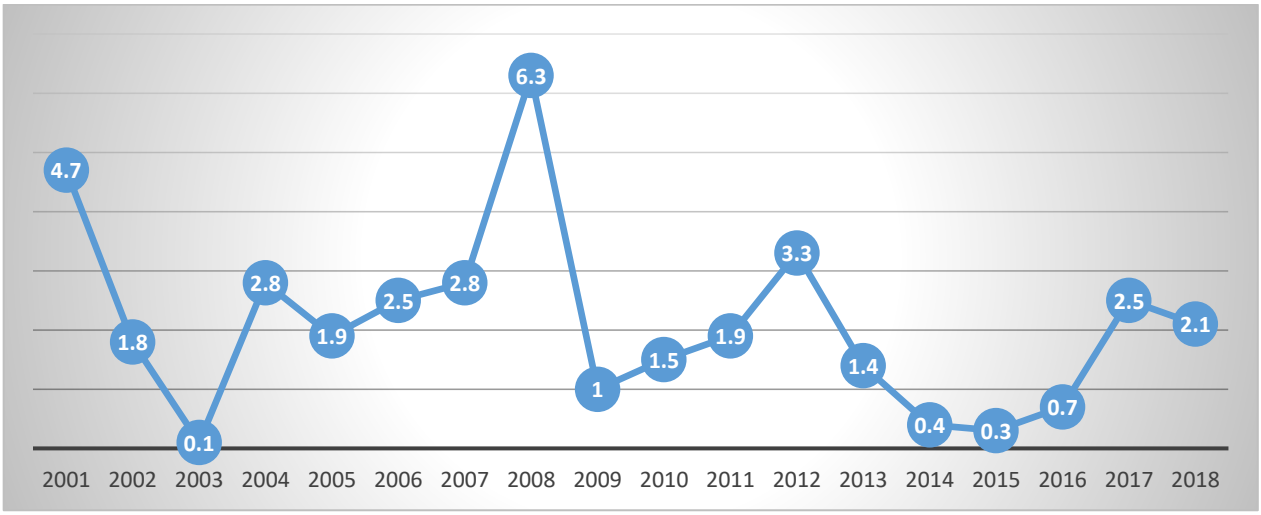
Note: Author's calculations in Stata

Source: CZSO (2019d)

Graph 4 shows the annual percentage change of prices of the consumption basket displayed in Table 6 and 7. Red horizontal lines mark years with a VAT rate increase. As we can see the changes are volatile and even though the observed period is just 214 months, the graph seems cyclical. The values oscillate around approximately 1 percent with five values below zero and eleven positive. For comparison, Graph 5 shows the annual inflation rate in the Czech Republic. We can see that those two graphs somewhat correspond but does not correlate at a statistically significant level. The highest annual inflation since 2001 was at 6,8 percent in 2008. The annual percentage change in our consumption basket was just slightly above average in 2008. The lowest inflation rate published by the Czech Statistical Office was in 2003 when prices of the examined basket of goods increased by 5 percent.

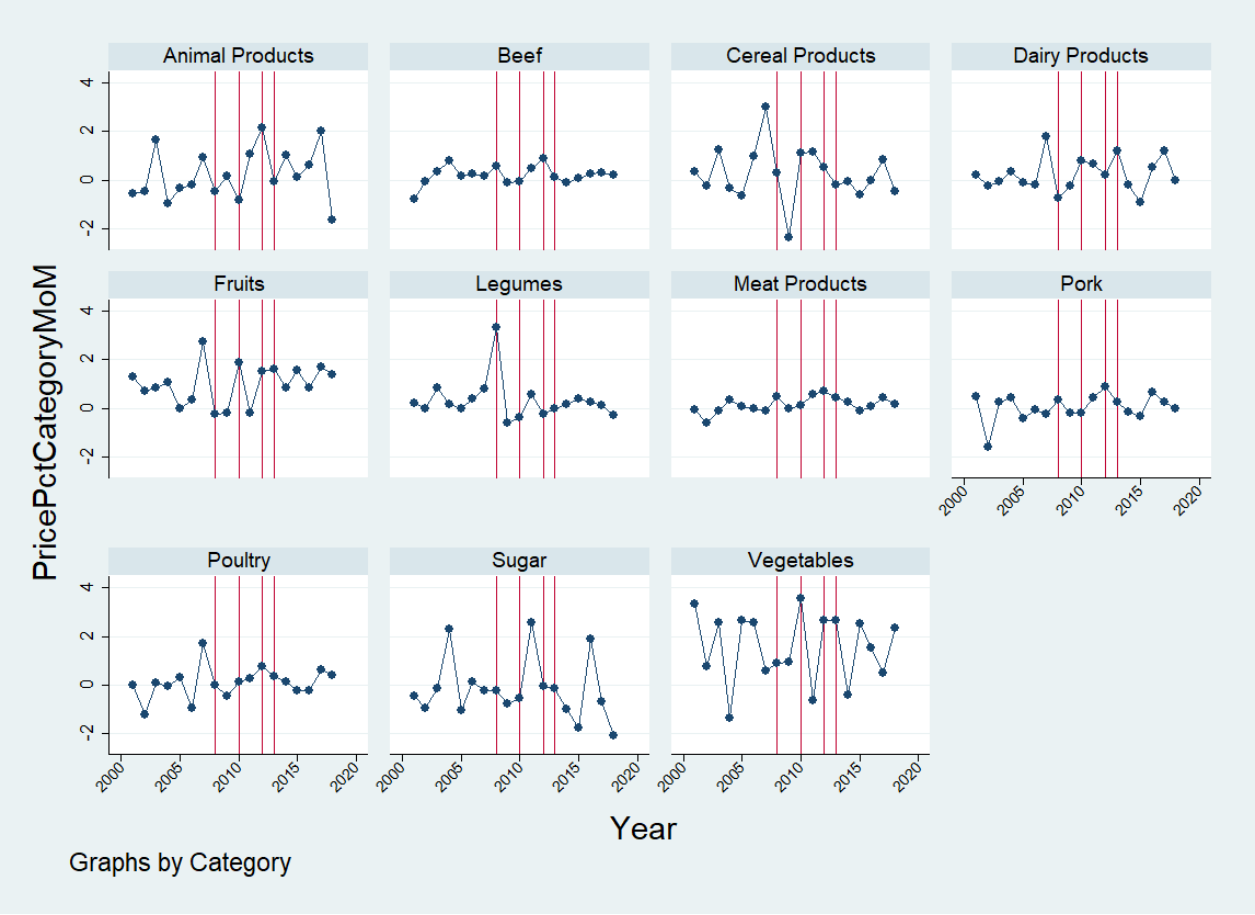
The reason is that eatables are less than 18 percent of the total consumption basket which is used to calculate the increase (or decrease) of the CPI. Plus the basket of examined goods used for my analysis does not proportionally represent eatables included in the CPI. I picked eatables as the available data at micro level published by the Czech Statistical Office are by far the most detailed among any other consumption goods. There are also way fewer problems with methodology. If we examined shoes or cars, for example, there are hundreds of different types, different brands, or different levels of quality. It also depends how old the model (of shoes or cars) or whether it went out of fashion or not. It gets way simpler with a homogenous product like onions.

Graph 5: Annual Inflation Rate In the Czech Republic



Source: CZSO (2019a)

Graph 6 - Annual Percentage Consumer Price Change Among Categories



Note: Author's calculations in Stata

Source: CZSO (2019d)

If we decompose Graph 5 to all 11 categories (Graph 6), we can see that the most stable prices are again among *Beef*, *Pork* and *Meat Products* as expected from Table 6 displaying monthly summary statistics. *Poultry* was more volatile than other analyzed meats but it has been very stable since 2008. Prices of *Legumes* have also been relatively stable except the year 2008. Prices of *Fruits* and especially prices of *Vegetables* are very volatile as expected based on the monthly numbers.

What may seem unexpected is the volatility of *Sugar*, mostly caused by price of *Icing Sugar* rather than more stable price of *Crystal Sugar*. The maximum monthly percentage change in the price of *Sugar* was 20,8 percent which is less one third of the maximum price

change of *Animal Products* (66,6 percent) and yet the annual volatility of *Sugar* is significantly higher than the one of animal products. This may be caused by seasonality of the prices of *Honey* and *Eggs*. As sugar does not spoil, the supply curve has probably higher elasticity; therefore, it is resistant to big price changes in short time periods. The price in longer time periods such as one year are not affected by seasonality as much as the volatility in the world supply of sugar. Price of *Beef*, *Fruits* and *Legumes* seem to be way more unstable between years 2008 and 2013 when the VAT rates where frequently changed. As discussed later, prices of these categories in Slovakia do not show such volatility in this time period.

