What Goes Up May Not Come Down: Asymmetric Incidence of Value-Added Taxes.*

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Abstract

This paper shows that prices respond more to increases than to decreases in Value-Added Taxes (VAT). First, we combine monthly commodity price data with information on VAT reforms across most European countries from 1996 to 2015 to show that the pass-through of VAT increases to prices is larger than the pass-through of VAT decreases. Second, using a case study, we show that the underlying micro distribution of pass-through is also asymmetric in ways that are hard to reconcile with the standard incidence model. Third, we find no evidence of convergence towards symmetric pass-through over time. Our findings caution against using incidence estimates derived without accounting for the direction of the tax change and questions the effectiveness of reductions in VAT to achieve redistribution.
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1 Introduction

Value-Added Taxes (VATs) affect a large portion of the world economies: all member countries of the Organization for Economic Co-operation and Development (OECD) have adopted a Value-Added Tax (VAT) except for the United States.[1] As a consequence, the revenue raised by VATs as a percentage of the GDP of OECD countries has been rapidly increasing and is now 5.6%. U.S. politicians and think tanks have often mentioned using the VAT as a National Sales Tax.[2] It was also recently considered as a possible source of funding for health care costs by the Obama administration.[3] For these reasons, understanding the mechanisms underlying the incidence of VATs is both economically and policy relevant.

In a standard incidence model, the direction of a tax change does not matter for incidence, as supply and demand elasticities are sufficient to determine what proportion of the tax is borne by each agent. In this paper, we question the premise that prices respond symmetrically to variation in consumption taxes by empirically showing that there is a consistently higher pass-through to prices for tax increases than for tax decreases. Using monthly observations and the full set of commodities in the economy, we provide systematic evidence of this asymmetry using VAT rate changes for most commodities and European countries from 1996 to 2015. We consistently find an asymmetry in the response of prices to VAT changes: prices change significantly more following a VAT increase than following a VAT decrease.

We address two potential concerns. The first is the presence of measurement error in the magnitude of VAT changes. This measurement error is due to the fact that commodity categories in the annual VAT rate database are different from commodity categories in the price database. This introduces measurement error in the VAT rate that applies to some commodities when merging the two databases. To address this, we follow Saez et al. (2012) and

[1] More generally, 140 countries out of approximately 190 have adopted a form of VAT.

[2] The first U.S. politician to suggest a VAT was Al Ullman, followed by many others including President Nixon and more recently Ted Cruz.

[3] Reported in *Washington Post, May 27, 2009.*

instrument for the magnitude of the VAT change using an indicator variable for experiencing a VAT change interacted with an indicator variable for the post-VAT change period. The second concern is that VAT changes are correlated with underlying economic conditions. This could result in VAT hikes during periods when prices are elastic and VAT cuts when prices are inelastic. To mitigate this concern, we first include time and country fixed effects when estimating pass-through and find that they do not affect the magnitude of the asymmetry. Second, we control for the price level of the commodity treated by a VAT change in all untreated countries. Third, we break down the sample of reforms into reforms that follow years of high GDP growth versus years of low GDP growth and show that the asymmetry is present and similar for both periods.

Next, using two plausibly exogenous reforms in Finland, we uncover additional facts about the response of prices to VAT changes. We use a 14 percentage point decrease in the VAT rate applied to hairdressing services in January 2007 and a subsequent 14 percentage point increase in the same sector in January 2012.[4] We document – using European Commission council directives – that the two reforms were part of a VAT experimentation program and therefore the timing of the reforms and the choice of sector are plausibly exogenous as they were set ex-ante by the European Commission. Using these two reforms along with micro price data, we find three main results. First, we confirm our finding of asymmetric pass-through: on average prices respond substantially more to the VAT increase than to the VAT decrease. Second, we compare the price evolution of hairdressing services to a similar control group formed of beauty salons – which is unaffected by the VAT changes – and find that prices respond immediately to both VAT increases and decreases and do not exhibit any evidence of convergence towards symmetry even 4 years after the VAT rate is adjusted. Third, we uncover an additional layer of asymmetry: the underlying distribution of prices changes for the VAT increase is substantially different from that of the VAT decrease. Following the VAT

[4] Kosonen (2015) analyzes the effect of the January 2007 reform on profits, prices and outputs.

decrease, 60% of the population of hairdressers keep their prices unchanged while 40% decrease their prices with no specific target. Following the VAT increase, the distribution is bi-modal with roughly 50% of hairdressers targeting 100% pass-through, 25% keeping their prices unchanged and the remaining 25% passing through between 0% and 80% of the VAT increase with no specific pass-through target. This distributional asymmetry is important because it is hard to reconcile with predictions of standard incidence theory.

We show that our findings are inconsistent with two straightforward explanations of asymmetric pass-through: convex demand/supply curves and capacity constraints. First, convex demand/supply functions can lead to asymmetric pass-through if the VAT changes are large because the curvature of the functions generate different elasticities. However, for small changes the difference in elasticities is small, implying little asymmetry.[5] As a consequence, if the curvature of the supply or demand functions are indeed the cause of the asymmetry we should observe no asymmetry for small changes and larger than average asymmetry for big changes. To test for this, we break down our sample of reforms and compare the 25% largest reforms to the 25% smallest ones. In contrast with this explanation, we find that the magnitude of the asymmetry is similar for both large and small VAT changes. Second, capacity constraints can prevent firms from reducing prices in order to attract additional customers since they would not be able to cater to them. We show that this would lead to price rigidity for VAT cuts and small VAT hikes and no rigidity for large VAT hikes. Capacity constraints would therefore predict asymmetric responses to large VAT changes but not to small ones, which is inconsistent with the empirical patterns described above. And they would only bind in the short-run which is inconsistent with the immediate response of prices to both VAT cuts and hikes and the absence of convergence over time.

Providing a precise mechanism for the asymmetry is beyond the scope of this paper but we benchmark more sophisticated explanations – some of which have been offered in other literatures – against our empirical findings. Menu

[5]Pass-through would be asymmetric even for small VAT changes if the demand/supply function is kinked. However the kink would need to match the pre-reform price level.

costs and adjustment frictions, fairness and consumer antagonism as well as loss-aversion could explain part of the empirical patterns we uncover.

The findings of this paper are important for three main reasons. First, because the asymmetry is present for a large set of countries and commodities, the results suggest a gap in an essential part of standard tax incidence analysis. Incidence theory treats changes in tax rates symmetrically and as a consequence incidence formulas are derived using increases and decreases in VAT rates interchangeably. If responses depend on the direction of tax changes, this should be accounted for when defining tax incidence.[6] Second, our results suggest that reform-based estimates of incidence may be systematically biased if they only consider a tax increase or a tax decrease but not both. Third, our findings question the usefulness of VATs as a fiscal policy tool to stimulate demand. Given that prices adjust upwards but not downwards, temporary VAT cuts aimed at stimulating demand may have the opposite effect resulting in a higher equilibrium price once the VAT cut is repelled and would mostly benefit firm owners at the expense of consumers.[7]

This paper contributes to a growing public finance literature that documents non-standard responses to consumption taxes – such as in Chetty et al. (2009), Marion and Muehlegger (2011), Li et al. (2014), Feldman and Ruffle (2015), Taubinsky and Rees-Jones (2015), Harju et al. (2017) and Kopczuk et al. (2016). More broadly, it is related to a literature in Public Finance that estimates the incidence of consumption taxes and more generally to a literature that analyzes the effects of VATs on the economy.[8] Our paper is the

[6]This finding is related to a set of papers that provide empirical evidence showing that incidence can be affected by features of the tax code that are theoretically neutral, see for example Kopczuk et al. (2016) and Tazhitdinova (2016).

[7]The distributional effects of VAT cuts is empirically analyzed in Benzarti and Carloni (2015) in the case of French restaurants.

[8]Notably, Benedek et al. (2015) estimate the pass-through of VAT to prices using the same sources of data as we do. While we focus on providing evidence that prices respond asymmetrically to variation in VAT rates and estimate the magnitude of the asymmetry, Benedek et al. (2015) estimate the pass-through of VAT. There are also some significant differences in our approaches as we consider a larger set of commodities, countries and years and we use a different empirical model. Kotlikoff and Summers (1987) and Fullerton and Metcalf (2002) provide a survey of the tax incidence literature. Feldstein and Krugman

first to provide systematic evidence on the asymmetric pass-through of consumption taxes and to show that prices consistently respond more to increases than to decreases in the VAT rate. Our paper is related to Carbonnier (2008), but our findings are different.[9] While we show that prices respond systematically more to VAT increases than to decreases, Carbonnier (2008) finds that in some industries prices respond more to VAT increases, while in others they respond more to VAT decreases.[10] Our paper goes beyond two limitations of Carbonnier (2008). First, we consider the entire set of commodities sold in each Member State of the European Union while Carbonnier (2008) only considers eleven commodities in France. Second, we consider all VAT changes across all Member States of the EU over a period of 20 years, with substantial variation in the magnitude of the VAT changes, some being as large as 15 percentage points. In contrast, Carbonnier (2008) uses two VAT changes: a 2 percentage point VAT increase and a 1 percentage point VAT decrease. Our results also contrast with those of Doyle and Samphantharak (2008) who find symmetric responses of prices to a 120 day temporary moratorium on a 5% gasoline tax.[11] Two possible reasons could explain the symmetric response in Doyle and Samphantharak (2008). First, the moratorium was implemented by the Governor of Indiana during an election year because he was concerned about the consequences soaring gasoline prices could have on his re-election. For this reason, gasoline retailers were likely to be under scrutiny and pressure to reduce prices. Second, because the moratorium only lasted 120 days, asymmetric price changes would have been relatively easy to detect and could have resulted in substantial consumer antagonism.

(1990), Hines and Desai (2005), Slemrod (2011), Naritomi (2013), Pomeranz (2015), Harju et al. (2015) are examples of papers analyzing some effects of VATs on the economy.

[9] Published version in French, see working paper version (Carbonnier (2005)) for English translation.

[10] Politi and Mattos (2011) is another paper that considers asymmetric responses of prices to VAT reforms. It suffers from the same shortcomings as Carbonnier (2008), namely small sample size and small tax changes. In addition, the study uses a difference-in-differences strategy but does not show evidence on pre-reform parallel trends.

[11] In our dataset, we find that gasoline prices respond symmetrically to VAT changes (see appendix Figure B.7).

Our findings are also related to a literature in Industrial Organization which tests for the asymmetric pass-through of input costs.[12] There is a fundamental difference between the asymmetry we document and the input cost asymmetry: prices tend to show a timing asymmetry when responding to cuts in input costs and typically converge to symmetry over time: the asymmetry lasts 1 month for example in Borenstein et al. (1997) and 5 months in Peltzman (2000). Instead we observe that prices respond immediately to VAT cuts and no evidence of converge over time. Further, there are two main distinctions between costs and consumption taxes. First, variation in costs can affect different firms differently: for example, an increase in the price of produce for example is likely to affect fast food restaurants more than Michelin star restaurants as produce costs represent a higher portion of the cost of fast food restaurants. On the contrary, changes in VATs affect all restaurants similarly, since taxes are a percentage of the final price. Second, variation in VAT rates are directly observable. This is important because some of the most convincing explanations of the asymmetric pass-through of input costs – such as Benabou and Gertner (1993) – are based on the uncertainty of consumers over the current and future level of input costs. This has also led this literature to mainly focus on goods that have one predominant input that experiences large cost variations. For example, Peltzman (2000) notes that his finding of asymmetric pass-through of input costs relies on a "possibly unrepresentative sample of low-tech, low-value-added items". Peltzman (2000) further points out that this context can lead to spurious asymmetries. Because input costs are not observable, they are measured with error and if this error is stronger for cost decreases than increases – possibly because of inflation – that could create spurious asymmetries. These fundamental differences could be some of the reasons why tax incidence analysis in the public finance literature seldom considers the possibility of asymmetric pass-through of taxes in spite of the evidence gathered by the industrial organization literature.

This paper is organized as follows. Section 2 presents the institutional details and the data we use for the analysis. Section 3 provides evidence of

[12] See Meyer and Cramon-Taubadel (2004) for a survey of the literature.

the asymmetry using aggregate price data and VAT reforms that occurred in Europe from 1996 to 2015. Section 4 focuses on the Finnish hairdressing services reforms and uses micro price data to uncover additional layers of asymmetry. Section 5 discusses potential explanations of the results. Section 6 concludes with policy implications.

2 Data and Institutional Background

2.1 Institutional Background

The VAT applies to the value added of goods and services sold. Consumer prices in the European Union (E.U.) are inclusive of the VAT. Firms remit the VAT they collect from consumers to the government and claim credits for the VAT they paid on input costs, which implies that only value-added is taxed. Final consumers, which are the last component of the chain, cannot claim any tax credit and therefore pay the tax on the final value of goods purchased.

Over 150 countries have implemented a form of VAT, including all OECD countries with the exception of the United States.[13] Total revenue from VATs represents 18.7 percent of the total tax revenue in the OECD countries.[14] For the European Union as a whole, the VAT is the second largest source of tax revenue after labor income taxes, and roughly amounts to 30% percent of total tax revenue.

Member countries of the European Union generally have several VAT rates in place, including a standard rate that applies to the majority of commodities, a reduced VAT rate for basic necessities such as food, heating and passenger transport and some commodities are tax exempt and others zero rated.[15]

[13] See Owens et al. (2008) for a broad overview of VAT taxes in OECD countries.

[14] See the information collected in Barbone et al. (2013).

[15] Producers of zero-rated commodities can claim credits for VATs paid on intermediate inputs while producers of VAT-exempt commodities cannot.

2.2 Data

Price data: We use price data from Eurostat's *Harmonised Indices of Consumer Prices* (HICP). The dataset contains monthly non seasonally adjusted information on commodity prices across European countries and covers the period 1996-2015.[16]

The HICP provides monthly price data by Classification of Individual Consumption According to Purpose (COICOP), and is assembled according to a harmonized approach that makes cross-country information comparable.[17] Eurostat first collects the data from surveys conducted separately by each member country of the European Union. Then, Eurostat constructs price series, which are harmonized to account for country specific sampling procedures.[18] This data is the single most reliable information on inflation across countries in the European Union.

Historical VAT rates: Information on VAT rates by commodity and country is provided directly by the European Commission (EC) in its annual report *VAT Rates Applied in the Member States of the European Community*. The report contains detailed information on the VAT rate applied to each commodity in each European country, as well as the exact date of the VAT reforms. It covers all commodities subject to VAT but does not contain information on VAT re-classifications, i.e. changes in the tax regime that apply to a given commodity (for instance, reclassifying a commodity from the standard rate to the reduced rate). For this reason, re-classifications are not part of our reforms.

Because the reports only contain information on current members of the EU, the dataset starts in 2004 for the Czech Republic, Cyprus, Estonia, Latvia,

[16] Eurostat is an organization of the European Commission in charge of collecting data and harmonizing it in order to provide statistical information about member states of the European Union.

[17] Appendix Tables B.6 and B.7 lists all the COICOP categories used in our analysis.