Producer Prices in the Czech Republic

Table 8 - Summary Statistics of Producer Prices in the Czech Republic by Category

Category	Mean	Sd	Min	Max
	PricePct	PricePct	PricePct	PricePct
Beef (12%)	0,1	1,4	-7,9	6,3
Cereal Products (25%)	0,1	2,5	-10,3	14,5
Dairy products (16%)	0,1	3,2	-12,5	15,1
Feed mixture (16%)	0,1	2,3	-9	12,6
Meat Products (16%)	0	1,9	-6,9	7,9
Pork (4%)	-0,1	2	-5,2	5,9
Poultry (4%)	0	2,2	-5,9	6,6
Sugar (4%)	-0,4	2,9	-11,3	17,7
Total (100%)	0	2,4	-12,5	17,7

Note: Author's calculations in Stata

Source: CZSO (2019b)

With slightly smaller data set, this section will examine producer prices in the Czech Republic. The Table 8 again lacks the absolute values statistics as the categories are filed with prices of goods measured in different units. The data for fruits and vegetables are unfortunately not available for producers prices as those were the most volatile. The least volatile prices are again those concerning meat. The most stable prices are those of *Pork* and *Beef* followed by *Poultry* which in this data set is only represented by chicken as other

Poultry was not available. Interesting fact is that producers' price of *Sugar* was decreasing at the rate twice as fast as the consumer price of *Sugar*. All the other categories showed very stable prices with average percentage change not further than 0,1 percentage point from zero including *Pork* which at the producers level was cheaper 2018 than in 2001 in terms of nominal price.

Table 9 - Summary Statistics of Producer Prices in the Czech Republic by Product

Product	Mean	Sd	Min	Max	Mean	Sd	Min	Max
	PriceAbs	PriceAbs	PriceAbs	PriceAbs	PricePct	PricePct	PricePct	PricePct
Beef Front Boneless (4%)	115,5	5,6	97,2	123,7	0,1	0,9	-2,7	5,7
Beef Leg Boneless (4%)	80,5	6,5	69,2	98,8	-0,1	2,2	-7,9	6,3
Beef Rear Boneless (4%)	142,7	8,5	117,8	156,5	0,1	0,7	-2,3	2,9
Butter (4%)	99	19,8	69,7	174,9	0,4	4,1	-12,5	14,8
Caraway Bread (4%)	15,5	1,7	12	18,4	0,1	1,6	-2,5	10,6
Chicken (4%)	40,9	2,9	33,7	46,3	0	2,2	-5,9	6,6
Crystal Sugar (4%)	15,905.5	3,188.8	8,308.2	22,729.4	-0,4	2,9	-11,3	17,7
Durable Milk (4%)	10,5	1,2	7,3	14,5	-0,1	3,1	-7,7	10,7
Edam Cheese (4%)	91,1	12,2	58,9	126,1	0	3,4	-12	15,1
Ham Salami (4%)	78,2	6,7	64,5	89,4	0	1,7	-6,1	7,9
Hot Dogs (4%)	55,1	4,7	42,7	64,8	0,2	2,3	-6,9	6,3
Mixture for Chicken (4%)	7,673.7	849,4	5,881.9	9,419.9	0,1	2	-5,4	11
Mixture for Hens (4%)	6,114.5	795,7	4,720.8	7,818.6	0	2,4	-9	11,8
Mixture for Pork (4%)	6,101.9	872,4	4,556.2	7,911.0	0,1	2,3	-8	11,7
Mixture for Pork U65kg (4%)	5,271.5	832,4	3,814.0	7,183.0	0,1	2,6	-7,7	12,6
Pork Roast (4%)	78,6	4,4	69,6	92	-0,1	2	-5,2	5,9
Raw Milk (4%)	12,5	0,9	10,7	14,7	0	1,5	-4,4	9
Rolls (4%)	28,8	3	24,1	34,4	0	2,1	-3,8	13,4
Rye Flour (4%)	6,722.9	1,067.5	5,206.1	8,700.0	0,1	2,7	-10	11,9
Salami (4%)	92,8	5,5	78,3	101,7	-0,1	1,5	-4,7	4,7
Smoked Ham (4%)	95,2	13,5	74	121,8	-0,2	1,9	-5,8	5,4
Wheat Baking Flour Smooth (4%)	6,715.0	931,5	5,534.4	9,023.9	0,1	2,5	-9,6	10,9
Wheat Flour Extra (4%)	7,574.1	1,125.4	5,704.3	10,153.6	0,1	3,1	-10,1	14,5
Wheat Flour for Bread (4%)	6,324.4	959,1	4,940.2	8,493.3	0,1	2,8	-10,3	12,9

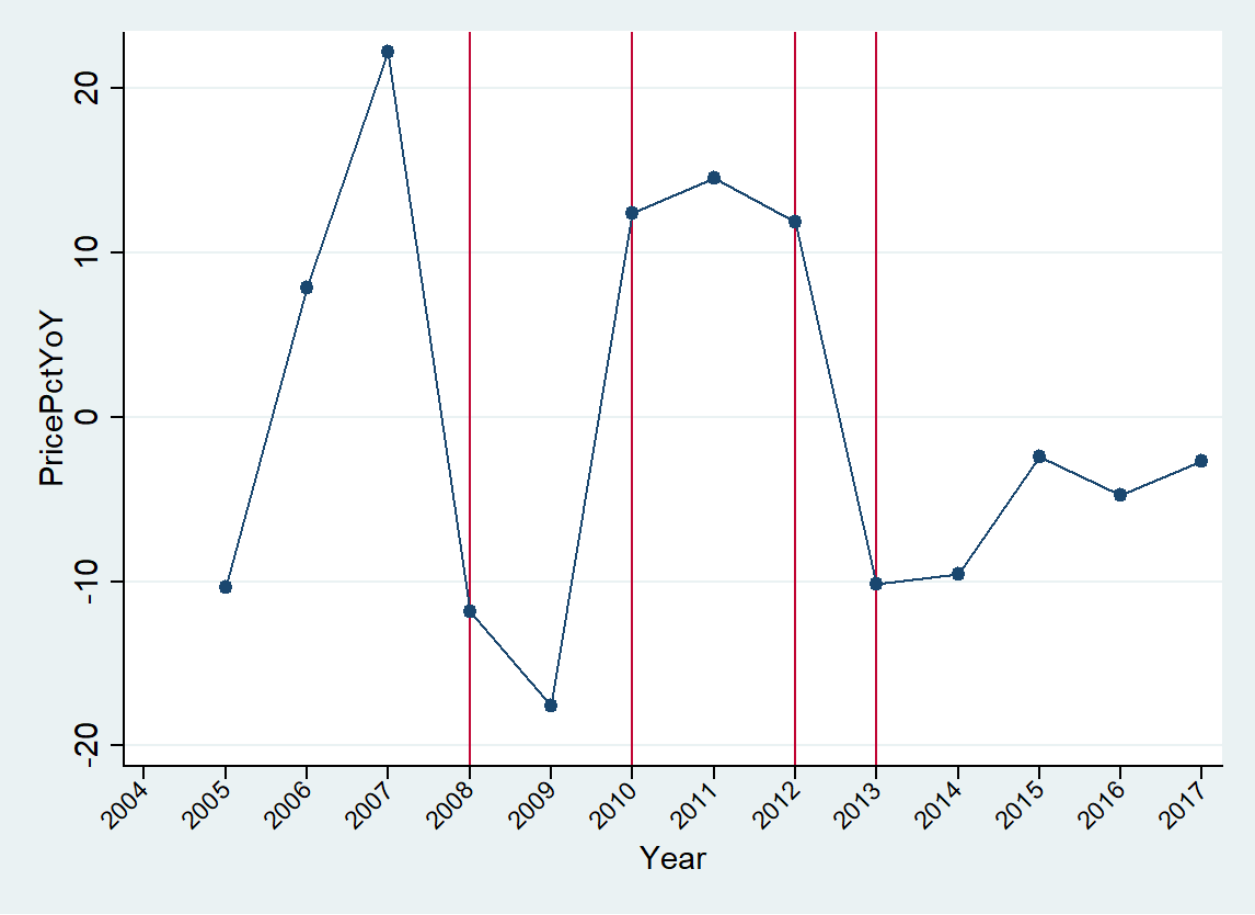
Total (100%)	2,893.3	4,174.8	7,3	22,729.4	0	2,4	-12,5	17,7

Note: Author's calculations in Stata

Source: CZSO (2019b)

As mentioned above, price of the *Pork* category was decreasing over the observed time period. It was not caused by one product which would bias the statistics of all other products in the category. *Ham Salami*, *Pork Roast*, *Salami* and *Smoked Ham* were showing decreasing price over time. *Durable Milk* is also showing an overall decrease in nominal price over the time period. *Raw Milk* shows close to zero change in the observed time period. When comparing those products for which I have data for both consumer and producer prices, we can see that producer prices have similar trend but are less volatile with smaller price changes both ways. *Chicken*, for example, shows very similar numbers in consumer and producer prices but one percentage point lower maximum and minimum price change meaning the short-term month-to-month changes were not as big. This behavior is typical for most of the analyzed products.

Graph 7: Annual Percentage Producer Price Change



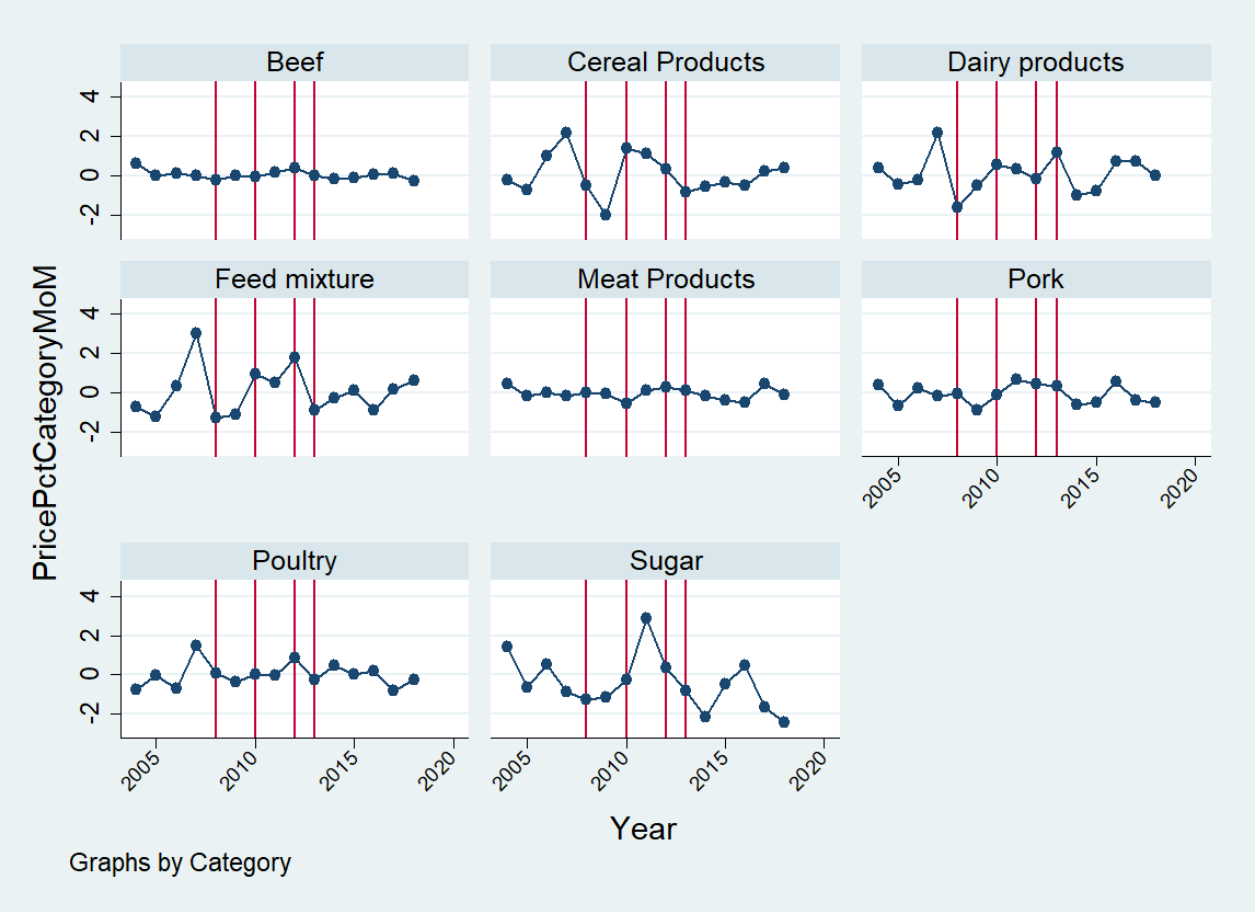
Note: Author's calculations in Stata

Source: CZSO (2019b)

On Graph 7, there is more than twice as big volatility of annual prices then in case of consumer prices. Graph 4 showing annual percentage changes in consumer prices show all results withing single-digit percentage points. With maximum lower than 9 percent change in 2012 and minimum higher than -8 percent change in 2002. Price increase in year 2007 surpassed 20 percent increase. Based on this annual Graph 7 and data from Table 9, we can conclude that producer prices are significantly more stable than consumer prices on monthly bases. After examining annual growth rates of both consumer and producer prices, data show

opposite results. The volatility of prices on annual basis is significantly higher for producer prices.

Graph 8: Annual Percentage Producer Price Change Among Categories



Note: Author's calculations in Stata

Source: CZSO (2019b)

Very little annual price volatility is again show for *Beef*, *Pork* and *Meat Products*. All three of these categories, which account for approximately one third of the data set, show less volatility than the same categories in consumer prices. The over all annual price volatility of the producers sample might be bias due to *Feed Mixture* which consist of food for different animals so it is obviously not represented in the consumer prices. However, *Feed Mixture* only represents 16% of the total basket so the bias should not be critical. *Sugar* shows very

similar shape in both consumer and producer prices with maximum in 2011 with maximum of 2,5 percent annual increase.

Even if every category in producer prices showed similar or smaller volatility than in case of consumer prices, it does not nesessarily mean the overall price level would be more stable. Basic intuition might suggest that the more volatile components are, the more volatile their sum is; however, the fluctuations around zero might cancel out in total and the result be different than expected. This seems to be the case for consumer prices as majority of products show more volatile price than in terms of producer prices but the overall effect is smaller showling more stable price growth rate on annual basis.

Consumer Prices in Slovakia

The data for Slovakia is nicely comapable to Czech data as some product, for which data was available, are identical. There is one relatively big problem with Slovak data and that is the currency the prices are denominated in. Both Czech and Slovak data are rounded by the statistical offices to second decimal point but one Czech crown is just about 4 percent worth of one Euro which means the data for Czech Republic are 25 more accurate. The average price of *Fruit Yoghurt*, for example, was 0,34 Euro in January 2001. If the prices rose just by one cent to 0,35, it would be an increase of almost 3 percent. That is very little change considering that the data are monthly. Fruit Yoghurt is an extreme example as its nominal price is among the smallest in the data set.

Table 10 - Slovak Consumer Prices by Categories

Category	Mean	Sd	Min	Max
	PricePct	PricePct	PricePct	PricePct
Beef (9%)	0,2	1	-6,5	4,6
Cereal Products (6%)	0,2	2,6	-9,6	21,1
Dairy Products (29%)	0,3	2	-10,7	19
Fats and Oils (6%)	0,2	4,5	-14,5	33,3

Fruits and Vegetables (6%)	1	12,5	-33,3	137
Legumes (3%)	0,2	2,2	-6,1	7
Meat Products (16%)	0,1	1,1	-3,8	7,1
Pork (16%)	0	2,7	-9,7	17,4
Poultry (3%)	0	1,8	-4,9	6
Sugar (3%)	-0,1	2,6	-9,3	12,8
Total (100%)	0,2	3,9	-33,3	137

Note: Author's calculations in Stata

Source: SOSR (2019)

The highest and also lowest extreme is again in category *Fruits* and *Vegetables* with consists of *Apples* and *Potatoes*. The familiar behavior of price of *Potatoes* will be discussed in the paragraph below Table 11. Mean percentage change seems about the same as in data for the Czech Republic. Except *Fruits* and *Vegetables* neither category surpassed average percentage change of 0,3. Categories *Beef*, *Pork* and *Meat Products* behave in very similar manner as in Czech data. The price of *Sugar* is also the only price that experienced a nominal decrease in the observed period. Showing that the markets are both open and very well connected.

Table 11 - Slovakia Consumer Prices by Products

Product	Mean	Sd	Min	Max	Mean	Sd	Min	Max
	PriceAbs	PriceAbs	PriceAbs	PriceAbs	PricePct	PricePct	PricePct	PricePct
Apples (3%)	1,1	0,2	0,7	1,7	0,5	7,1	-23,3	20,2
Beef Front (3%)	3,9	0,7	2,7	5	0,2	1,1	-6,5	4,6
Beef Front Boneless (3%)	6	0,6	4,7	7	0,1	1	-6,1	4
Beef Rear Boneless (3%)	7,4	0,9	5,7	8,8	0,1	1	-5,7	3,9
Bread (3%)	1,1	0,2	0,6	1,4	0,4	1,3	-9,6	8,2
Butter (3%)	0,9	0,2	0,5	1,4	0,5	2,8	-7,1	19
Chicken (3%)	2,4	0,2	2,1	2,8	0	1,8	-4,9	6
Chocolate (3%)	0,8	0,1	0,6	1,1	0,3	2,8	-9,5	7,2
Cottage Cheese (3%)	1	0,1	0,7	1,2	0,3	1,7	-5	6,5