[18] In general, individual countries collect price data by sending field agents to different point of sales to record the posted prices of a given set of commodities. For example, France collects 160,000 prices every month in each of 27,000 points of sales to construct prices series for each commodity.

Lithuania, Hungary, Malta, Slovenia and Slovakia and in 2007 for Bulgaria and Romania. We exclude Croatia because it only became a member of the European Union in 2013. The EC reports are missing information on some labor-intensive commodities for some countries in the period 1996-1999.[19] We exclude them from our analysis when the data is missing.

Overall, we consider 27 European countries: Austria, Belgium, Bulgaria (since 2007), the Czech Republic (since 2004), Cyprus (since 2004), Denmark, Germany, Estonia (since 2004), Greece, Spain, France, Finland, Ireland, Italy, Hungary (since 2004), Latvia (since 2004), Lithuania (since 2004), Luxembourg, Malta (since 2004), the Netherlands, Poland, Portugal, Romania (since 2007), Slovakia (since 2004), Slovenia (since 2004), Sweden and the United Kingdom.

Matching the two datasets: Matching the price data with the VAT data presents three main challenges. First, the EC does not directly provide COICOP codes for each commodity. We therefore assign each commodity in the EC dataset to the closest four-digit COICOP code. Second, the price dataset is coarser than the VAT dataset. For example, in France, *housing repairs* are subject to three different VAT rates depending on the age of the house being repaired and whether the repairs match environmental restrictions. But the price dataset only contains one COICOP category: Services for the Maintenance and Repair of the Dwelling (04.3.2). This is likely to introduce some VAT rate measurement error, which we address in section 3.2. Third, the EC documents are only published once a year. For this reason, if a VAT rate for a given country is changed twice within a given year, we would fail to account for it.

We drop Education (COICOP category number 10) because for-profit institutions are subject to VATs whereas not-for-profit institutions are exempt. The majority of institutions are not-for-profit and therefore unaffected by the reforms but we cannot differentiate for-profit from not-for-profit institutions

[19] These categories are bicycles, shoes and leather goods, clothing and household linen, renovation and repairing of private dwellings, window cleaning and cleaning in private households, domestic care services and hairdressing.

in the price dataset. We also drop Clothing and Footwear (COICOP category number 3) as prices exhibit strong seasonality with most sales occurring in January which is also the month in which most VAT changes occur (see appendix Figure B.10).

Table 1 provides summary statistics on the reforms we consider. We perform our analysis on the full sample of reforms which is composed of all commodities that experience either an increase or a decrease in the VAT rate between 1996 and 2015. This corresponds to 2,832 commodity specific VAT reforms spanning 48 commodities across 22 countries (see appendix Table 1). As a robustness check, we also consider a restricted sample where we only focus on commodities that experience both a VAT increase and a VAT decrease between 1996 and 2015. The restricted sample includes 1,050 VAT changes. This sample addresses the concern that VAT increases are systematically implemented on different commodities than VAT decreases.

3 Asymmetric Pass-Through

3.1 Graphical Evidence

In this section, we use changes in VAT rates to compare the response of prices to VAT increases and VAT decreases. We show unconditional means of the price index – without controlling for inflation – and the VAT rate in the three months before and after the reform, normalizing the series to 100 in the month before the reform.[20]

Figure 1a aggregates all the reforms we consider in the *full sample* of commodities and plots the response of prices to VAT increases and decreases. Figure 1a shows that while prices increase discontinuously in the month following a VAT increase, they do not decrease as much when VATs decrease. Figure 1b

[20] Alternative windows around the reform can be used. However, the larger the window the more likely it is that the price response reflects additional changes in the VAT rate and factors that are unrelated to the reform. In addition, as several VAT reforms occur within six months of each other across countries, our choice of window mitigates the concern that the pre-reform period of one reform overlaps with the post-reform period of a previous reform.

shows comparable evidence for the *restricted sample*, where we only include commodities that experience both a VAT increase and decrease over time. The observed asymmetry is not driven by a selected subset of commodities. Instead, when we plot disaggregated versions of Figure 1a by 3-digit COICOP groups, we find that all commodities exhibit asymmetric pass-through with the exception of Communication (COICOP group number 8) – for which the decrease pass-through is 318% – and Furnishings, Household Equipment and Routine Household Maintenance (COICOP group number 5) – for which pass-through is small for both VAT increase and decrease (see appendix Figure B.10).[21] We also find similar levels of asymmetry for commodities subject to the standard VAT rate (Figure 1c) and the reduced VAT rate (Figure 1d).

Does the asymmetry persist over the long run? While it is unclear how to define long-run, Figures 1a, 1b, 1c and 1d show no trends of convergence towards symmetry as the price level for VAT decreases keeps increasing after the reform. We return to this question in section 4.2.1 when we analyze the Finnish hairdressing services reforms.

3.2 Empirical Approach

OLS Specification: To estimate the pass-through to prices of VAT increases and decreases we run the following specification on the full sample of reforms:[22]

$$\begin{aligned} \log p_{ict} = \beta_0 + \beta_1 \cdot \text{Treat} + \beta_2 \cdot \text{After} + \beta_3 \cdot \tau_{ict} + \\ + \beta_4 \log p_{it,-c}^{EA19} + \pi_t + \omega_c + \epsilon_{ict} \end{aligned} \tag{1}$$

where i is the commodity considered, c the country subscript and t is the month in which the price index is observed, p_{ict} is price and τ_{ict} is the tax rate. *Treat* takes a value of 1 if the VAT rate of commodity i in country c changes at time t and 0 otherwise. *After* takes a value of 0 before the reform and a value of 1 after the reform. $p_{it,-c}^{EA19}$ is the month t price of commodity i in the

[21] Clothing and Footwear (COICOP group number 3) is dropped from the analysis as discussed in the previous section.

[22] The results for the restricted sample are reported in appendix Table B.9.

EA19 countries excluding country c to which commodity i belongs.[23] It allows us to control for changes in economic conditions and international commodity prices. Finally, we control for systematic differences in prices over time and across European states by including time (π_t) and country fixed effects (ω_c). Standard errors are clustered by four digit COICOP categories to account for the serial correlation in commodity-specific errors. Thus, β_3 in specification (1) measures the pass-through of the VAT change to price and is equal to:[24]

$$\beta_3 = \frac{[E(\log p_{ic}^{Aft}|T=1) - E(\log p_{ic}^{Bef}|T=1)] - [E(\log p_{ic}^{Aft}|T=0) - E(\log p_{ic}^{Bef}|T=0)]}{[E(\tau_{ic}^{Aft}|T=1) - E(\tau_{ic}^{Bef}|T=1)] - [E(\tau_{ic}^{Aft}|T=0) - E(\tau_{ic}^{Bef}|T=0)]}$$

Measurement Error: Our data suffers from two types of measurement error. First, the commodity categories used in the price dataset are coarser than the commodity categories used in the annual reports that contain information on VAT rates. Because of differences in classification, after merging the two datasets, some price observations are assigned multiple VAT rates. For example, there is only one price category for *House Renovation and Repair* (COICOP category number 04.3.2). However, prior to 2000, Belgium had three different VAT rates for this service – 6%, 12% and 21% – depending on whether it was performed on a new or an old house and whether the dwelling is used as a primary residence for the owner. In 2000, the 12% and 21% rates were repelled and replaced by the 6% rate leading to a VAT decrease for two out of three house renovation and repair services. Because the price observations are a composite of three different services with different VAT rates, using 21% would lead to an overestimate in the VAT cut and would underestimate the price elasticity, using 12% or an average of the three rates can lead to either an overestimate or an underestimate of the VAT cut depending on the

[23] EA19 includes Belgium, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Austria, Portugal, Slovenia, Slovakia and Finland. It corresponds to the group of countries that have adopted the Euro as of 2015. Our results are unaffected by including different country aggregates.

[24] The notation holds for a specification in which we exclude $\log p_{ct,-i}^{all}$, $\log p_{it,-c}^{EA19}$, π_t and ω_c. Including these variables makes the notation heavier without changing the interpretation of β_3.

relative weights of each services. Overall, 18.33% of our dataset is subject to this type of measurement error.

Second, measurement error may be introduced if there is a behavioral response to VAT variation that data surveyors fail to account for. For example, the VAT rate on sit-down restaurants in France was increased from 5.5% to 7% in 2012 and from 7% to 10% in 2014. The VAT rate on take-out restaurants was held fixed at 5.5%. As a consequence of the VAT increase, one may reasonably expect some sit-down restaurants to re-classify as take-out restaurants in order to benefit from the reduced VAT rate. If this behavioral response occurs but price collectors fail to account for it, the sit-down restaurants that switched to take-out restaurants will be counted as sit-down restaurants by surveyors. This type of measurement error would lead to under-responses of prices to VAT variations and lead to an attenuation bias when estimating elasticities. We are not able to assess the extent of this measurement error as we do not have access to information on the price collection process.

2SLS Specification: To address the measurement error issues discussed above, and similarly to Saez et al. (2012), we use Treat × After as an instrument for the VAT rate change τ_{ict}. Our baseline empirical model can be described by the following two-equation system:

$$\begin{aligned}\tau_{ict} = \alpha_0 + \alpha_1 \cdot \text{Treat} + \alpha_2 \cdot \text{After} + \alpha_3 \cdot \text{Treat} \times \text{After} + \alpha_4 \log p_{it,-c}^{EA19} \\ + \alpha_5 \pi_t + \alpha_6 \omega_c + u_{ict} \qquad (2)\end{aligned}$$

$$\begin{aligned}\log p_{ict} = \beta_0 + \beta_1 \cdot \text{Treat} + \beta_2 \cdot \text{After} + \beta_3 \cdot \tau_{ict} + \beta_4 \log p_{it,-c}^{EA19} + \beta_5 \pi_t \\ + \beta_6 \omega_c + v_{ict} \qquad (3)\end{aligned}$$

where i, c, t, Treat, After, $\log p_{it,-c}^{EA19}$, τ_{ict}, π_t and ω_c are defined similarly to equation (1). Treat × After is a dummy variable equal to 1 if the commodity is treated and in the post-treatment period and 0 otherwise. u_{ict} and v_{ict} are the error terms for the first stage and the second stage, respectively. We perform 2SLS with equation (2) as the first stage and equation (3) as the second stage with the goal of solving the measurement error problems described above. The instrument is valid if it is correlated with the VAT rate and uncorrelated with

the error term. Treat × After is mechanically correlated with τ_{ict} and we find large F-statistics for both the VAT increases and decreases. The fact that Treat × After is not correlated with the error term relies on the assumption price changes are not endogenous to the timing of reforms. We discuss this assumption in more details in section 3.4.

3.3 Elasticity Estimates

The 2SLS estimates are reported in the first panel and the OLS estimates in the second panel of Table 2. Columns (1) and (4) report the VAT pass-through estimates with the full set of controls but without time and country fixed effects, columns (2) and (5) add time fixed effects and columns (3) and (6) include the full set of controls as well as country and time fixed effects for VAT increases and decreases respectively. The first row of each regression (labeled VAT Rate) corresponds to the β_3 coefficient which measures VAT pass-through and is equal to 0 for 0% pass-through and 1 for 100% pass-through. Consistent with our concerns over measurement error and attenuation bias, the estimated pass-through using the OLS specification (1) is very small for both VAT increases and decreases. However, the 2SLS regression estimates are consistent with the graphical evidence of asymmetric pass-through presented in the previous section. First, the pass-through of VAT decreases is consistently small and we systematically fail to reject the null of zero pass-through. Second, the pass-through of VAT increases is larger and we reject the null of zero pass-through in every 2SLS specification. Third, the pass-through coefficient for both VAT increases and decreases is fairly stable when including time and country fixed effects and varies between 46% to 41% for VAT increases and between 6.4% and 3.6% for VAT decreases, mitigating some of the endogeneity concerns we address below. Table B.9 reports similar findings for the restricted sample, where we only include commodities affected by both VAT increases and decreases over time. Finally, Stock and Yogo (2005) (in Table 1) show that the critical value of the first-stage F statistic while restricting the bias of the IV estimator to 5% of the OLS bias with one endogenous variable and

four excluded instrumental variables is 16.95. The first-stage F statistics we get using our instrument are consistently above the critical value.

3.4 Endogeneity Concerns

While we are confident that a significant portion of the VAT changes we analyze – particularly the ones after 2003 – are exogenous to economic conditions because they are imposed on EU member states by the European Commission with the goal of VAT rate harmonization, we cannot rule out that some tax changes are not. This raises three possible concerns addressed below.

The first concern is that VAT reforms and economic conditions could change precisely in the same month. If a change in economic conditions leads to a discontinuous change in price levels, we would be misattributing changes in prices to changes in VAT rather than to changes in economic conditions. VAT changes take time because Member States cannot independently legislate on them. Instead, they have to first request an authorization from the European Commission to change the VAT rate, then wait for its approval and finally implement the change. For example, while France started the application for the July 2009 VAT cut on sit-down restaurants in 2001, it was only approved by the European Commission in January 2009 and then implemented July 2009. For this reason, it is unlikely that governments have the ability to precisely time VAT reforms to match the month in which economic conditions change enough to cause discontinuous changes in prices.

A second concern is that business cycles could create trends in prices. This would bias the pass-through estimates upwards for VAT increases if prices trend upwards at times when VAT increases are implemented and vice-versa. Figure 1a shows no significant pre-trends in prices except for a general upward pre and post-trend for both VAT increases and decreases which is also present during non-reform times and can be reasonably attributed to inflation.[25] Can

[25] We also observe a small decrease in the price level before VAT decreases are implemented and an increase in the price level before and after VAT increases are implemented. This can be attributed to the fact that some reforms are implemented mid-month and are misattributed to the previous or following month.

inflation cause the asymmetry? It can certainly cause a small level of asymmetry as it would tend to push prices upwards both in the case of increases and decreases. This would be a concern if the VAT changes we consider are of similar magnitude as inflation. However, Figure 1a shows that inflation is approximately 0.1 to 0.2 percentage points per month whereas the VAT changes we consider are much larger: on average 2 percentage points for VAT increases and 3 percentage points for VAT decreases.

A third concern is that tax increases could happen at times when economic conditions are particularly different from those of tax decreases *and* prices respond differently to VAT shocks during those different times. If, for example, VAT decreases tend to happen at times when the economy is receding and prices tend to be particularly inelastic when the economy is slow, the asymmetry would be an artifact of the timing of reforms. We address this concern in two ways. First, if VAT increases and decreases happen at different economic times and are correlated across countries, then adding time and country fixed effects would affect the pass through coefficient. We include both time and country fixed effects in our main specification in Table 2 and find that their effect on the magnitude of the asymmetry is minimal. Second, we can directly test whether business cycles affect the magnitude of the asymmetry by breaking down our sample into reforms that follow periods of above- and below-median GDP growth and estimate equations (2) and (3) on each sample. The results are reported in Table 3. While pass-through is smaller in periods of low growth, possibly because prices are generally less elastic, the asymmetry is still present in both subsamples: pass-through for VAT increases is 49% in periods of high growth and 31% in periods of low growth; pass-through for VAT decreases is 1% for periods of high growth and 4% in periods of low growth. Similarly, Figures 2a and 2b show graphical evidence using unconditional means on the same subsamples.

3.5 Heterogeneity Analysis

Reform Size: In standard incidence theory, the size of VAT changes is irrelevant. However, it can matter however if large changes are more salient than small ones or if firms face adjustment costs such as menu costs or capacity constraints. For these reasons, we estimate equation (3) on above and below median VAT changes and compare VAT increases to decreases. The results are reported in Table 4 as well as Figures 2c and 2d: we find similar levels of asymmetry for both large and small changes.

Standard and Reduced VAT Rates: Second, countries in our sample have at least two VAT rates: one that applies to most commodities and one that applies to commodities that are considered to be necessity commodities such as food, medication, books etc. We compare the asymmetry for commodities that are subject to the standard versus reduced rate. Theoretically it is unclear whether we should expect different levels of asymmetry. On the one hand, the standard rate might be more salient in that it applies to a much larger number of commodities. In practice however the VAT is in many cases not visible to consumers, and reforms of standard and reduced rates often occur contemporaneously. On the other hand, the reduced rate applies to a subset of commodities for which demand is likely to be less elastic. Figures 1c, 1d and Table 5 show that VAT pass-through is asymmetric in both cases, although smaller for the standard VAT rate, suggesting that salience might matter for the asymmetry. The estimated pass-through for VAT increases is 32% for the standard VAT rate and 29% for the reduced VAT rate. For VAT decreases, pass-through is 16% for the standard VAT rate and 2.7% for the reduced VAT rate.

4 Finnish Hairdressing Services Case Study

In this section, we focus on two plausibly exogenous reforms and use micro price data to further our understanding of how prices respond to VAT increases and decreases. In addition to confirming our result of asymmetric

pass-through, we find two additional results. First, the underlying distribution of pass-through is asymmetric in ways that are inconsistent with standard incidence theory. Second, there are no trends of convergence towards symmetry even four years after the reforms have taken place.

4.1 Data and Institutional Background of the Reforms

The institutional setting of the reforms is explained in detail in Kosonen (2015) and briefly summarized here. While the European Commission restricts excessive VAT changes to avoid VAT competition, it allows member States to experiment with reduced VAT rates for a small sample of labor-intensive services with the explicit goal of analyzing the incidence of VAT on prices and employment.[26] Finland joined the second wave of experiments and selected hairdressing services, bicycle repairs, shoes and leather goods and clothing and household linen as a treatment group. The full set of services over which countries are allowed to experiment is set by the European Commission and explicitly listed in EuropeanCommission (1999). While it includes hairdressing services, it excludes otherwise very similar services such as beauty salons. This makes hairdressing services a natural treatment group, which we compare to beauty salons. The experimentation period was set by the European Commission to start on January 2007 and end in January 2012 when the rate would revert back to the original one. This resulted in a reduction of the VAT rate on hairdressing services from 22% to 8% in January 2007 and a subsequent increase from 9% to 23%.[27] Because the timing, magnitude and commodities affected by this reform were set by the European Commission, the reforms are plausibly exogenous to economic conditions.

Hairdressing services are particularly suited to our analysis. First, firm size is relatively small and there are no large buyers, which allows us to rule out any market-power based explanations of the asymmetric pass-through. Second, there is nothing particular about the hairdressing sector in Finland

[26] See EuropeanCommission (1999) and EuropeanCommission (2006).

[27] The reduced and standard rates were both increased by 1 percent point in January 2010.

that is likely to threaten the external validity of the reforms. For example, there are no specific business or licensing requirements imposed on hairdressers that could create barriers to entry. Similarly, the sector does not benefit from any particular status that would warrant subsidies or lower regulations than the rest of the economy.[28]

We use price data collected by surveyors from a random sample of the full population of hairdressers before and after each VAT change. Prices for nine types of services were collected: short hair haircuts, long hair haircuts, children haircuts, complicated haircuts, short hair permanent waves (perms), long hair permanent waves, short hair coloring, long hair coloring and complicated coloring. The dataset contains 2,822 price observations for the decrease reform originating from 427 firms and 2,106 price observations for the increase reform stemming from 347 firms. We further supplement our analysis with aggregate price series from Statistics Finland for haircuts, other hairdressing services and beauty salons to analyze the long-term effects of the reforms.

4.2 Results

4.2.1 Response Timing and Long Term Asymmetry

Figure 4 uses publicly available aggregate time series from Statistics Finland from January 2005 to November 2015 to show the evolution of hairdressing prices and beauty salon prices. The underlying dataset used to calculate the aggregate time series is similar to the one we use in section 4.2.2.

Prior to the January 2007 reform the VAT rate for hairdressing services and beauty salons were the same. In January 2007, the VAT is decreased by 14 percentage points for hairdressing services and held fixed for beauty salons. In January 2012, the VAT rate for hairdressing services is increased to match its pre-2007 level. Three main empirical patterns emerge from Figure 4. First, beauty salons seem to be a natural control group for hairdressing services: pre-reform, the price levels are similar and follow parallel trends throughout the entire 10 years. Second, the largest response of hairdressing

[28] See Kosonen (2015) for a detailed description of the hairdressing industry.

prices happens during the first month for both the VAT decrease and increase contradicting explanations based on adjustment frictions due, for example, to menu costs or capacity constraints. Third, after the VAT rate for hairdressing services is brought back to the same level as for beauty salons, hairdressing prices remain higher than beauty salon prices without any signs of convergence. This suggests that the asymmetric responses of prices to VAT rates persists over the medium run – in this case, after 4 years.

4.2.2 Pass-Through Distribution

We use the micro level price data to plot the distribution of pass-through. We calculate pass-through by taking the log difference of prices one month before and one month after the VAT reform: $\rho_i = \log(p_{after}) - \log(p_{before})$. Figures 3a and 3c plot the distribution of ρ_i respectively for the VAT decrease and increase for all nine types of services. The distribution of pass-through for the VAT decrease is uni-modal: 61.37% of prices do not change in response to the VAT cut while the rest decrease but without targeting full pass-through (11.67% are located within 20% of full pass-through). The pass-through distribution for VAT increases is substantially different and bi-modal: 26.50% of services pass through 0% of the VAT decrease while 47.72% of services pass through between 80% and 120% of the VAT increase.

The asymmetry in pass-through distributions is not driven by specific services: we systematically observe a bi-modal distribution following a VAT increase and uni-modal distribution following a VAT decrease for each of the nine services (see appendix Figures B.11, B.12, B.13 and **??**). The observed heterogeneity can instead be explained by firm behavior. In Figure 5, we count the number of prices that are changed by any magnitude and divide it by the number of services offered by each firm and plot the distribution of the resulting ratio. The distributions suggest the presence of two types of firms: those that tend to change all prices and those that keep all prices fixed. This heterogeneity in pricing behavior explains part of the pricing patterns we observe in Figures 3a and 3c. It is consistent with the argument made by Kopczuk and Slemrod (2006) and Slemrod and Gillitzer (2013) who insist on the importance

of accounting for firm level heterogeneity when modeling tax behavior. It is also consistent with the empirical findings of Harju et al. (2017) who show that restaurant chains are more likely to fully pass through VAT decreases while independent restaurants pass through 0% of the same VAT cuts.[29]

5 Interpretation

5.1 Standard Incidence Theory

Standard incidence theory makes a clear prediction over the pass-through of consumption taxes. Assume that the government levies an *ad valorem* tax τ on good x. We denote by p the pre-tax price and $q = p(1+\tau)$ the post-tax price. $D(q)$ and $S(p)$ respectively denote the demand and supply for good x.

$$\rho = \frac{dq}{d\tau} = 1 + \frac{dp}{d\tau}$$

is the effect of a small tax increase/decrease on post-tax price. It determines the proportion of the tax that is passed through to price, i.e. the burden falling on consumers. Denote by $\epsilon_D = \frac{q}{D}\frac{dD}{dq}$ the price elasticity of demand and $\epsilon_S = \frac{p}{S}\frac{dS}{dp}$ the price elasticity of supply. Then it can be shown that the pass-through to consumers is given by:

$$\rho = 1 + \frac{\epsilon_D}{\epsilon_S - \epsilon_D} = \frac{\epsilon_S}{\epsilon_S - \epsilon_D}.$$

This formula treats increases and decreases in VAT the same way. Denote by ρ^i and ρ^d the pass-through for increases and decreases in VAT, F_i and F_d the respective distributions of ρ^i and ρ^d, ϵ_S^i and ϵ_S^d the supply elasticity for increases and decreases in the VAT and ϵ_D^i and ϵ_D^d the demand elasticity for increases and decreases in the VAT.

[29] Our result is not driven by chains vs. independents as there are very few hairdressing chains.

The pass-through following an increase in VAT is therefore given by:

$$\rho^i = \frac{dq}{pd\tau} = \frac{\epsilon_S^i}{\epsilon_S^i - \epsilon_D^i}.$$

And for a decrease in VAT:

$$\rho^d = \frac{dq}{pd\tau} = \frac{\epsilon_S^d}{\epsilon_S^d - \epsilon_D^d}.$$

Our estimates show that $\rho^i > \rho^d$. In theory, this could hold if:

(i) $\epsilon_D^d > \epsilon_D^i$ i.e. demand is more reactive to decreases than increases

(ii) Or $\epsilon_S^i > \epsilon_S^d$ i.e. supply is more reactive to increases than decreases

(i) and/or (ii) would imply that $\rho^i \neq \rho^d$ and would lead to a "horizontal" shift in F_d relative to F_i such that the distribution of pass-through for decreases would be closer to zero but otherwise symmetric to F_i as illustrated in Figures 3b and 3d. Instead, we observe that the pass-through distributions are asymmetric for VAT cuts and hikes – as shown in Figures 3a and 3c – which implies that the asymmetry cannot be explained by different demand and supply elasticities and suggests a gap in standard incidence theory.

5.2 Interpretation

Providing a mechanism underlying the asymmetry is beyond the scope of this paper. Instead, we discuss the main stylized facts a model would need to match and consider some common models. To simplify exposition, we call positive asymmetries instances when prices respond more to VAT increases than to VAT decreases and conversely negative asymmetries instances when prices respond more to VAT decreases than to increases. We also distinguish between timing asymmetries – which happen when prices adjust at different speeds for increases and decreases but eventually converge to symmetry – and magnitude asymmetries which occur when the pass through magnitude is different and prices do not tend to converge over time as documented in this

paper. We refer to *distributional* asymmetry as asymmetries in the underlying price distribution (documented in section 4.2.2 using the Finnish case study) as opposed to mean asymmetries which are asymmetries in the first moment of the underlying distributions of pass-through.

For a model to match our findings, it needs to explain the following three main empirical patterns:

Empirical pattern 1: Because we find evidence of asymmetry in markets where firm size is relatively small, such as hairdressing services, the model must generate asymmetric pass-through without assuming strong market power or concentration.

Empirical pattern 2: Such a model also needs to generate substantial price dispersion and predict some degree of *distributional* asymmetry.

Empirical pattern 3: The model needs to match the observed price dynamics, in particular it should predict *short run* responses of prices following both an increase and a decrease in the VAT rate and small to no convergence over time towards symmetry in the medium run.

We discuss menu costs, consumer loyalty and loss averse firm owners and argue that they can explain part of the findings. In contrast, we argue that explanations based on convex demand/supply curves, capacity constraints and collusion are less successful.

5.2.1 Plausible Mechanisms

Menu Costs: If firms need to pay a menu cost c to change their price p so that it is equal to the optimal price p^*, they will only do so if the benefit of changing prices exceeds its cost c. This can lead to upwards and downwards rigidity. Ball and Mankiw (1994)[30] provide an explanation of positive timing asymmetries using menu costs and inflation. They assume that the economy experiences constant inflation π. Following a VAT increase, if firms do not adjust their price, the posted price p will be lower than the optimal price p^*. Over time, inflation will increase the real difference between p and p^*. Firms

[30] And more recently Karadi and Reiff (2014)

are therefore forced to adjust their prices upwards. Following a VAT decrease, the posted price is now higher than the optimal price. If a firm does not adjust its posted price, inflation will push the optimal price p^* upwards and reduce the difference between posted and optimal price until at some point the two are equal. Therefore, if inflation is large enough relative to menu costs, firms would adjust prices upwards but not necessarily downwards in order to avoid paying any menu costs.

A menu cost explanation would match the first empirical pattern as it predicts mean asymmetries without assuming strong market power. If menu costs are heterogenous, price responses will also be heterogenous leading to price dispersion, which could match the second empirical pattern. Most firms would fully pass-through VAT increases immediately, but only firms with small menu costs would adjust prices downwards. However, menu costs would predict eventual convergence towards symmetric pass-through over time, which seems at odds with the empirical evidence and the fact that we observe prices changing and trending upwards one month after the reform. Finally, while menu costs would bind for small VAT reforms, one would need extremely large menu costs to predict downwards rigidity in the Finnish hairdressing services case and other large VAT reforms. And given the low levels of inflation, it would take many years for the posted price to reach the optimal price if firms fail to adjust prices.

Loss Averse Firm Owners: We introduce loss aversion in a model of monopolistic competition with a fixed cost of entry. We posit that firm owners experience a loss when profit margins drop below a given reference point assumed to be the status-quo. VAT increases bring profit margins in the loss-domain and are therefore more likely to trigger price changes than VAT decreases. We assume that firms maximize the following profit function:

$$\pi_i = (\phi_i(q_i)(1-t) - C)q_i - F - v(P_i - r_i)$$

where π_i are profits of firm i, $\phi_i(q_i)$ is the price charged by firm i and is a function of quantities q_i, t is the ad-valorem tax, C is marginal cost and is

assumed to be constant and F are the fixed costs of entry. We denote by P profit margins, r a reference-point for profit margins and $v()$ the loss aversion function, which has the following properties:

$$\frac{\partial v(P-r)}{\partial(P-r)} = \mu \mid \triangle P > 0$$
$$\frac{\partial v(P-r)}{\partial(P-r)} = \lambda\mu \mid \triangle P < 0$$

where $|\lambda| > 1$.
If $v(.)$ is assumed to be zero or $P = r$, π_i is equal to the standard monopolistic competition profit function. In section B we derive the following pass-through formula:

$$\frac{d\phi}{dt} = \frac{K + Jv'(P-r)}{(q(\rho+1) - (\rho-1)v'(P-r))}$$

The formula predicts asymmetric pass-through of VAT changes under the condition that the demand function is concave (when $\rho > 1$). In this case, the first derivative of the loss aversion function leads to more pass-through for tax increases than for tax decreases compared to the standard case when $v(.) = 0$. The predictions are ambiguous for convex demand functions, when $0 < \rho \leq 1$, since $v'(.)$ increases both the numerator and denominator.

While there is no empirical evidence of loss-averse firms in the literature and it can be rightfully argued that large firms are unlikely to experience such bias, this serves as a proof of concept that modeling firm behavior when considering behavioral responses to taxes can help match empirical findings that are hard to rationalize with the standard incidence model.