Crystal Sugar (3%)	0,9	0,1	0,7	1,2	-0,1	2,6	-9,3	12,8
Eatable Oil (3%)	1,7	0,3	1,2	2,2	0,2	3,2	-6,9	33,3
Edam Cheese (3%)	5,8	0,5	4,6	7,1	0,1	2,4	-8,1	11,9
Flour (3%)	0,4	0,1	0,3	0,5	0,1	3,4	-8,9	21,1
Fruit Yoghurt (3%)	0,4	0	0,3	0,4	0,1	2	-5,3	5,9
Ham Salami (3%)	4,8	0,3	4,4	5,4	0	1,1	-3,8	3,7
Margarine (3%)	0,6	0,1	0,5	0,8	0,3	5,5	-14,5	21,3
Pasta (3%)	1	0,2	0,7	1,2	0,3	1,2	-3,5	4,2
Pasteurized Milk (3%)	0,7	0,1	0,5	0,8	0,2	1,8	-10,7	6,5
Pork Flank (3%)	3,2	0,3	2,6	3,9	0,1	2,8	-7	17,4
Pork Lard (3%)	2,3	0,3	1,9	2,8	0,2	1,1	-2,2	4,9
Pork Leg (3%)	4,8	0,6	3,6	6,4	-0,2	2,2	-5,7	14,5
Pork Neck (3%)	3,9	0,4	3,1	5	0	3	-8,4	15,8
Pork Roast (3%)	4,7	0,4	3,6	5,8	0	3	-9	17,4
Pork Shoulder (3%)	4,2	0,6	3,1	5,9	-0,2	2,7	-9,7	15,5
Potatoes (3%)	0,5	0,2	0,2	0,9	1,5	16,2	-33,3	137
Rice (3%)	1,2	0,2	0,8	1,6	0,2	2,2	-6,1	7
Salami (3%)	7,6	0,3	6,9	8,3	0	0,9	-2,1	3,9
Sardines in Oil (3%)	0,8	0,1	0,7	1,1	0,2	1,2	-3,8	3,1
Sausages (3%)	3,5	0,7	2,5	4,9	0,2	1,4	-3,3	7,1
Smoked Cheese (3%)	9,5	1,6	6,4	11,7	0,3	1,2	-3,3	5,4
Sour Milk (3%)	0,5	0,1	0,4	0,8	0,4	1,7	-3,3	14,5
Total (100%)	2,8	2,5	0,2	11,7	0,2	3,9	-33,3	137

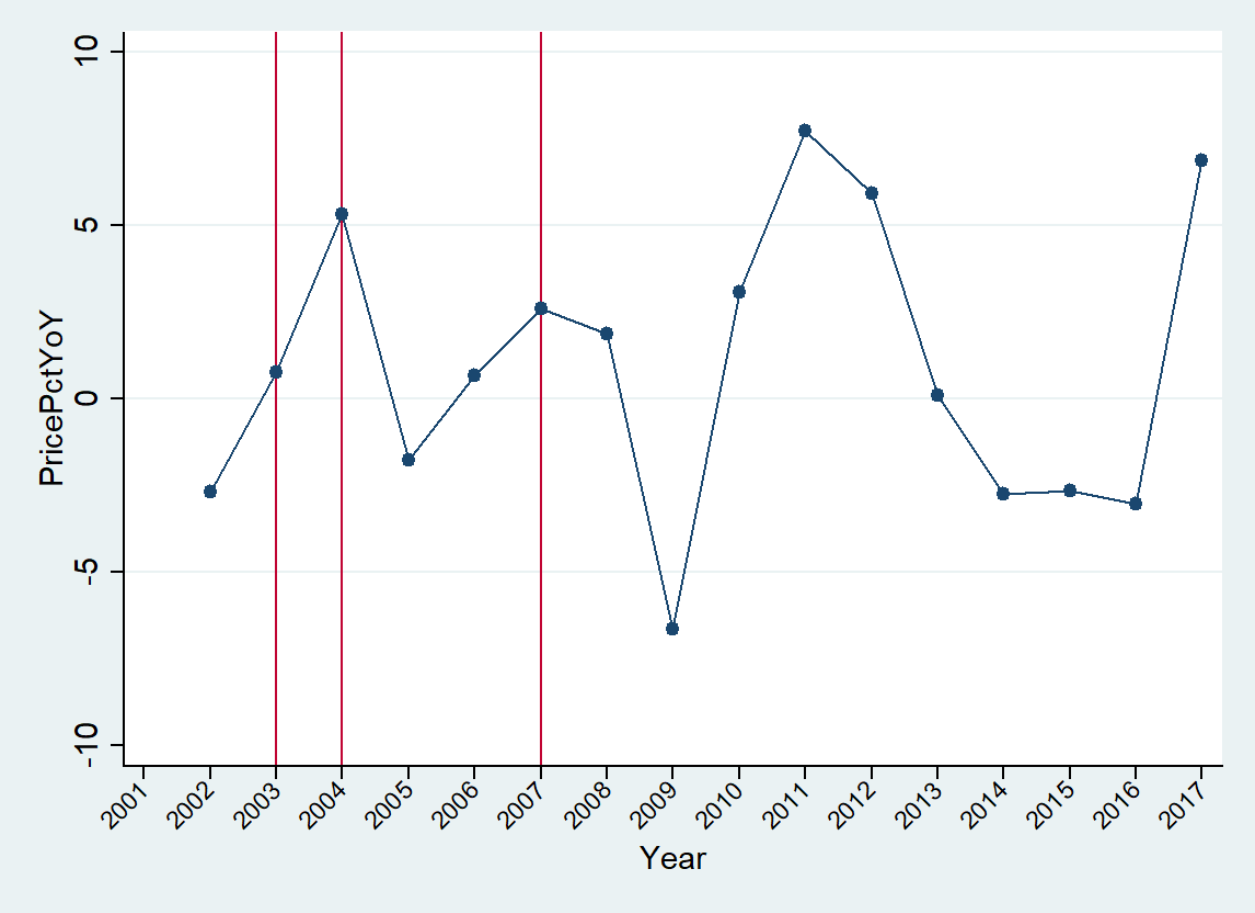
Note: Author's calculations in Stata

Source: SOSR (2019)

The most volatile price was, as mention above, observed among *Potatoes*. The maximum and minimum are not as extreme as in Czech data; however, the pattern is identical. A sharp increase in consumer price of *Potatoes* can be observed around May of every year with price returning back close to the original price around September. This is due to strong seasonality and elasticity of the supply curve of Potatoes as it is described above.

At this point, product that are similar for both countries can be easily compared. Consumer prices of *Apples* behaved almost identically. Price of one kilo of apples in Slovakia experienced an average of 0,5 percent monthly change (0,5 in CZE), with highest price decrease of 23,3 percent (24,6 in CZE) and highest price increase of 20,2 percent (20,8 in CZE). The same applies to most of the products.

Graph 9: Annual Percentage Consumer Price Change in SVK



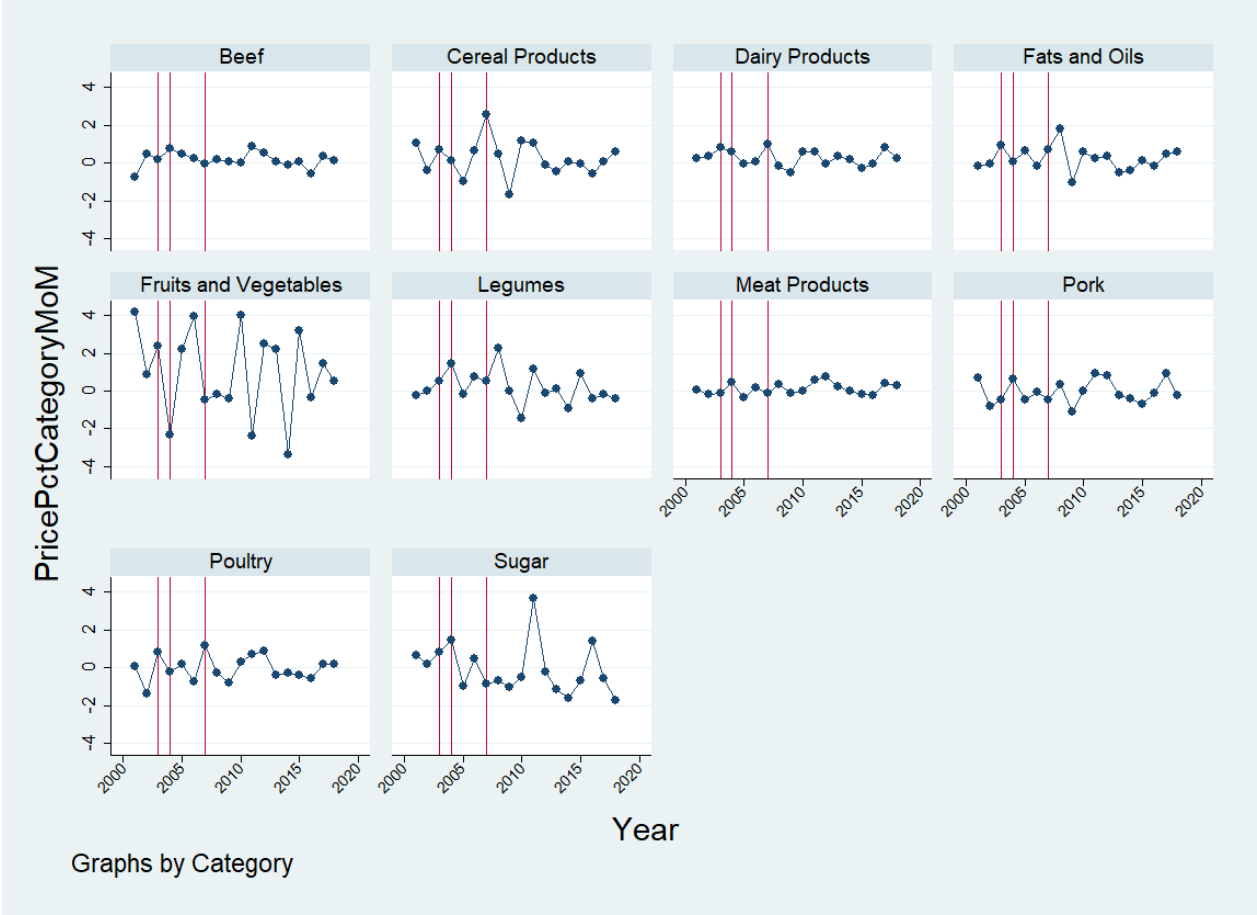
Note: Author's calculations in Stata

Source: SOSR (2019)