Fairness and Consumer Loyalty: An alternative explanation of the asymmetric pass-through of VAT is that firms are not exclusively responding to demand and supply when setting prices but also to how prices are perceived by customers. Kahneman et al. (1986) show that customers will accept price increases if they prevent firm profits from decreasing – such as in the case

of a VAT increase – but not as a response to an increase in demand. Conversely, consumers do not feel antagonism towards firms' failure to adjust prices downwards even if they result in higher profits.[31] They conclude that "There is a notable asymmetry between the rules of fairness that apply when circumstances increase or decrease the profits of a firm. The rules of fairness evidently permit firms to pass on the entire amount of a cost increase, but [...] firms are allowed to retain most of the benefits of a cost reduction." Okun (1981) suggests that firms might respond to fairness considerations when setting prices because of the risk of losing some of their loyal customers which threatens future profits. In our setting, consumers would perceive price increases due to VAT hikes as fair, which would not trigger an increase in search and would allow firms to fully pass through VAT hikes. At the same time, downwards price rigidity would not trigger additional search since consumers find it acceptable. A firm that would undercut competitors following a VAT cut would not attract additional consumers but instead decrease their margins on their current customers. This explanation would fit the three empirical patterns but relies on the strong assumption that switching is only triggered when firms antagonize consumers, which requires a high degree of consumer loyalty.

5.2.2 Unlikely Explanations

Convex Demand and/or Supply Curves: Elasticities are different along convex supply and demand functions. Locally, these differences in elasticities are small and should not result in large pass through asymmetries for small VAT changes. Depending on the curvature of the functions, large VAT changes can lead to large differences in pass through. However, this explanation is inconsistent with the evidence presented in section 3.5: Figures 2c and 2d and Table 4 show that the asymmetry is present for both large and small changes. In addition, this explanation is not consistent with the second empirical finding: it would not predict any price dispersion nor *distributional*

[31] See survey questions in appendix section A

asymmetries.

Capacity Constraints: Capacity constraints can lead to price rigidity: if firms cannot cater to additional demand, they may be less likely to change prices. Capacity constraints create a kink in the supply function at the capacity constraint K. The elasticity of supply ϵ_S is positive when producing at quantities below the capacity constraint and $\epsilon_S = 0$ above the capacity constraint (see Figure 6a). Assume capacity constraints are binding and there is a VAT rate increase. Firms would want to increase post-tax prices which would result in a decrease in quantities. However if this reduction in quantities is such that capacity constraints are still binding, firms will not adjust their quantities – and since they are producing on the portion of the supply curve where $\epsilon_S = 0$ – they will bear the entire VAT rate increase and post-tax prices will not change as illustrated in Figure 6b. On the other hand, if the tax rate increase is large enough such that it would increase price enough to reduce quantities produced up to the point where the capacity constraints are not binding anymore, firms will be producing on the portion of the supply curve where $\epsilon_S > 0$ and should only bear part of the VAT rate increase. In this case, we should observe a post-tax price increase, as illustrated in Figure 6c. If instead there is a tax decrease and firms are producing at capacity constraint, the tax decrease will always lead firms to operate on the portion of the supply curve where $\epsilon_S = 0$ and will not lead to a post-tax price decrease (see Figure 6d).

Therefore, capacity constraints predict that prices will be fully downward rigid, upward rigid for small VAT changes and exhibit no rigidity for large tax changes. This explanation however has several shortcomings. First, we should observe asymmetric pass-through for large VAT changes but not for small ones. This is inconsistent with Figures 2c and 2d and Table 4: we still observe asymmetric pass-through even in the case of small VAT changes and the magnitude of the asymmetry is not smaller than for large VAT increases. Second, while it is reasonable to assume that some industries are capacity constrained, it is unlikely that all industries in the economy are. This is

emphasized in Tirole (1988): "Except in special cases, a firm usually has some leeway to increase its production beyond its efficient level." Third, while this explanation would match the first empirical pattern, it does not predict any price dispersion and is inconsistent with the third empirical finding as it predicts no immediate response for small decreases and eventual convergence once capacity constraints are relaxed.

Collusion: If firms are able to collude, they can fully pass through VAT increases and only partially pass through VAT decreases as long as it leads to higher profits. This would match the third empirical pattern: we would observe immediate responses of prices to both VAT increases and decreases and no convergence towards symmetry over time as long as the cartel exists. However it would not match the fact that the asymmetric pass-through exists in industries with many small firms such as hairdressing services.

6 Conclusion

In this paper, we show that prices increase more following a VAT increase than they decrease following a VAT decrease. We use monthly price variation in the price of the entire spectrum of commodities across European countries from 1996-2015 and find that the pass-through of VAT increases to prices is higher than it is for tax decreases. Further, using Finnish hairdressing services as a case study, we find that pass-through distributions are also asymmetric in ways that are hard to rationalize with standard incidence theory. We also find no evidence of convergence towards symmetry even 4 years after the last VAT change.

Our findings question the effectiveness of reductions in consumption taxes to achieve redistribution or stimulate the economy. For example, following the meltdown of the Great Recession, Kotlikoff and Leamer (2008) argued in 2008 that the government should run a "National Sale" in order to "immediately and directly stimulate consumption". The plan they suggested was to have all 50 states reduce their sales taxes by 5 percentage points for a period of

6 months. They posited that this should stimulate demand and reduce the severity of the recession. In 2009, the UK implemented this policy by reducing the standard VAT rate from 17.5% to 15% for a period of 12 months, with the explicit goal of increasing consumer spending. The premise of these policies relies on the assumption that prices respond symmetrically to variation in consumption taxes. Our findings show that this assumption does not hold, which implies that these policies would not stimulate consumption and may even reduce it as equilibrium prices will be higher after the temporary tax cuts are expired. They would instead lead to a transfer from the government to firms – a £12.4 billion one in the case of the 2009 UK temporary VAT cut.

Our findings also have implications for the incidence literature. Empirically, they caution against using incidence estimates derived from studies that only consider either a tax increase or a tax decrease but not both. Theoretically, the concept of tax incidence is defined as the percent change in price relative to the percent change in tax, and is agnostic about the direction of the change. As a consequence, our findings suggest a gap in standard incidence theory and future research is needed to understand what drives the asymmetry and how to incorporate it in models of incidence.

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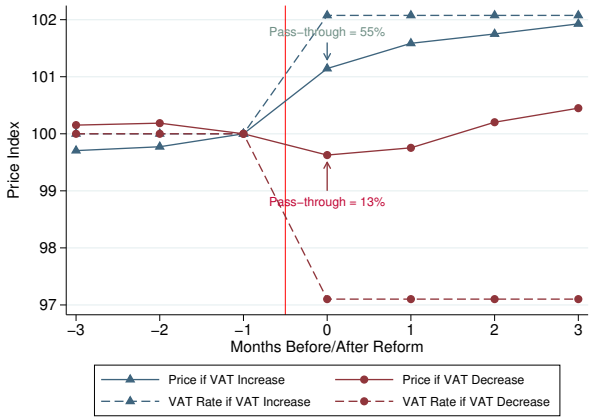
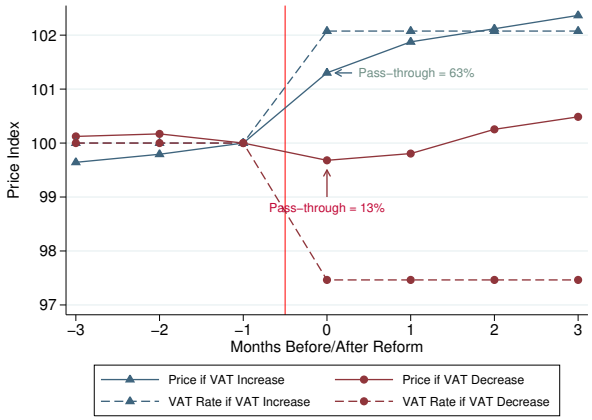
Figure 1: Asymmetric Response of Prices to VAT Changes

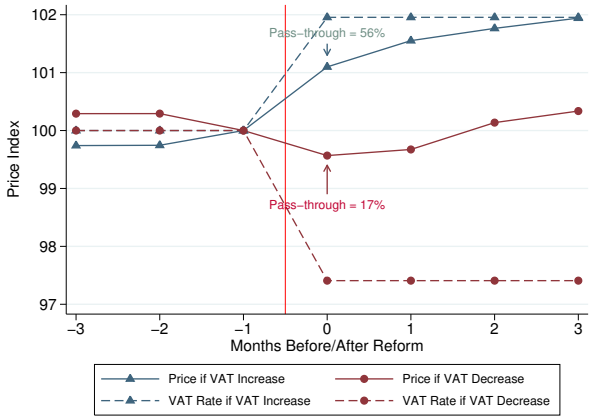
(a) Full Sample



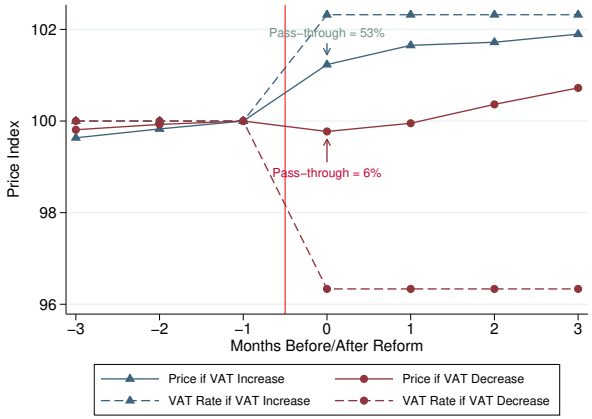
(b) Restricted Sample



(c) Standard VAT Rate



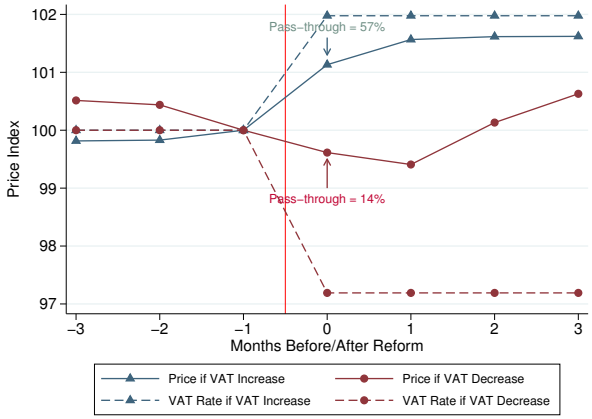
(d) Reduced VAT Rate



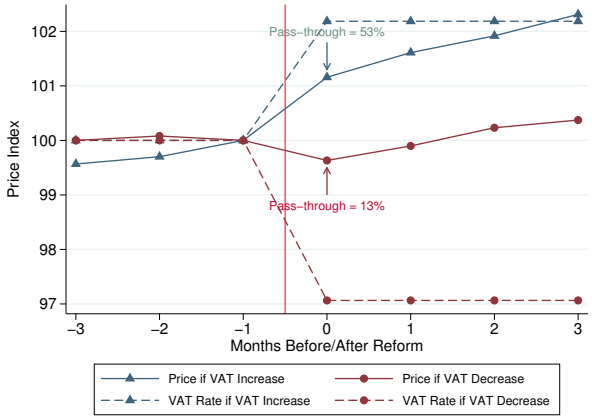
Notes: These Figures plot the response of prices to VAT increases and decreases. The underlying dataset consists of 3-month window price and VAT time series around each VAT reform from 1996 to 2015. We average out and normalize each series to 100 one month before the reform. Figure 1a considers the full sample of reforms (excluding education and clothing and footwear), Figure 1b the restricted sample (commodities that experience both a VAT increase and decrease over time), Figure 1c commodities subject to the standard VAT rate and Figure 1d commodities subject to the reduced rate.

Figure 2: Asymmetric Response of Prices to VAT Changes (continued)

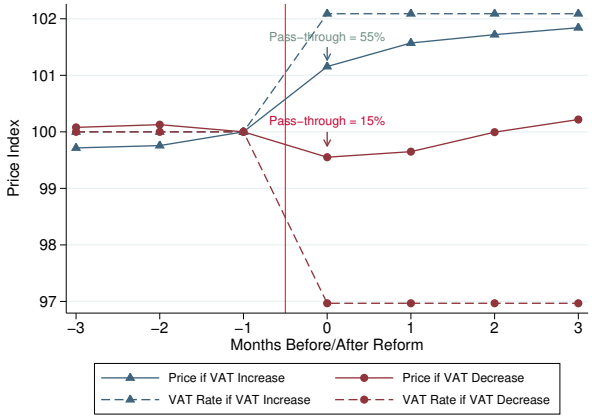
(a) Low Growth



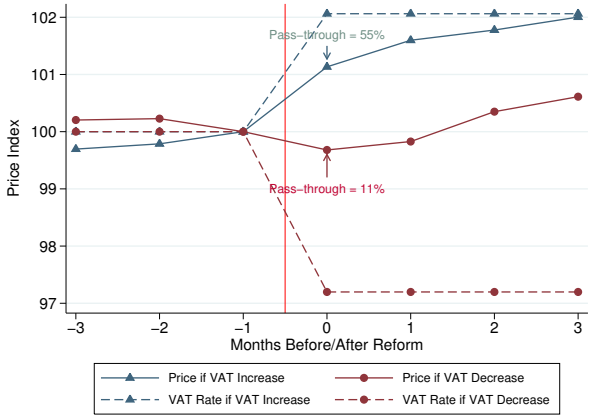
(b) High Growth



(c) Small VAT Changes



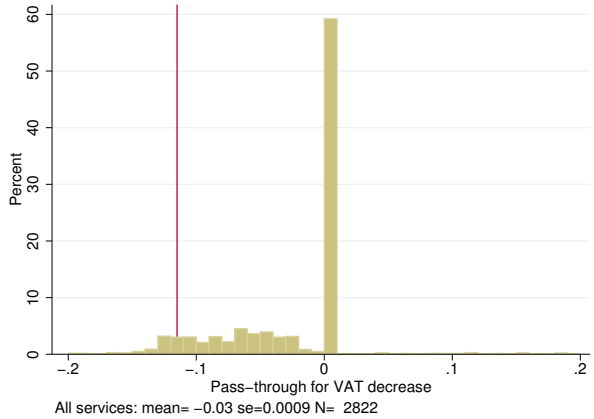
(d) Large VAT Changes



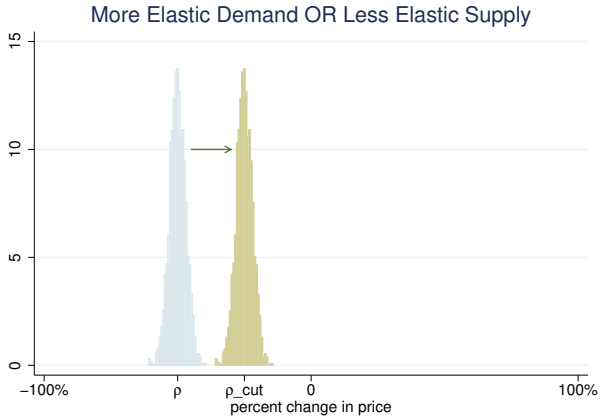
Notes: These Figures plot the response of prices to VAT increases and decreases. The underlying dataset consists of 3-month window price and VAT time series around each VAT reform from 1996 to 2015. We average out and normalize each series to 100 one month before the reform. Figures 2a and 2b consider reforms following periods of below and above median growth, respectively. Figures 2c and 2d consider the 25% smallest and 25% largest reforms, respectively.

Figure 3: Distributional Asymmetry

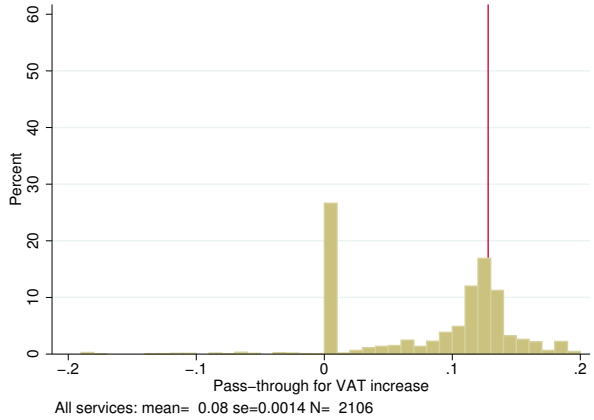
(a) VAT Decrease (Observed)



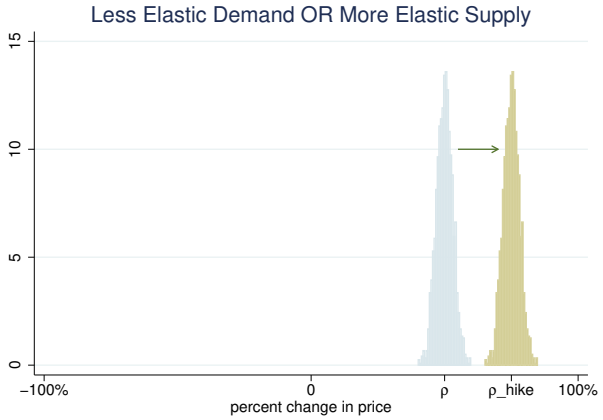
(b) VAT Decrease (Incidence Theory)



(c) VAT Increase (Observed)

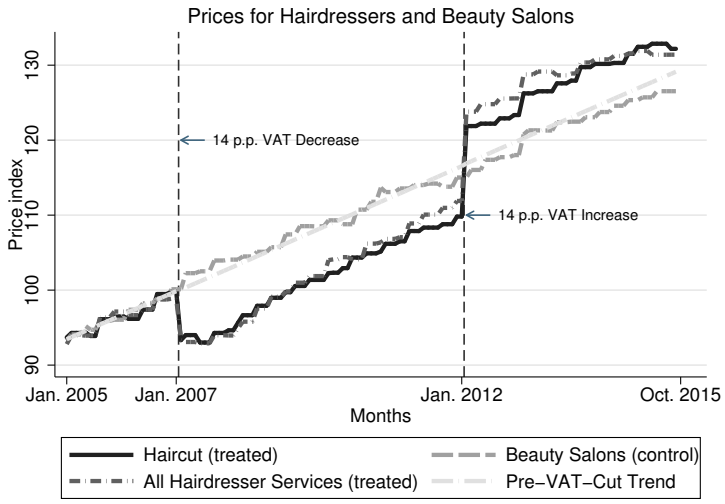


(d) VAT Increase (Incidence Theory)



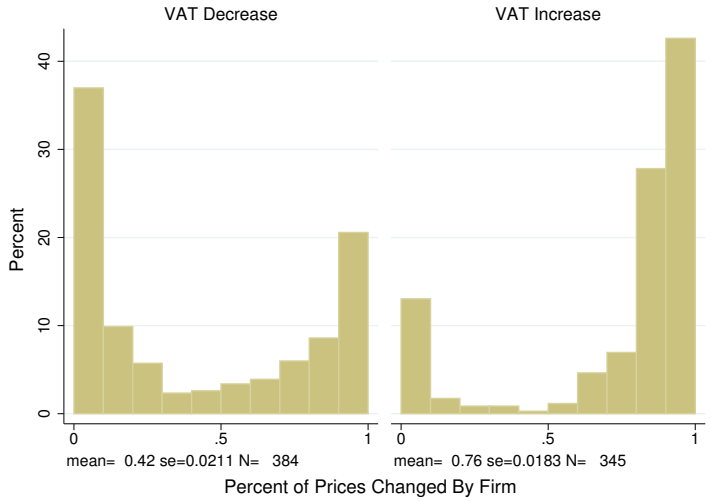
Notes: These Figures compare the observed pass-through distributions following the VAT decrease (Figure 3a) and VAT increase (Figure 3c) for hairdressing services to the pass-through distributions predicted by the standard incidence model for VAT decreases (Figure 3b) and increases (Figure 3d). Standard incidence theory with different elasticities for VAT increases and decreases would predict shifted pass-through distributions but otherwise symmetric, which is inconsistent with the observed pass-through distributions.

Figure 4: Long Term Asymmetry



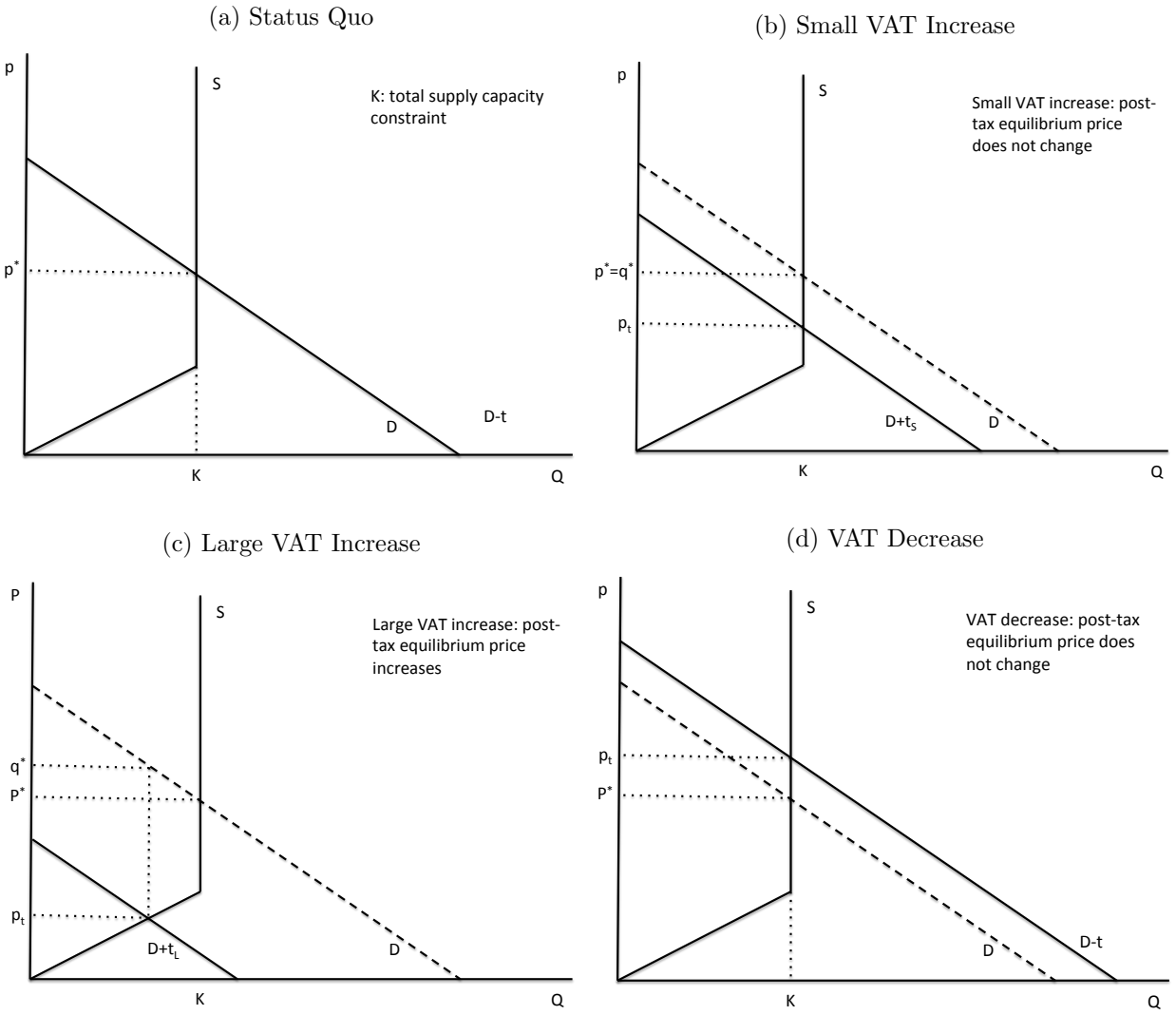
Notes: This Figure shows the price level of haircuts, other hairdressing services and beauty salons before and after the 14 percentage point hairdressing services VAT cut in January 2007 and the 14 percentage point VAT hairdressing services hike in January 2012. Pre-VAT-Cut trend linearly extrapolates the price index from months prior to the VAT cut to the remaining months.

Figure 5: Proportion of Prices Changed by Hairdresser



Notes: This figure plots the distribution of within hairdresser ratio of services for which prices are changed over total services offered following the VAT cut and hike.

Figure 6: Capacity Constraints



Notes: These figures show how prices respond to a small VAT increase (Figure 6b), a large VAT rate increase (Figure 6c) and a VAT decrease (Figure 6d) when firms are capacity constrained.

Table 1: Summary Statistics on VAT Rate Reforms

Panel A: All Commodities

	Number of VAT Reforms (1)	Change in VAT Rate (2)	Mean VAT After Reform (3)	Standard Deviation (4)
VAT Changes	2,832	1.34	17.87	5.26
VAT Increases	2,481	2.03	17.97	5.30
VAT Decreases	351	-3.02	17.26	4.98

Panel B: Commodities to which Standard Rate is Applied

	Number of VAT Reforms (1)	Change in VAT Rate (2)	Mean VAT After Reform (3)	Standard Deviation (4)
VAT Changes	1,918	1.28	18.59	4.78
VAT Increases	1,667	1.93	18.68	4.86
VAT Decreases	251	-2.67	18.05	4.23

Panel C: Commodities to which Reduced Rate Is Applied

	Number of VAT Reforms (1)	Change in VAT Rate (2)	Mean VAT After Reform (3)	Standard Deviation (4)
VAT Changes	914	1.48	16.38	5.86
VAT Increases	814	2.24	16.51	5.82
VAT Decreases	100	-3.83	15.42	6.02

Notes: Column (1) shows the number of VAT reforms considered; Column (2) shows the average change in the VAT rate in percentage points in the month of the reform; Columns (3)-(4) display summary statistics for the VAT rate in the month of the reform.

Table 2: Pass Through Estimates Using IV and OLS (Full Sample)

IV	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.46***	0.41***	0.41***	-0.064	0.040	0.036
	(0.13)	(0.11)	(0.11)	(0.19)	(0.12)	(0.12)
Treat	0.0078***	0.012**	0.011**	-0.011***	0.00081	0.00037
	(0.0027)	(0.0047)	(0.0046)	(0.0037)	(0.0078)	(0.0079)
After	0.00062	0.013***	0.0020	-0.0096**	0.015	-0.018
	(0.0020)	(0.0043)	(0.0013)	(0.0045)	(0.017)	(0.013)
Log(EA19 Price)	0.73***	0.61***	0.61***	1.02***	0.72***	0.73***
	(0.12)	(0.17)	(0.17)	(0.15)	(0.22)	(0.23)
R^2	0.38	0.47	0.54	0.50	0.64	0.65
Observations	34734	34734	34734	4914	4914	4914
First Stage F-Stat	1679	1608.8	1628.2	126.3	123	123.1
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

OLS	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.19*	0.14	0.023	0.30*	-0.11	-0.057
	(0.11)	(0.12)	(0.14)	(0.17)	(0.19)	(0.089)
Treat	0.011***	0.015***	0.017***	-0.0045	-0.0017	-0.0011
	(0.0032)	(0.0047)	(0.0047)	(0.0057)	(0.0095)	(0.0084)
After	0.0036**	0.016***	0.0033**	-0.0044	0.011	-0.021
	(0.0014)	(0.0041)	(0.0014)	(0.0028)	(0.018)	(0.015)
Log(EA19 Price)	0.74***	0.62***	0.62***	1.01***	0.72***	0.73***
	(0.13)	(0.17)	(0.17)	(0.15)	(0.22)	(0.23)
R^2	0.38	0.48	0.54	0.51	0.64	0.65
Observations	34734	34734	34734	4914	4914	4914
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Notes: The coefficients reported in this Table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) and (3) on the full sample of reforms. The first panel shows the 2SLS estimates and the second panel the OLS estimates. Standard errors are clustered by COICOP. * p<0.10, ** p<0.05, *** p<0.01

Table 3: 2SLS Estimates of Pass-Through to Prices by GDP Growth

High GDP Growth	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.52***	0.49***	0.49***	-0.17	-0.0067	-0.0097
	(0.13)	(0.12)	(0.12)	(0.30)	(0.17)	(0.16)
Treat	0.0065**	0.0093*	0.0091*	-0.011**	0.0040	0.0037
	(0.0032)	(0.0054)	(0.0053)	(0.0050)	(0.0092)	(0.0094)
After	-0.000089	0.013**	0.0058	-0.012*	0.0067	-0.014
	(0.0022)	(0.0059)	(0.0039)	(0.0073)	(0.021)	(0.016)
Log(EA19 Price)	0.77***	0.68***	0.69***	0.86***	0.52**	0.53**
	(0.10)	(0.17)	(0.16)	(0.22)	(0.25)	(0.26)
R^2	0.41	0.49	0.54	0.39	0.59	0.59
Observations	15330	15330	15330	2338	2338	2338
First Stage F-Stat	602.9	575.4	574.1	128.9	120.9	120
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Low GDP Growth	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.33**	0.31**	0.31**	0.031	0.043	0.043
	(0.15)	(0.13)	(0.13)	(0.12)	(0.10)	(0.10)
Treat	0.0084***	0.010**	0.010**	-0.013**	-0.0090	-0.0091
	(0.0027)	(0.0043)	(0.0042)	(0.0053)	(0.0085)	(0.0085)
After	0.0029	0.022***	0.0026	-0.0077**	-0.012	0.0080
	(0.0023)	(0.0066)	(0.0028)	(0.0034)	(0.029)	(0.012)
Log(EA19 Price)	0.76***	0.70***	0.70***	1.21***	1.07***	1.07***
	(0.13)	(0.18)	(0.18)	(0.14)	(0.21)	(0.21)
R^2	0.40	0.48	0.55	0.60	0.70	0.71
Observations	18620	18620	18620	2478	2478	2478
First Stage F-Stat	634.6	616.9	620.6	79.4	75.6	75.2
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Notes: The coefficients reported in this Table indicate the pass-through of VAT increases and decreases to prices estimated using specification (3) on a subsample of reforms occurring during high growth periods in the first panel and low growth periods in the second panel. Standard errors are clustered by COICOP. * p<0.10, ** p<0.05, *** p<0.01