Graph 9 displaying annual percentage consumer price changes in Slovakia is very similar to Graph 4 showing similar data from the Czech Republic. As discussed earlier, Czech consumer prices and Czech producer prices show very different, seemingly uncorrelated

annual price growth graphs. However, if we compare only consumer prices from both countries, the correlation is apparent. Neither of all observed years deviated from zero for more than 9 percentage points. There are four peeks in both graphs in years 2003 and 2004, 2007, 2012 and 2017. Two biggest price decreases came in 2002 and 2009 for both countries. It is important to mention that the last vertical red line represents a reduction in the VAT rate, the only reduction in data of this whole thesis. The reduction was in fact massive. From 19 percent to 10 percent slashing the tax by nearly one half. Despite very different tax policies in both countries, it is safe to say that the data sets for consumer prices for these two countries are similar and can serve as a control group for any analysis.

Graph 10: Annual Percentage Consumer Price Change in SVK by Category



Note: Author's calculations in Stata

Source: SOSR (2019)

Very stable consumer prices can be again observed among *Beef*, *Pork*, and *Meat Products*. From looking at Graph 10, it does not seem there is any significant effect of VAT rate changes on the annual price change. It may seem there is a significant price increase of *Cereal Products*, *Dairy Products*, and *Poultry* in year 2007 which is marked by red vertical line but again this year is marked for VAT rate decrease. When comparing categories with consumer price data from the Czech Republic, all the categories behave in very similar matter following the same pattern. The only category that might seem different is *Fruits* and *Vegetables* but it only contains two products in Slovak data set compared to fourteen (5 products in *Fruits* and 9 products in *Vegetables*) in Czech data set.

Research Hypothesis

Based on the results of Carrare and Danniger (2008) who reported statistically significant preadoption effect of price increase in response to the tax increase, I formulate the following research hypothesis:

Hypothesis 1: There is a statistically significant preadoption effect of price change in response to the VAT rate change.

Based on the results of Kaufmann (2009) who reported that the VAT rate changes do not cause pre-adoptive changes in prices and prices adjust only after the VAT rate change, the following hypothesis can be made:

Hypothesis 2: There is a statistically significant adoption effect of price change in response to the VAT rate change after the change takes place.

Based on the results of Buettner and Madzharova (2017) who reported statistically significant preadoption and adoption effect of price increase after the tax rate changes, this final hypothesis can be made:

Hypothesis 3: There is a statistically significant both preadoption and adoption effect of price change in response to the VAT rate change.

Methods and Identification Strategy

Effects discussed in hypotheses 1, 2 and 3 can be identified by constructing a linear fixed-effects regression model with dummy variables denoting preadoption effects (price change before the VAT rate change) and treatment effects (price change after the VAT rate change). Similar to specification in Benkovskis and Fadejeva (2013), preadoption variables are set to: 1 month before the VAT change, 3 months before the VAT change, and 6 months before the VAT change (using earlier periods could make a false significance by including coincident events). Treatment variables are set to: 1 month after the VAT change, 3 months after the VAT change, 6 months after the VAT change, and 12 months after the VAT change.

The model fixed-effects are specified and estimated for: i) years fixed-effects, ii) month fixed effects to control for the possibility that firms might tend to change their prices in particular month every year, iii) product fixed-effects to capture behavior specific to particular products, and iv) product category fixed-effects to capture behavior specific to particular product category. However, to check for the possibility of overcontrolling – i.e. including too many fixed-effects, which could result in the loss of significant signals in the data, I will include controls one by one.

Formally, the model takes a following econometrical specification:

$$\%PriceChange_{i,t} = \beta_{t-6} I_{t-6} + \beta_{t-3} I_{t-3} + \beta_{t-1} I_{t-1} + \beta_{t+1} I_{t+1} + \beta_{t+3} I_{t+3} + \beta_{t+6} I_{t+6} + \beta_{t+12} I_{t+12} + YearFixedEffects + MonthFixedEffects + ProductFixedEffects + ProductCategoryFixedEffects$$

Where $\%PriceChange_{i,t}$ denotes price change of product i observed in time t (month and year), β_{t-6} to β_{t+12} are estimated effects of price change before and after the VAT rate and corresponding time periods before and after are captured through dummy variables I_{t-6} to I_{t+12}. Estimated beta coefficients are identified effects of price response in the before and after corresponding periods. Rest of the equations - four fixed-effects

variables, which are time-invariant, will be set on and off during estimation to check for overcontrolling and robustness of the estimates.

Results

Estimating VAT Rate Change Effects on Consumer Prices in the Czech Republic

Table 12 shows estimated effects under different controlling regimes. Baseline regression in Model 1 shows statistically significant price increase of 0.834% in the first month period after the change in response to the 1 percentage point increase in VAT rate. Hence, sellers are "preadopting" the VAT rate increase by partly increasing price of their products before the official change takes a place. The effect is highly statistically significant (at an alpha level 0.01). Model 2 controls for category of product (fixed-effects of 11 categories discussed in data section). Model shows the same coefficient estimates as in a baseline regression. Model 3 shows an important feature - controlling for month fixed-effects. This is important because if sellers tend to change prices in the beginning of the year, this would coincide with all VAT changes (recalling that all consumer products in the dataset are subject to reduced VAT rate which changed 4 times and always in January). Now this behavior is captured and controlled for in month fixed-effects variables.

The effect in the first month is now even higher – 0.956 %, indicating that sellers are transferring almost entire tax burdens onto consumers. The estimate keeps high statistical significance at an alpha level 0.01. Model 4 shows that when including both category and month fixed-effects, significant variance diminishes from the model. Model 5 uses category and year fixed-effects, results are similar to first two models. Model 6 extends model 4 by further including year fixed-effects, the results are similar to model 4. Models 4 and 6 are then likely cases of overcontrolling (using too many control variables). On the other hand, models 1, 2 and 5 lack to control for the effects of seasonality of price changes. Model 3 with month controls is then methodologically most likely the way to go. Models 1, 2,3 and 5 also indicate that the price increase happens during one month and there is no (statistically significant) cumulative effect.

Table 12 – Model Results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	All	All	All	All	All	All
Preadopted6M	-0.293	-0.293	0.296	0.296	-0.354	0.275
	(0.221)	(0.221)	(0.239)	(0.238)	(0.231)	(0.251)
Preadopted3M	0.250	0.250	0.331	0.331	0.189	0.309
	(0.221)	(0.221)	(0.239)	(0.238)	(0.231)	(0.251)
Preadopted1M	0.108	0.108	-0.207	-0.207	0.0392	-0.232
	(0.222)	(0.222)	(0.241)	(0.240)	(0.233)	(0.253)
Treatment1M	**0.834*** **	**0.834*** **	**0.956*** **	0.244	**0.893*** **	0.220
	(0.221)	**(0.221)**	**(0.219)**	(0.240)	**(0.233)**	(0.254)
Treatment3M	0.237	0.237	0.273	0.273	0.297	0.258
	(0.221)	(0.221)	(0.239)	(0.238)	(0.233)	(0.253)
Treatment6M	0.200	0.200	0.304	0.304	0.259	0.289
	(0.221)	(0.221)	(0.239)	(0.238)	(0.233)	(0.253)
Treatment12M	0.394*	0.394*	0.0803	0.0803	0.462**	0.0612
	(0.222)	(0.222)	(0.241)	(0.240)	(0.234)	(0.255)
Observations	10,437	10,437	10,437	10,437	10,437	10,437
R-squared	0.002	0.006	0.014	0.020	0.008	0.021
Category FE	No	Yes	No	Yes	Yes	Yes
Year FE	No	No	No	No	Yes	Yes
Month FE	No	No	Yes	Yes	No	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, *

p<0.1

Note: Author's calculations in Stata

Source: CZSO (2019d)

Tables 13a and 13b (split into two tables for easier reading) show implementation of month-controlling strategy. Estimating separate regressions for different categories helps to disentangle which product's price really changes and the magnitude of the change. We can see that effects of VAT rate hike by 1% are in the 6-month preceding period very strong for *Poultry* – 0.920% price increase and also another 0.988% price increase in the first-month period following the change. Effects are also strong for *Beef* – 0.823% price increase, *Pork* – 0.546 % price increase 1 month before VAT increase and 0.492% price increase 1 month after VAT increase, *Meat Products* – 0.452% price increase 1 month before and 0.599% price increase 1 month after VAT hike. Surprisingly, *Animal Products'* price increases by almost 4% after 3 months from the 1 percentage point VAT increase. *Legumes'* price increases 0.7% in one month in response to 1 percentage point VAT increase. *Dairy products'* price increases 1 % 3 months before anticipated VAT increase. All discussed effects are highly significant at significance level 0.01 and controlled for seasonality using month fixed-effects. Since products in the dataset can be considered as necessities (basic food), it is not surprising that sellers can transfer almost entire tax hike to consumers, although the sales might decrease as reported in Buettner and Madzharova (2017). However, in this study the quantity demanded is not studied. *Poultry, Beef, Animal Products, Legumes* behave according to Hypothesis 2 – there are price effects present in the model after the VAT rate change. *Pork* and *Meat Products* behave according to Hypothesis 3. *Dairy Products* are consistent with Hypothesis 1 – there is a pre-adoption effect present (in 3 month period before implementation).