Table 4: 2SLS Estimates of Pass-Through to Prices By Size of Change

Large Change	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.52***	0.49***	0.49***	-0.17	-0.0067	-0.0097
	(0.13)	(0.12)	(0.12)	(0.30)	(0.17)	(0.16)
Treat	0.0065**	0.0093*	0.0091*	-0.011**	0.0040	0.0037
	(0.0032)	(0.0054)	(0.0053)	(0.0050)	(0.0092)	(0.0094)
After	-0.000089	0.013**	0.0058	-0.012*	0.0067	-0.014
	(0.0022)	(0.0059)	(0.0039)	(0.0073)	(0.021)	(0.016)
Log(EA19 Price)	0.77***	0.68***	0.69***	0.86***	0.52**	0.53**
	(0.10)	(0.17)	(0.16)	(0.22)	(0.25)	(0.26)
R^2	0.41	0.49	0.54	0.39	0.59	0.59
Observations	15330	15330	15330	2338	2338	2338
First Stage F-Stat	602.9	575.4	574.1	128.9	120.9	120
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Small Change	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.41**	0.35***	0.35***	0.056	0.095	0.093
	(0.16)	(0.13)	(0.13)	(0.11)	(0.10)	(0.10)
Treat	0.0090***	0.013***	0.013***	-0.0096**	-0.0040	-0.0044
	(0.0031)	(0.0047)	(0.0046)	(0.0038)	(0.0067)	(0.0067)
After	0.0013	0.013***	0.00082	-0.0062**	0.025	0.019
	(0.0023)	(0.0045)	(0.0029)	(0.0027)	(0.020)	(0.012)
Log(EA19 Price)	0.70***	0.55***	0.55***	1.18***	1.02***	1.03***
	(0.16)	(0.19)	(0.19)	(0.091)	(0.15)	(0.16)
R^2	0.36	0.47	0.54	0.63	0.73	0.75
Observations	19404	19404	19404	2576	2576	2576
First Stage F-Stat	1130.9	1106.8	1095.9	49.6	47.7	47.7
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Notes: The coefficients reported in this Table indicate the pass-through of VAT increases and decreases to prices estimated using specification (3) on a subsample of large VAT changes in the first panel and small VAT changes in the second panel. Standard errors are clustered by COICOP. * p<0.10, ** p<0.05, *** p<0.01

Table 5: 2SLS Estimates of Pass-Through to Prices By Type of VAT Rate

Standard Rate	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.33***	0.32***	0.32***	0.13	0.16*	0.16*
	(0.11)	(0.11)	(0.11)	(0.094)	(0.090)	(0.090)
Treat	0.0067**	0.0079**	0.0079**	-0.012***	-0.0079	-0.0088
	(0.0028)	(0.0039)	(0.0039)	(0.0046)	(0.0075)	(0.0075)
After	0.0023	0.020***	0.0016	-0.0059***	0.031	-0.0098
	(0.0016)	(0.0046)	(0.0017)	(0.0022)	(0.023)	(0.0073)
Log(EA19 Price)	0.86***	0.81***	0.81***	1.13***	1.01***	1.03***
	(0.074)	(0.12)	(0.12)	(0.12)	(0.18)	(0.19)
R^2	0.49	0.54	0.60	0.62	0.70	0.70
Observations	23338	23338	23338	3514	3514	3514
First Stage F-Stat	1664.1	1644.5	1618.9	80.3	78.5	78.7
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Reduced Rate	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.51***	0.29**	0.29**	-0.31	0.026	0.027
	(0.13)	(0.13)	(0.13)	(0.33)	(0.12)	(0.12)
Treat	0.015***	0.027***	0.027***	-0.0046	0.024***	0.024***
	(0.0042)	(0.0050)	(0.0050)	(0.0054)	(0.0075)	(0.0077)
After	0.0016	0.000078	0.0035*	-0.014*	0.011	-0.0037
	(0.0023)	(0.0069)	(0.0021)	(0.0082)	(0.021)	(0.014)
Log(EA19 Price)	0.43***	0.14*	0.14*	0.77**	0.14	0.14
	(0.15)	(0.081)	(0.080)	(0.30)	(0.11)	(0.11)
R^2	0.16	0.47	0.58	0.29	0.66	0.69
Observations	11396	11396	11396	1400	1400	1400
First Stage F-Stat	578	537.8	530.5	43.9	41.8	41.4
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Notes: The coefficients reported in this Table indicate the pass-through of VAT increases and decreases to prices estimated using specification (3) on a subsample of standard rate reforms in the first panel and reduced rate reforms in the second panel. Standard errors are clustered by COICOP. * p<0.10, ** p<0.05, *** p<0.01

APPENDIX FOR ONLINE PUBLICATION

A Fairness and Consumer Loyalty

Kahneman et al. (1986) provide evidence that fairness considerations matter to consumers when firms set prices. They show that consumers perceive price increases as fair when costs are increased, on the basis that firms have to do it to protect their own profits. When costs are decreased however, consumers find it acceptable that firms keep prices constant.

They establish that consumers find price increases aimed at increasing profits unfair relative to price increases aimed at protecting profits using the following two questions:

1. *A hardware store has been selling snow shovels for $15. The morning after a large snowstorm, the store raises the price to $20.*

2. *Suppose that, due to a transportation mixup, their is a local shortage of lettuce and the wholesale price has increased. A local grocer has bought the usual quantity of lettuce at a price that is 30 cents per head higher than normal. The grocer raises the price of lettuce to customers by 30 cents per head.*

They find that 82% of the people they survey find situation 1 to be unfair, whereas only 21% find situation 2 to be unfair. This asymmetry in peoples' opinions shows that the reasons behind price increases matter in determining whether they are fair or not.

The authors also show that individuals consider the absence of price decreases when costs are decreased to be fair using the following two questions:

1. *A small factory produces tables and sells all that it can make at $200 each. Because of changes in the price of materials, the cost of making each table has recently decreased by $40. The factory reduces its price for the tables by $20.*

2. *... the cost of making each table has recently decreased by $20. The factory does not change its price for the tables.*

79% of respondents find the first outcome to be acceptable and 53% find the second outcome acceptable. Even though none of the reduction in costs is passed through to consumers in the second situation, individuals find that to be acceptable. This stands in contrast with the evidence that individuals find

it unfair that firms increase their profits when taking advantage of increases in demands or decreases in supply.

Kahneman et al. (1986) show that consumers care about fairness in price setting by firms. But are firms aware of it? Blinder et al. (1998) address this question by surveying firms. Two of their main findings are that:

1. 64% of surveyed firms claim that "customers do not tolerate price increases after increases in demand"

2. 71% of firms believe that "customers do tolerate price increases after increases in cost".

B Monopolistic Competition with Loss Aversion

The economy consists of n identical firms producing differentiated products which gives them some monopoly power. Firm i produces product q_i and sells it with price $\phi_i(q_i)$. Firms have an objective function that consists of profits and a loss aversion term. Firms need to pay a fixed cost F in order to enter the market. They face taxes at a rate t and an ad valorem tax set to price $\phi_i(q_i)(1-t)$. We assume constant marginal cost C to focus on the effect of $v()$. The loss aversion part depends on a reference point r that enters the objective function. Assume the firm owner cares about profit margin for each product $(P = \phi(1-t) - C)$ relative to the reference point. If the profit margin is less than the reference point, the firm owner experiences larger losses. $v(P-r)$ has the following properties:

$$\frac{\partial v()}{\partial(P-r)} = \mu \mid \triangle(P-r) > 0$$
$$\frac{\partial v()}{\partial(P-r)} = \lambda\mu \mid \triangle(P-r) < 0$$

where $|\lambda| > 1$.

We write the objective function for firm i as

$$\pi_i = (\phi_i(q_i)(1-t) - C)q_i - F - v(P_i - r_i)$$

The consumers purchase products in the non-market sector Y and in the market sector. They have weakly separable preferences over these two sectors, and their utility function takes the form

$$U = (1-\delta)\log Y + \delta \log(\sum (Aq_i - \frac{B}{1+\rho} q_i^{1+\rho})^{\alpha}$$

They face the following budget constraint

$$\phi_Y Y + \sum \phi_i q_i = M$$

Utility maximization leads to the following demand equation price relation

$$\phi_i = \frac{\delta M}{\alpha(\sum Aq_i - \frac{B}{1+\rho} q_i^{1+\rho})^{\alpha-1}}(A - Bq_i^{\rho})$$

where $\alpha(\sum Aq_i - \frac{B}{1+\rho} q_i^{1+\rho})^{\alpha-1}$ is a constant and labeled ζ in the following. Note that

$$\frac{\partial \phi_i}{\partial q_i} = -\frac{\delta M}{\zeta} B\rho q_i^{\rho-1}$$

$$\frac{\partial^2 \phi_i}{\partial q_i^2} = -(\rho-1)\frac{\delta M}{\zeta} B\rho q_i^{\rho-2}$$

Thus, ϕ'' is positive if $0 < \rho < 1$ and negative if $\rho > 1$. We assume that firms do not take the pricing of other firms into account when pricing their products. Due to symmetry of the market we focus on firm i and drop the subscripts to simplify the notation. To get equilibrium prices, we take the consumer demand, and insert it in the firm decision problem. We then take the first order condition (FOC) of the firm objective function $\pi = (\phi(q)(1-t) - C)q - F - v(\phi(q)(1-t) - C - r)$.

$$\frac{\partial \pi}{\partial q} = q\phi'(q)(1-t) + (\phi(q)(1-t) - C) - v'()\phi'(q)(1-t)$$

$$\phi(q)(1-t) - C = -\phi'(q)(1-t)(q - v'())$$

where $\phi'(q) = \frac{\partial \phi}{\partial q}$ and $v'(P-r) = \frac{\partial v}{\partial q}$ denote the first derivatives of the function in question w.r.t. quantity q. The price equation is $\phi(q) = -\phi'(q)(q - v') + \frac{C}{1-t}$, which under free entry is equated with a price that gives zero profits $\phi_0(q) = \frac{C}{1-t} + \frac{1}{q(1-t)}(F + v())$. This yields the following equation:

$$-\phi'(q)(q - v'()) + \frac{C}{1-t} = \frac{C}{1-t} + \frac{1}{q(1-t)}(F + v())$$

$$-\phi'(q)(q - v'()) = \frac{1}{q(1-t)}\left(F + v()\right)$$

$$-\phi'(q)(q - v'())q = \frac{F + v()}{1-t}$$

Assume $v''() = 0$. Next differentiate the FOC for firm's objective function by varying all quantities and taxes to get

$$dq\left[-\phi'(q)2q + \phi'(q)v'() - \phi''(q)(q - v'())q - v'()\phi'(q)\right] = dt\left[\frac{F + v()}{(1-t)^2} - \frac{\phi(q)v'()}{1-t}\right]$$

$$dq\left[-\phi'(q)2q - \phi''(q)(q - v'())q\right] = dt\left[\frac{F + v()}{(1-t)^2} - \frac{\phi(q)v'()}{1-t}\right]$$

$$\frac{dq}{dt} = \frac{\frac{F+v()}{(1-t)^2} - \frac{\phi(q)v'()}{1-t}}{-\phi'(q)2q - \phi''(q)(q - v'())q}$$

Note that we use the inverse demand function $\phi(q)$. By definition, we get by differentiating $d\phi = \phi'(q)dq$, which allows to write the above expression in terms of prices.

$$\frac{d\phi}{dt} = \frac{(\frac{F+v()}{(1-t)^2} - \frac{\phi(q)v'()}{1-t})\phi'(q)}{-\phi'(q)2q - \phi''(q)(q - v'())q}$$

$$\frac{d\phi}{dt} = \frac{(\phi(q)v'() - \frac{F+v()}{1-t})\phi'(q)}{(1-t)\left(\phi'(q)2q + \phi''(q)(q - v'())q\right)}$$

The first term in parentheses in the numerator is $(\phi(q)v'() - \frac{F+v()}{1-t})$, which is positive as long as $(\phi(q)v'() > \frac{F+v()}{1-t})$. From the zero profit condition $\frac{(F+v())}{(1-t)} = \left(\phi(q) - \frac{C}{1-t}\right)q$. Thus the term in the numerator is positive as long as $\phi(q) > \left(\phi(q) - \frac{C}{1-t}\right)\frac{q}{v'()}$, which holds for realistic profit margins (price is larger than price minus marginal cost inflated with the tax rate). Thus the term in parentheses is positive, and multiplied by the negative first derivative of the inverse demand function, $\phi'(q)$, the whole numerator is negative. The first term in the denominator is the first derivative of inverse demand followed by a term having the second derivative of the same function. If the latter is negative, all terms are negative, and larger denominator in absolute value decreases pass through. If the second derivative is positive, that is, demand

function is convex, pass through is increased and more than full pass through is possible.

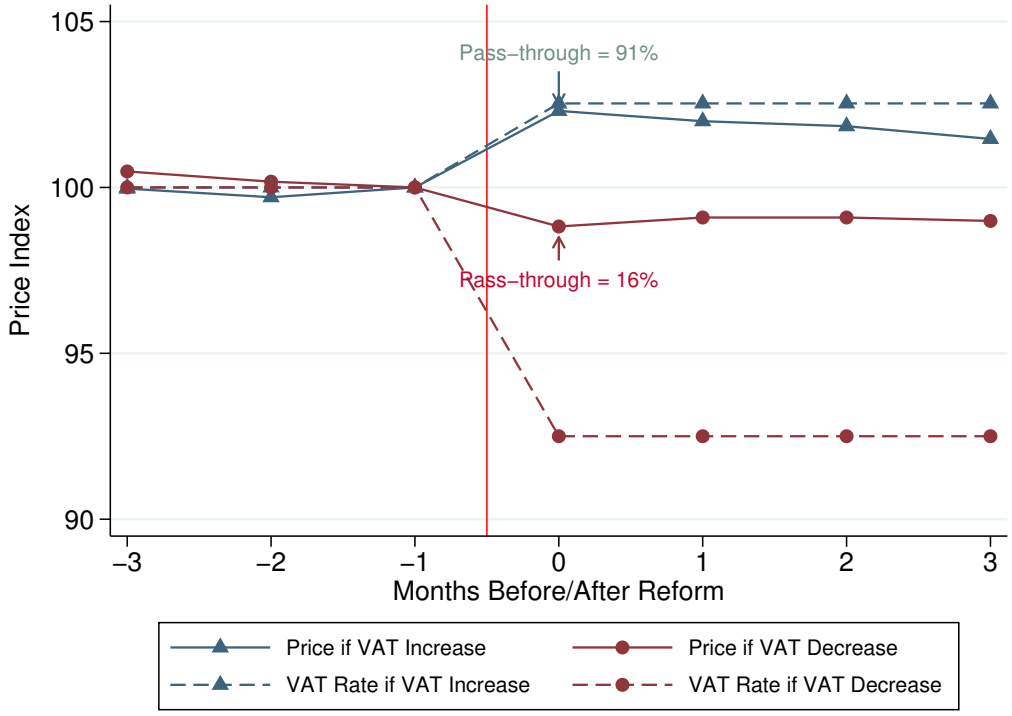
The $v'()$ function multiplies these terms in the direction that increases the extent of pass through when demand is concave and in an unclear direction with convex demand. To see this, consider first the numerator. Since we just deduced that the term having $v'()$ function in the numerator is positive, larger loss aversion function makes pass through larger. The function has larger first derivative for losses than gains, that is, for tax decreases than tax increases. Thus, through the numerator pass through is larger for tax increases than for tax decreases. In the denominator the v' function has negative sign and is multiplied with the second derivative of the inverse demand function. Assume that $q - v'() > 0$. Thus, when the demand is concave and the second derivative negative, a larger v' makes the denominator smaller, and thus pass through larger. This works in the opposite direction for convex demand.