Table 13a – Model Results

VARIABLES	(1) All	(2) Fruits	(3) Vegetables	(4) Poultry	(5) Beef	(6) Pork
Preadopted6M	0.296	0.538	1.077	0.920**	-0.0297	0.183
	(0.239)	(1.086)	(1.062)	(0.370)	(0.109)	(0.166)
Preadopted3M	0.331	1.931*	-0.683	-0.161	0.0986	-0.0250
	(0.239)	(1.086)	(1.062)	(0.370)	(0.109)	(0.166)
Preadopted1M	-0.207	-1.090	-1.991*	0.330	0.111	**0.546*** **
	(0.241)	(1.095)	(1.070)	(0.373)	(0.110)	**(0.167)**
Treatment1M	**0.956*** **	2.021**	1.885*	**0.988*** **	**0.823*** **	**0.492*** **
	(0.219)	(0.993)	(0.971)	**(0.338)**	**(0.0998)**	**(0.152)**
Treatment3M	0.273	0.109	0.623	-0.351	0.101	0.225
	(0.239)	(1.086)	(1.062)	(0.370)	(0.109)	(0.166)
Treatment6M	0.304	0.124	1.106	0.157	0.0648	0.224
	(0.239)	(1.086)	(1.062)	(0.370)	(0.109)	(0.166)
Treatment12M	0.0803	-0.359	0.730	0.329	0.0222	0.0374
	(0.241)	(1.095)	(1.070)	(0.373)	(0.110)	(0.167)
Observations	10,437	1,065	1,917	426	852	1,065
R-squared	0.014	0.036	0.092	0.150	0.115	0.106
Year FE	No	No	No	No	No	No
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	No	No

Standard errors in parentheses

*** p<0.01, ** p<0.05, *

p<0.1

Note: Author's calculations in Stata

Source: CZSO (2019d)

Table 13b – Model results

VARIABLES	(7) Meat Products	(8) Animal Products	(9) Legumes	(10) Sugar	(11) Cereal Products	(12) Dairy Products
Preadopted6M	-0.122	-0.233	-0.236	0.227	0.120	0.0464
	(0.110)	(0.612)	(0.248)	(0.487)	(0.354)	(0.200)
Preadopted3M	0.00323	0.937	0.233	0.0476	0.810**	**1.006*** **
	(0.110)	(0.612)	(0.248)	(0.487)	(0.354)	**(0.200)**
Preadopted1M	**0.452*** **	0.151	0.477*	0.295	0.235	0.494**
	(0.111)	(0.617)	(0.250)	(0.491)	(0.357)	(0.201)
Treatment1M	**0.599*** **	0.712	**0.705*** **	0.548	0.374	0.347*
	(0.101)	(0.560)	**(0.227)**	(0.445)	(0.324)	(0.183)
Treatment3M	0.0157	**4.030*** **	-0.179	-0.310	-0.136	-0.0348
	(0.110)	**(0.612)**	(0.248)	(0.487)	(0.354)	(0.200)
Treatment6M	0.220**	-0.0714	0.467*	-0.408	0.294	-0.00972
	(0.110)	(0.612)	(0.248)	(0.487)	(0.354)	(0.200)
Treatment12M	0.182	-0.582	-0.280	0.179	-0.180	-0.138
	(0.111)	(0.617)	(0.250)	(0.491)	(0.357)	(0.201)
Observations	1,491	426	426	426	852	1,491
R-squared	0.065	0.165	0.115	0.067	0.027	0.060
Year FE	No	No	No	No	No	No
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	No	No

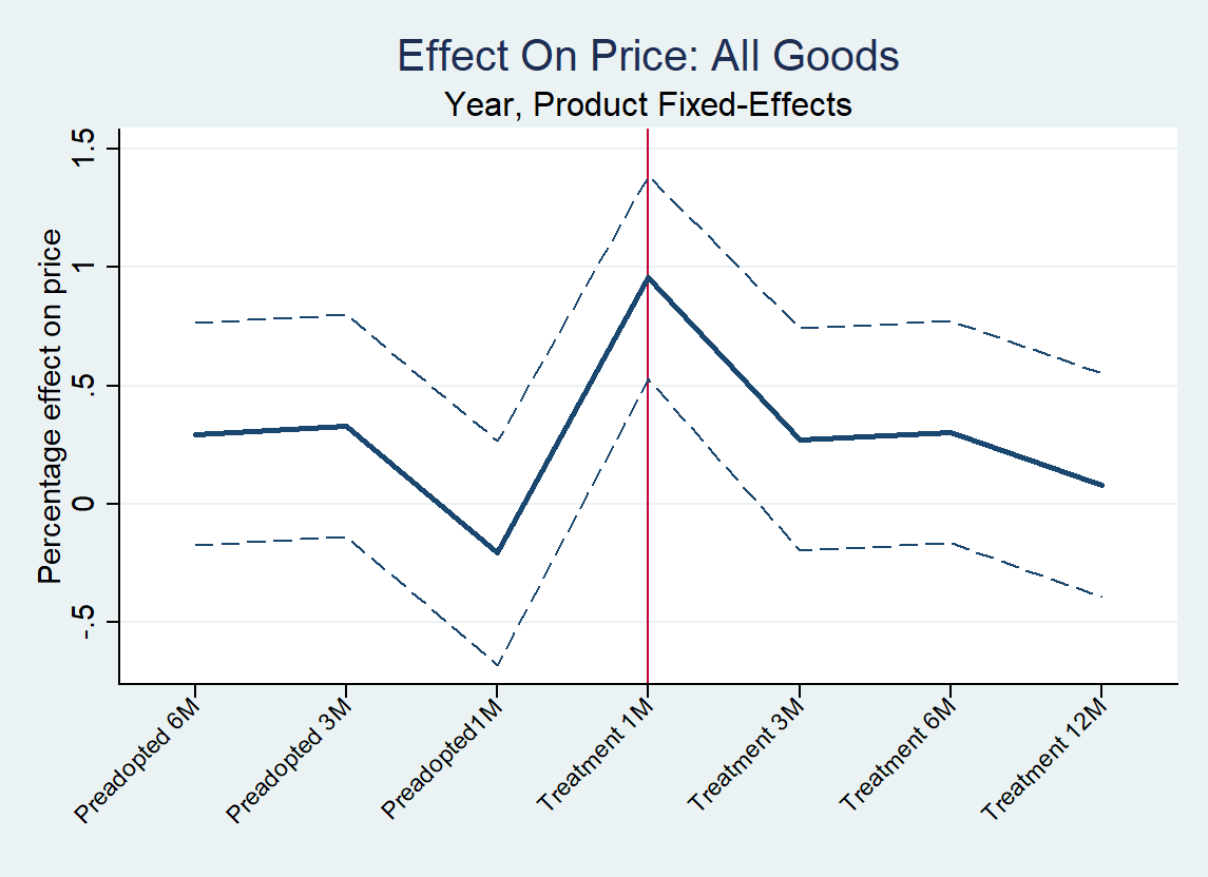
Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Author's calculations in Stata

Source: CZSO (2019d)

Graph 11 – Effect on Price



Note: Author's calculations in Stata

Source: CZSO (2019d)

The red vertical line shows statistically significant estimate – 0.956 % price increase in response to 1 percentage point VAT increase. The estimation demonstrates that sellers are able to transfer almost entire tax increase burden to the consumers.