Next insert from the condition for consumer demand derived above to get:

$$\frac{d\phi}{dt} = \frac{K + Jv'()}{(q(\rho + 1) - (\rho - 1)v'())}$$

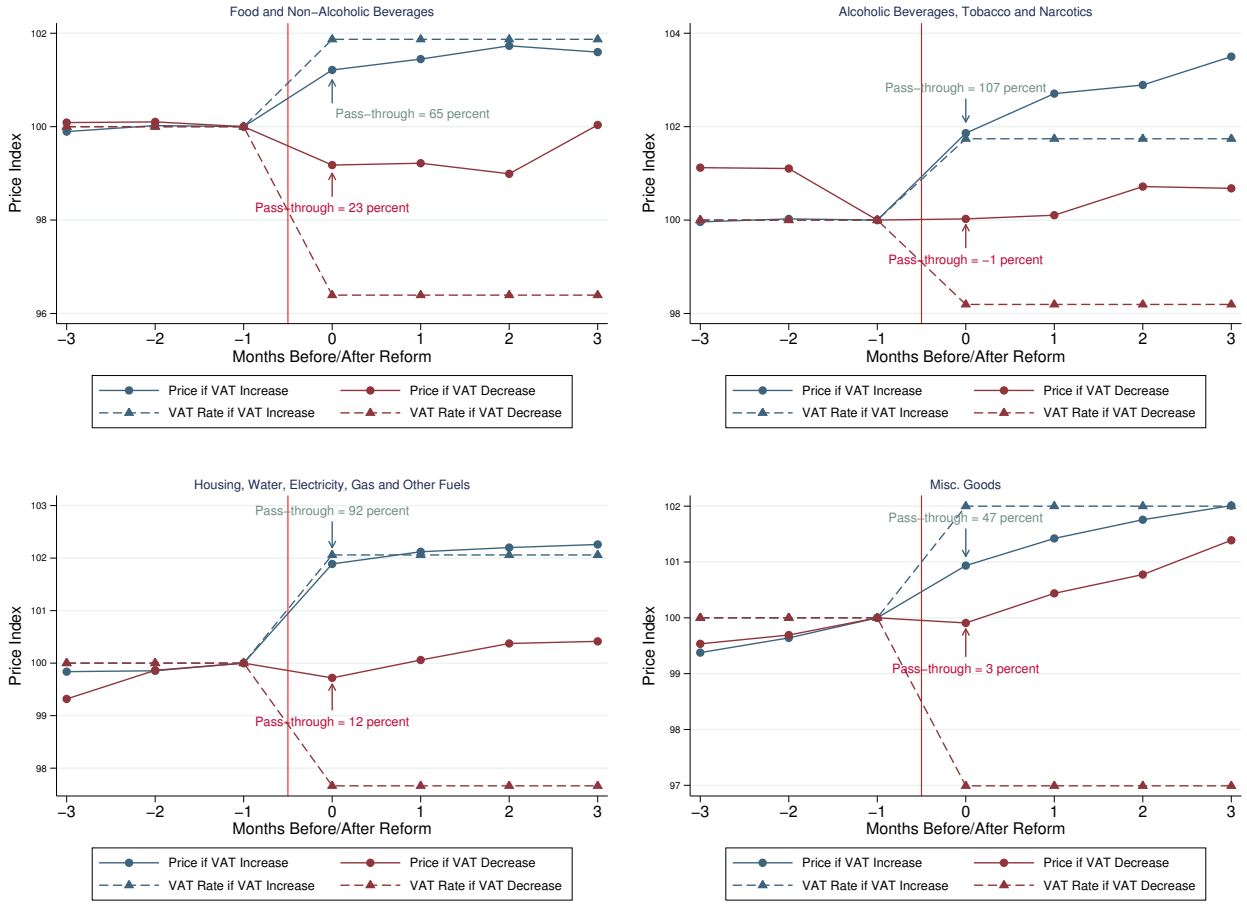
where $K = -\frac{F+v()}{(1-t)^2}$ and $J = \phi(q)$.

Figure B.7: Asymmetric Pass-Through of VAT to Gasoline Prices



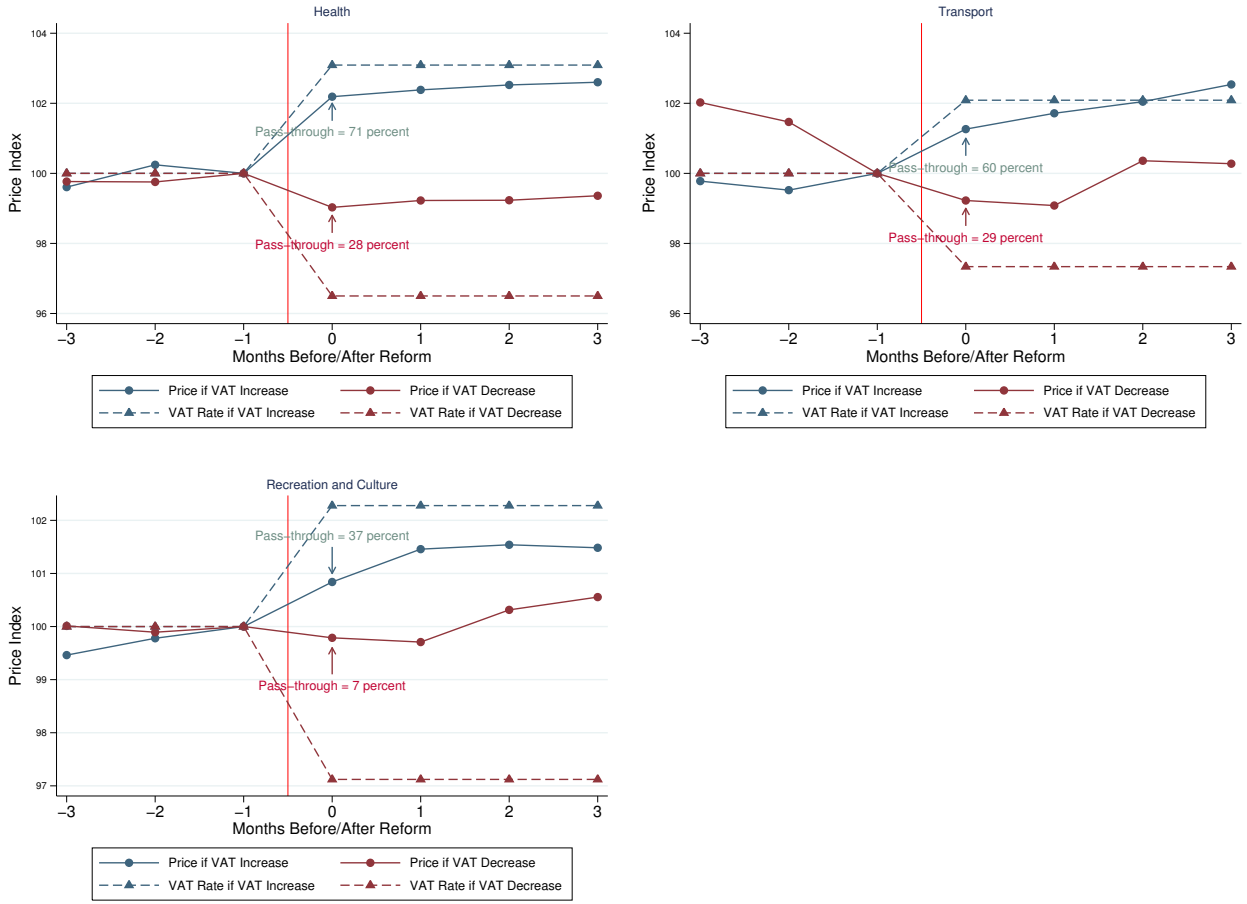
Notes: This Figure shows the response of gasoline prices (COICOP category 04.5.2) to VAT increases and decreases.

Figure B.8: Asymmetric Response of Prices to VAT Changes by 2-Digit COICOP Code in the Full Sample



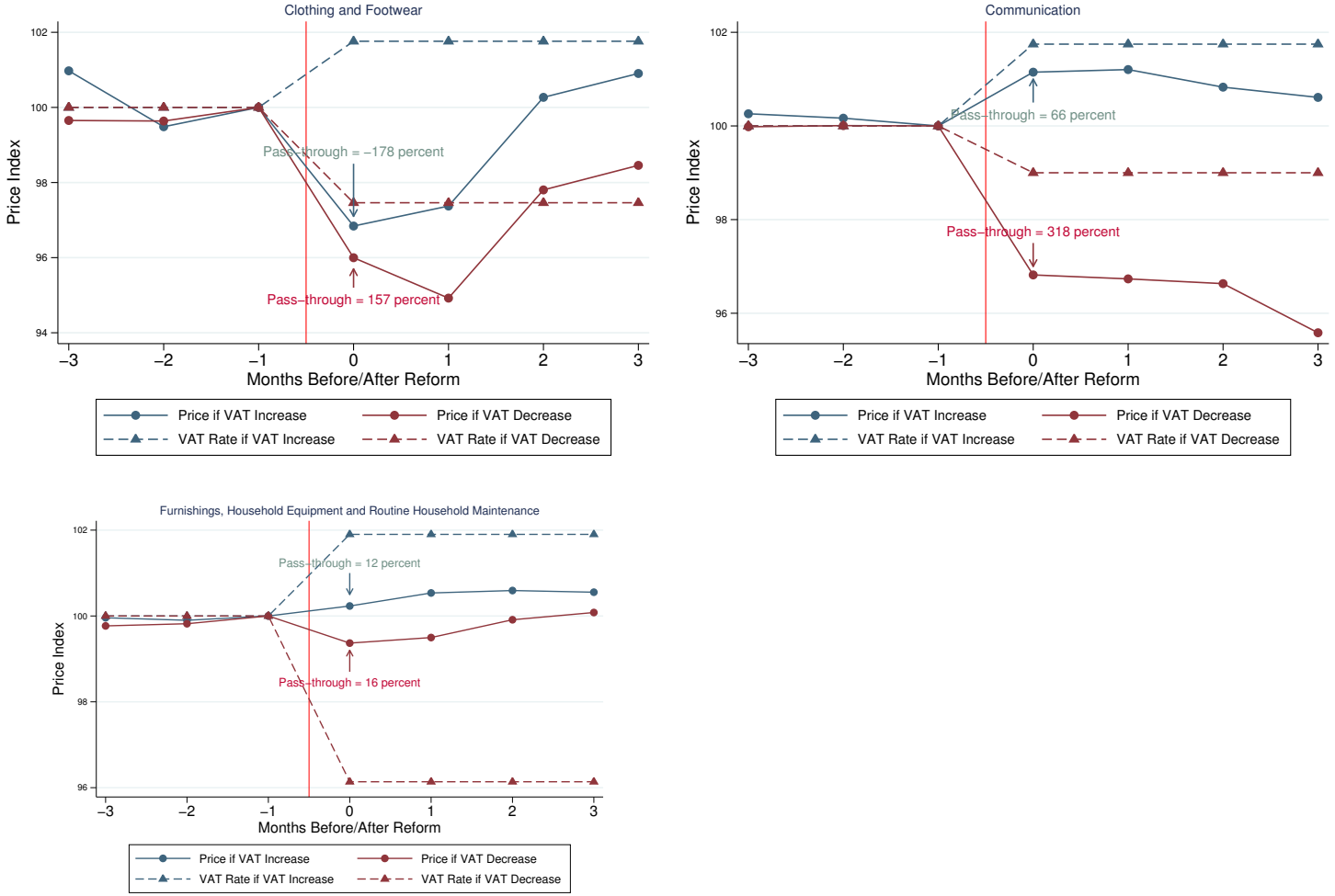
Notes: Each of these graphs are a disaggregated version of figure 1a: they plot the response of prices to variation in the VAT rate by groups of commodities.

Figure B.9: Asymmetric Response of Prices to VAT Changes by 2-Digit COICOP Code in the Full Sample



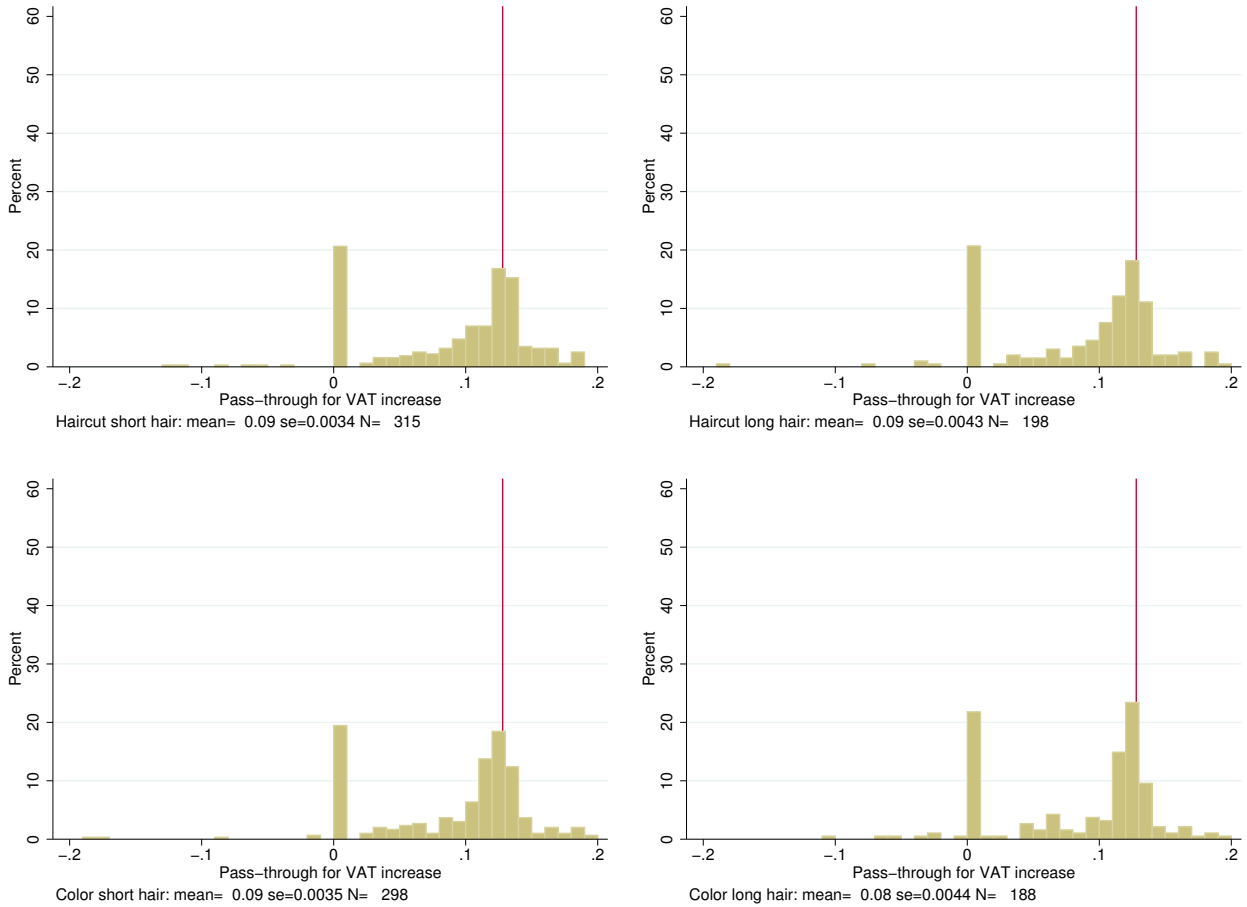
Notes: Each of these graphs are a disaggregated version of figure 1a: they plot the response of prices to variation in the VAT by groups of commodities.