Model selection situation for producer prices is very similar to the situation with consumer prices although even when controlling for both category and month fixed-effects, the coefficients remain same strength and significance as if only controlling for month fixed-effects. Baseline regression' effects of increasing the price 0.496 % 3 months before the VAT rate change for every 1 VAT rate percentage point increase and cumulative effect of 0.226 % increase 1 month before the VAT change for every 1 VAT rate percentage point increase is almost not changing in size or significance when changing the model specification. Models 1 – 5 also show that the price adjustment (increase) happens cumulatively during 3 months before the VAT change. In 3 months before the VAT change, the price increases (by 0.496 % for every 1 percentage point VAT change) but then slightly decreases so the cumulative effect 1 month before the new rate is price higher by 0.226 % for every 1 percentage point VAT change. This result is consistent with results of Buettner and Madzharova (2017) who also show price slightly decreasing after a sharp increase but the final effects is still higher price. Discussed estimates are highly significant – at significance level 0.01.

Table 14 – Model Results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	All	All	All	All	All	All
Preadopted6M	0.129	0.129	0.0373	0.0373	-0.0870	-0.240**
	(0.0840)	(0.0840)	(0.0925)	(0.0925)	(0.0856)	(0.0951)
Preadopted3M	**0.496*** **	**0.496*** **	**0.483*** **	**0.483*** **	**0.280*** **	0.205**
	(0.0840)	**(0.0840)**	**(0.0925)**	**(0.0925)**	**(0.0856)**	(0.0951)
Preadopted1M	**0.226*** **	**0.226*** **	**0.272*** **	**0.272*** **	0.00641	-0.0109
	(0.0844)	**(0.0844)**	**(0.0940)**	**(0.0940)**	(0.0862)	(0.0965)
Treatment1M	0.161*	0.161*	0.156*	**0.151**	0.164*	0.180*
	(0.0840)	(0.0840)	(0.0830)	(0.0933)	(0.0861)	(0.0965)
Treatment3M	-0.110	-0.110	-0.0227	-0.0227	-0.107	0.00712
	(0.0840)	(0.0840)	(0.0925)	(0.0925)	(0.0861)	(0.0956)
Treatment6M	0.0450	0.0450	0.0125	0.0125	0.0475	0.0423
	(0.0840)	(0.0840)	(0.0925)	(0.0925)	(0.0861)	(0.0956)
Treatment12M	-0.154*	-0.154*	-0.108	-0.108	-0.126	-0.111
	(0.0844)	(0.0844)	(0.0940)	(0.0940)	(0.0867)	(0.0971)
Observations	4,248	4,248	4,248	4,248	4,248	4,248
R-squared	0.012	0.014	0.021	0.023	0.065	0.075
Category FE	No	Yes	No	Yes	Yes	Yes

Year FE	No	No	No	No	Yes	Yes
Month FE	No	No	Yes	Yes	No	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Author's calculations in Stata

Source: CZSO (2019d)

Tables 15a and 15b (again split in 2 tables for easier reading) show estimated models with month fixed-effects specification for different categories of producers' goods. All effects have the same interpretation as in the previous section – how much a price of product changes, when the VAT rate increases by one percentage point. Over all categories, the price reacts (in average) first by increasing by 0.483 % 3 months before the VAT hike and cumulative effect is increase of 0.272 % one month before the change for 1 percentage point hike. Surprisingly, we can see that in *Feed Mixture*, price reacts by high 1.4 %. In *Cereal Products*, price increases by 0.569 % 3 month before the VAT hike. Overall, producers are not that successful in transferring the tax burden onto the buyers, in comparison to the sellers of consumer goods discussed in previous section, as the producers only transfer 0.272% of the rate increase on buyers but sellers of consumer goods actually transfer 96 % of the rate hike to consumers. This result is consistent with estimated consumers' elasticities of Andreyeva, Long and Brownell (2010) who report elasticities ranging from 0.27 % for eggs to 0.79 % for soft drinks. All discussed effects are highly significant at an alpha level 0.01 and controlled for seasonality using month fixed-effects strategy.

Table 15a – Model Results

VARIABLES	(1) All	(2) Feed mixture	(3) Dairy products	(4) Poultry	(5) Beef
Preadopted6M	0.0373	0.285	0.286	0.265	-0.130
	(0.0925)	(0.217)	(0.290)	(0.412)	(0.155)
Preadopted3M	**0.483*** **	**1.360*** **	0.645**	-0.216	-0.0572
	(0.0925)	**(0.217)**	(0.290)	(0.412)	(0.155)
Preadopted1M	**0.272*** **	0.350	0.321	-0.370	0.182
	(0.0940)	(0.220)	(0.295)	(0.418)	(0.157)
Treatment1M	0.156*	0.137	0.251	0.857**	-0.0143
	(0.0830)	(0.194)	(0.260)	(0.369)	(0.139)
Treatment3M	-0.0227	-0.0116	-0.0548	0.0560	0.0386
	(0.0925)	(0.217)	(0.290)	(0.412)	(0.155)
Treatment6M	0.0125	0.155	-0.272	-0.348	-0.0768
	(0.0925)	(0.217)	(0.290)	(0.412)	(0.155)
Treatment12M	-0.108	-0.164	-0.343	-0.317	-0.0447
	(0.0940)	(0.220)	(0.295)	(0.418)	(0.157)
Observations	4,248	708	708	177	531
R-squared	0.021	0.076	0.114	0.120	0.077
Year FE	No	No	No	No	No
Month FE	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	No

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Author's calculations in Stata

Source: CZSO (2019d)

Table 15b – Model Results

VARIABLES	(6) Pork	(7) Meat Products	(8) Sugar	(9) Cereal products
Preadopted6M	0.0269	-0.273	0.230	-0.0702
	(0.306)	(0.176)	(0.562)	(0.195)
Preadopted3M	0.0520	0.0372	0.334	**0.569*** **
	(0.306)	(0.176)	(0.562)	**(0.195)**
Preadopted1M	0.191	0.221	0.544	0.342*
	(0.311)	(0.178)	(0.571)	(0.198)
Treatment1M	-0.235	-0.101	0.162	0.310*
	(0.274)	(0.157)	(0.504)	(0.175)
Treatment3M	0.265	-0.0732	-0.0420	-0.0636
	(0.306)	(0.176)	(0.562)	(0.195)
Treatment6M	-0.0126	0.140	-0.614	0.235
	(0.306)	(0.176)	(0.562)	(0.195)
Treatment12M	-0.122	0.101	0.0429	-0.0747
	(0.311)	(0.178)	(0.571)	(0.198)
Observations	177	708	177	1,062
R-squared	0.415	0.071	0.082	0.020
Year FE	No	No	No	No
Month FE	Yes	Yes	Yes	Yes
Product FE	No	No	No	No

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Author's calculations in Stata

Source: CZSO (2019d)

Graph 12 – Effect on Price

Note: Author's calculations in Stata

Source: CZSO (2019d)

This section concludes that producer prices of *Feed Mixture* and *Cereal Products* behave according to Hypothesis 1 – price responses in the three months period before the implementation happen.

Estimating VAT Rate Change Effects on Consumer Prices in Slovakia

Models for consumer prices in Slovakia are again estimated with the same methodology as in the previous 2 sections. All specifications show highly significant 0.221 % response to the 1 percentage point VAT rate increase which survives numerous fixed-effects. The results also show that the price adjustment happens only during the first month of the new VAT rate and the effect is not cumulative.

Table 16 – Model Results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	All	All	All	All	All	All
Preadopted6M	-0.127**	-0.127**	-0.127**	-0.127**	-0.128*	-0.128*
	(0.0631)	(0.0630)	(0.0629)	(0.0625)	(0.0663)	(0.0657)
Preadopted3M	0.0129	0.0129	0.0129	0.0129	0.0120	0.0120
	(0.0631)	(0.0630)	(0.0629)	(0.0625)	(0.0663)	(0.0657)
Preadopted1M	-0.0149	-0.0149	-0.0149	-0.0149	-0.0175	-0.0175
	(0.0640)	(0.0639)	(0.0637)	(0.0633)	(0.0672)	(0.0666)
Treatment1M	**0.211*** **	**0.211*** **	**0.211*** **	**0.211*** **	**0.221*** **	**0.221*** **
	(0.0631)	**(0.0630)**	**(0.0629)**	**(0.0625)**	**(0.0667)**	**(0.0661)**
Treatment3M	-0.0572	-0.0572	-0.0572	-0.0572	-0.0472	-0.0472
	(0.0631)	(0.0630)	(0.0629)	(0.0625)	(0.0667)	(0.0661)
Treatment6M	0.0481	0.0481	0.0481	0.0481	0.0581	0.0581
	(0.0631)	(0.0630)	(0.0629)	(0.0625)	(0.0667)	(0.0661)
Treatment12M	-0.0745	-0.0745	-0.0745	-0.0745	-0.0640	-0.0640
	(0.0640)	(0.0639)	(0.0637)	(0.0633)	(0.0676)	(0.0670)
Observations	6,603	6,603	6,603	6,603	6,603	6,603
R-squared	0.003	0.006	0.014	0.025	0.014	0.033
Category FE	No	Yes	No	Yes	Yes	Yes
Year FE	No	No	No	No	Yes	Yes
Month FE	No	No	Yes	Yes	No	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Author's calculations in Stata

Source: SOSR (2019)

Estimating separate regressions for different consumer goods categories again helps to disentangle the size and direction of the price response. We see that most products actually do not (statistically significantly) respond to the VAT rate change – only a few do, such as *Dairy Products* (in the first month) by 0.303 %. Surprisingly, *Pork* reacts inversely – by decreasing the price by 0.374 % in response to 1 percentage point VAT increase.

Table 17a – Model Results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	All	Fruits and Vegetables	Dairy products	Poultry	Beef	Pork
Preadopted6M	-0.127**	-0.835	0.0155	0.143	-0.0813	**-0.374*** **
	(0.0629)	(0.672)	(0.0613)	(0.146)	(0.0525)	**(0.0949)**
Preadopted3M	0.0129	-0.104	0.0310	-0.00636	-0.0121	0.0883
	(0.0629)	(0.672)	(0.0613)	(0.146)	(0.0525)	(0.0949)
Preadopted1M	-0.0149	-0.0386	0.0857	-0.219	-0.00455	-0.230**
	(0.0637)	(0.681)	(0.0622)	(0.148)	(0.0532)	(0.0962)
Treatment1M	**0.211*** **	0.602	**0.303*** **	0.145	0.191***	0.112
	(0.0629)	(0.672)	**(0.0613)**	(0.146)	(0.0525)	(0.0949)
Treatment3M	-0.0572	-0.241	-0.0421	-0.160	-0.0473	-0.170*
	(0.0629)	(0.672)	(0.0613)	(0.146)	(0.0525)	(0.0949)
Treatment6M	0.0481	0.707	0.00186	-0.0726	-0.0136	0.0681
	(0.0629)	(0.672)	(0.0613)	(0.146)	(0.0525)	(0.0949)
Treatment12M	-0.0745	0.0505	-0.0798	-0.105	0.0359	-0.141
	(0.0637)	(0.681)	(0.0622)	(0.148)	(0.0532)	(0.0962)
Observations	6,603	426	1,917	213	639	1,065
R-squared	0.014	0.328	0.041	0.249	0.093	0.276
Year FE	No	No	No	No	No	No
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	No	No

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Author's calculations in Stata

Source: SOSR (2019)

Table 17b – Model Results

VARIABLES	(7) Meat Products	(8) Sugar	(9) Cereal products	(10) Fats and Oils products	(11) Legumes
Preadopted6M	-0.00616	-0.213	-0.0539	-0.0539	-0.0539
	(0.0460)	(0.238)	(0.168)	(0.168)	(0.168)
Preadopted3M	-0.0179	0.134	-0.102	-0.102	-0.102
	(0.0460)	(0.238)	(0.168)	(0.168)	(0.168)
Preadopted1M	-0.0439	-0.0376	0.0479	0.0479	0.0479
	(0.0466)	(0.242)	(0.170)	(0.170)	(0.170)
Treatment1M	0.114**	0.359	0.259	0.259	0.259
	(0.0460)	(0.238)	(0.168)	(0.168)	(0.168)
Treatment3M	-0.0457	-0.0115	0.0270	0.0270	0.0270
	(0.0460)	(0.238)	(0.168)	(0.168)	(0.168)
Treatment6M	-0.00383	0.105	-0.144	-0.144	-0.144
	(0.0460)	(0.238)	(0.168)	(0.168)	(0.168)
Treatment12M	0.00997	0.0448	-0.292*	-0.292*	-0.292*
	(0.0466)	(0.242)	(0.170)	(0.170)	(0.170)
Observations	1,065	213	426	426	426
R-squared	0.043	0.089	0.041	0.041	0.041
Year FE	No	No	No	No	No
Month FE	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	No

Standard errors in parentheses

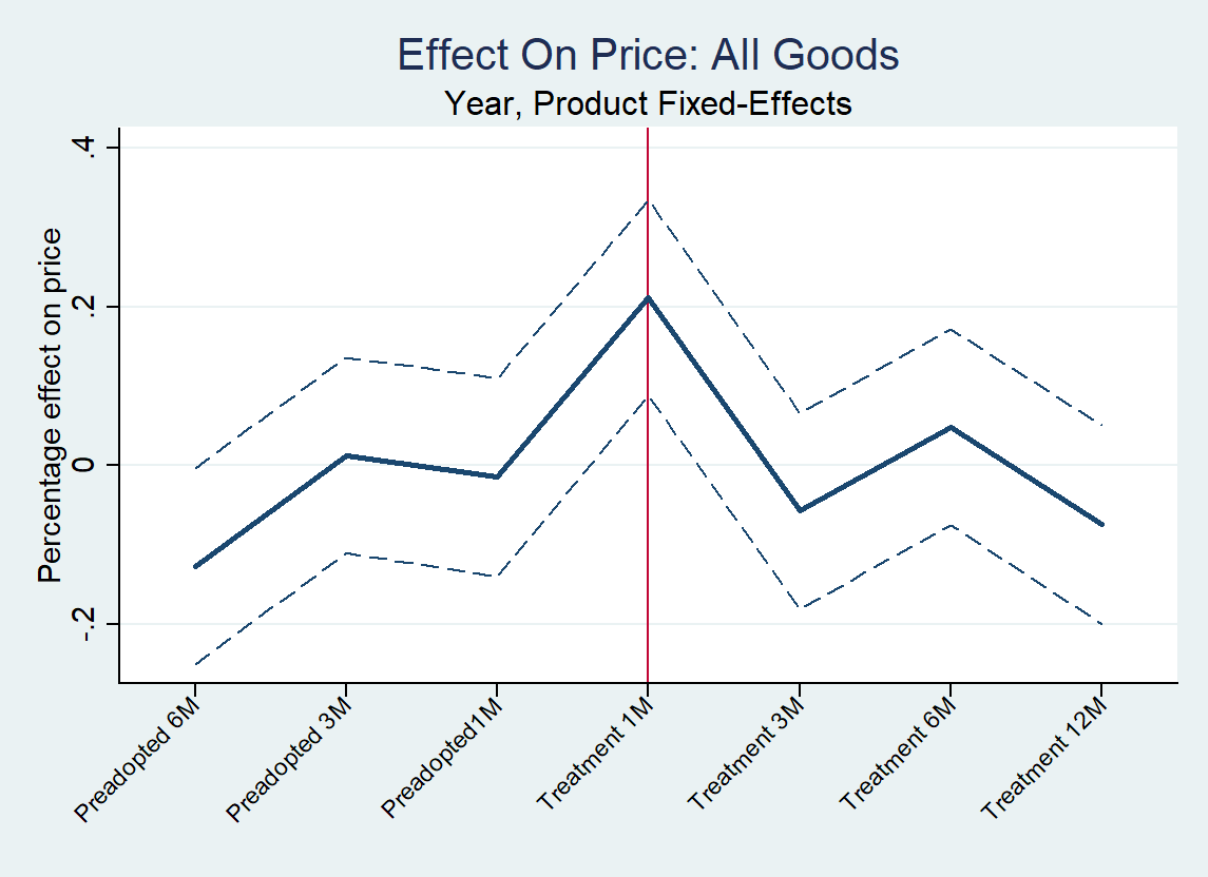
*** p<0.01, ** p<0.05, * p<0.1

Note: Author's calculations in Stata

Source: SOSR (2019)

Graph 13 plots the estimates over all categories, the vertical line represents the statistically significant estimate.

Graph 13 – Effect on Price



Note: Author's calculations in Stata

Source: SOSR (2019)

This section concludes that *Dairy Products* and *Pork* behave according to Hypothesis 2. Prices of these two product categories change in the first month after the VAT rate change as seen above in Graph 13.

Conclusions

In response to the 1 percentage point VAT rate increase, Czech consumer prices react on average by increasing by 0.956 % in the first month after a VAT rate change indicating that sellers are transferring almost entire tax burden onto consumers. Results provide evidence that prices of different categories of products react differently to the anticipated VAT rate change. Poultry, Beef, Animal Products, and Legumes react consistently with Hypothesis 2 – there are only statistically significant price responses after the new VAT rate is effective. However, Pork and Meat Products react according to Hypothesis 3 – there are both preadoption and postadoption effects. Finally, Dairy Products show preadoption effect and no postadoption effect.

Czech producer prices, over all categories, react in average first by increasing by 0.483 % 3 months before the VAT hike and cumulatively by 0.272 % 1 month before the VAT change. Feed Mixture and Cereal Products react according to Hypothesis 1 – there are statistically significant preadoption effects. Most product categories; however, remain unresponsive in price.

In Slovakia, overall effects show highly significant 0.221 % response to the 1 percentage point VAT rate increase during the first month of the new VAT rate. Dairy Products and Pork behave consistently with Hypothesis 2. There are significant preadoption price effects. Most product categories remain unresponsive in price like in case of Czech producer prices.

This thesis provides evidence that there is no universal rule applying on all product categories or even single products. This is most likely caused by different price elasticities (sensitivity) among examined products. However, these elasticities are unobserved variables and data limitations do not allow for even more sophisticated specification of the model. Future research should ideally employ specifying dynamic unobserved effects model to account for these unobserved elasticities.

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