Figure B.10: Commodities With No Asymmetry



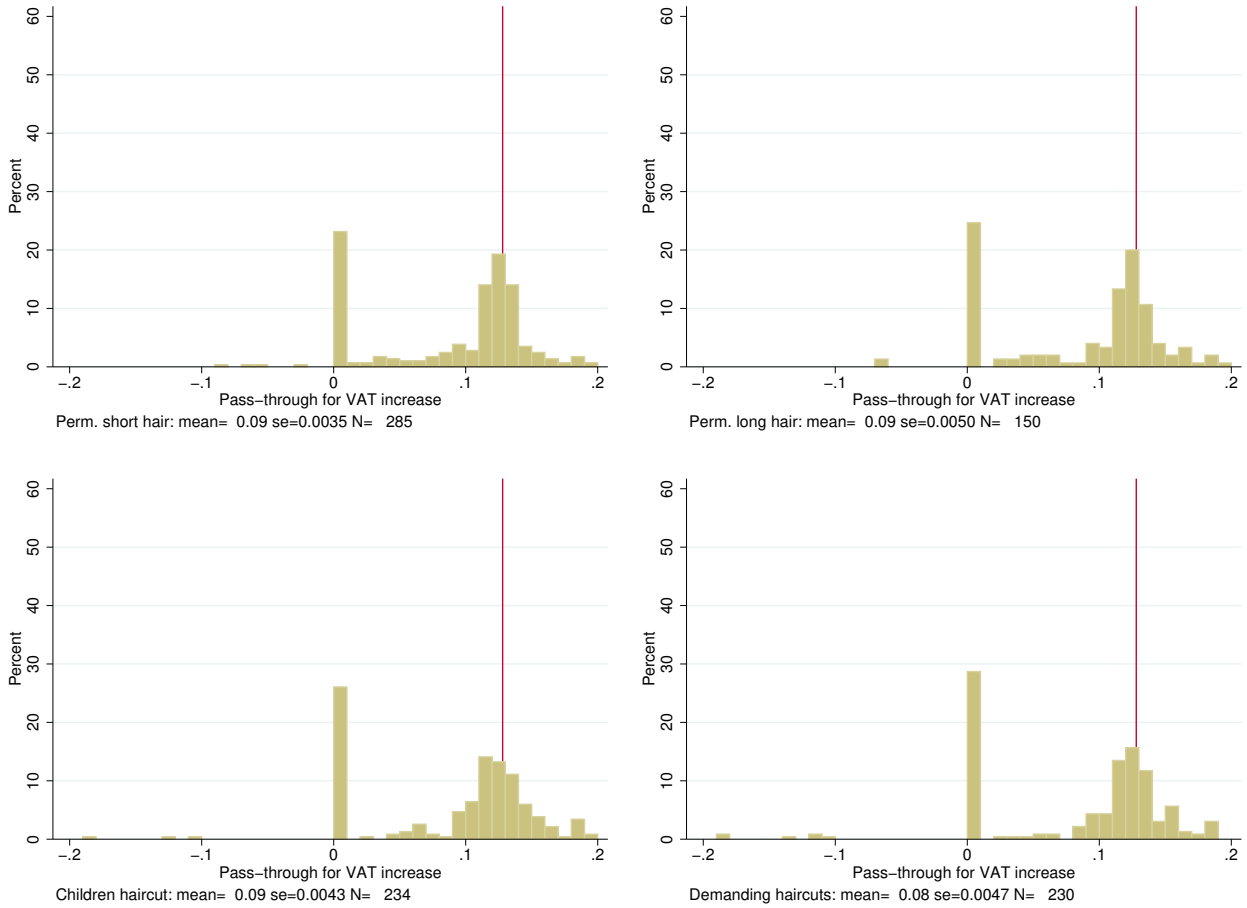
Notes: Each of these graphs are a disaggregated version of figure 1a: they plot the response of prices to variation in the VAT by groups of commodities. This panel shows the commodities for which there is no asymmetry. Clothing and Footwear shows a price decrease for both VAT increases and decreases consistent with sales occurring at the same time as VAT reforms (mostly in January), it is excluded from our main specification. Communication and Furnishings, Household equipment etc. are included in our main specification.

Figure B.11: Pass-Through Distribution By Good: VAT Increase



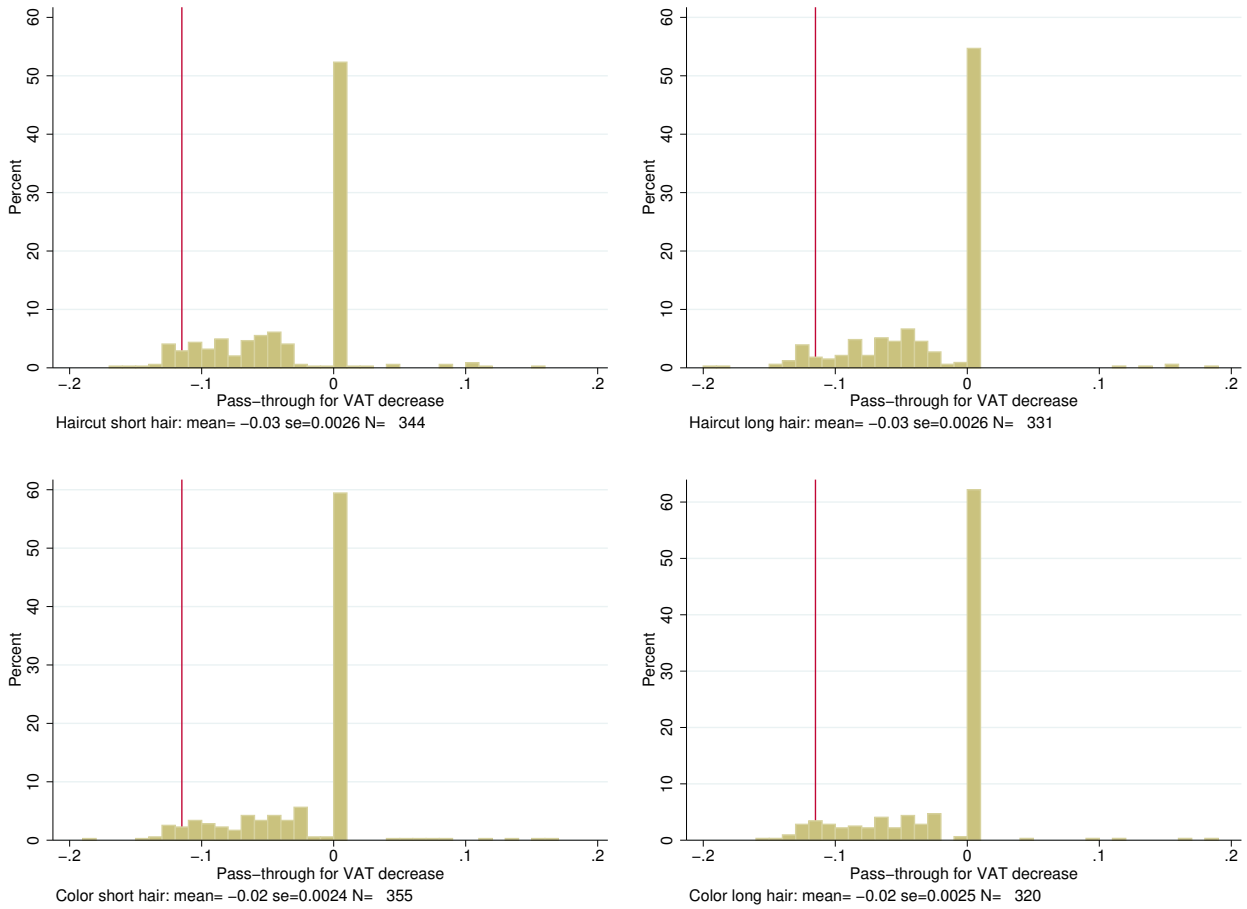
Notes: These Figures are a disaggregated version of Figure 3. Each Figure plots the distribution of pass-through following a VAT increase for each service offered by hairdressers.

Figure B.12: Pass-Through Distribution By Good: VAT Increase



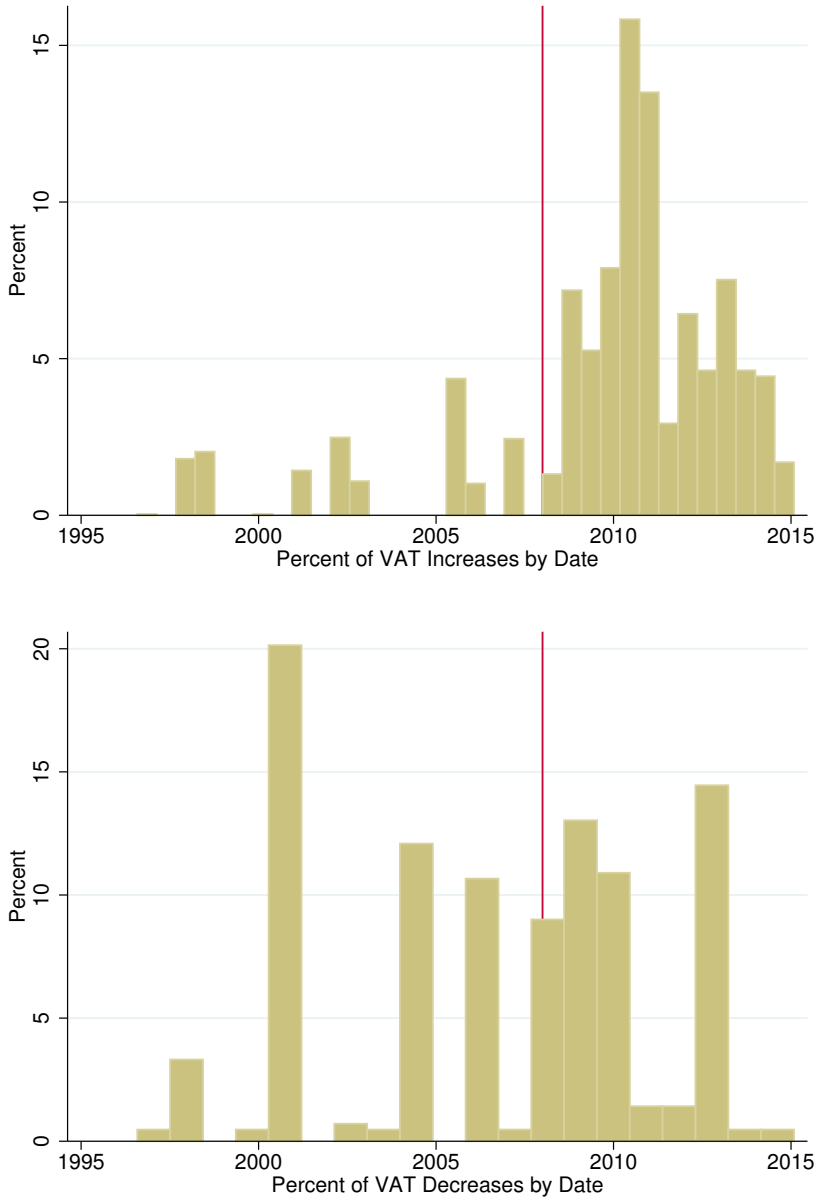
Notes: These Figures are a disaggregated version of Figure 3. Each Figure plots the distribution of pass-through following a VAT increase for each service offered by hairdressers.

Figure B.13: Pass-Through Distribution By Good: VAT Decrease



Notes: These Figures are a disaggregated version of Figure 3. Each Figure plots the distribution of pass-through following a VAT decrease for each service offered by hairdressers.

Figure B.14: Timing of VAT Increases and Decreases



Notes: These Figures plot the distribution of VAT increases and decreases by month.

Table B.6: COICOP Codes

COICOP Codes	Description
01	**Food and Non-Alcoholic Beverages**
01.1	Food
01.2	Non-Alcoholic Beverages
02	**Alcoholic Beverages, Tobacco and Narcotics**
02.1	Alcoholic Beverages
02.2	Tobacco
02.3	Narcotics
03	**Clothing and Footwear**
03.1	Clothing
03.2	Footwear
04	**Housing, Water, Electricity, Gas and Other Fuels**
04.1	Actual Rentals For Housing
04.2	Imputed Rentals For Housing
04.3	Maintenance and Repair of the Dwelling
04.4	Water Supply and Misc Services Relating to the Dwelling
04.5	Electricity, Gas and Other Fuels
05	**Furnishings, Household Equipment and Routine Household Maintenance**
05.1	Furniture and Furnishings, Carpets and Other Floor Coverings
05.2	Household Textiles
05.3	Household Appliances
05.4	Glassware, Tableware and Household Utensils
05.5	Tools and Equipment for House and Garden
05.6	Goods and Services for Routine Household Maintenance
06	**Health**
06.1	Medical Products, Appliances and Equipment
06.2	Outpatient Services
06.3	Hospital Services
07	**Transport**
07.1	Purchase of Vehicles
07.2	Operation of Personal Transport Equipment
07.3	Transport Services

Notes: This Table reports the COICOP codes used to aggregate prices as well as their description.

Table B.7: COICOP Codes (continued)

COICOP Code	Description
08	**Communication**
08.1	Postal Services
08.2	Telephone and Telefax Equipment
08.3	Telephone and Telefax Services
09	**Recreation and Culture**
09.1	Audio-Visual, Photographic and Information Processing Equipment
09.2	Other Major Durables For Recreation and Culture
09.3	Other Recreational Items and Equipment, Gardens and Pets
09.4	Recreational and Cultural Services
09.5	Newspapers, Books and Stationery
09.6	Package Holidays
10	**Education**
10.1	Pre-Primary and Primary Education
10.2	Secondary Education
10.3	Post-Secondary Non-Tertiary Education
10.4	Tertiary Education
10.5	Education Not Definable By Level
11	**Restaurants and Hotels**
11.1	Catering Services
11.2	Accommodation Services
12	**Misc. Goods and Services**
12.1	Personal Care
12.2	Prostitution
12.3	Personal Effects
12.4	Social Protection
12.5	Insurance
12.6	Financial Services
12.7	Other Services

Notes: This Table reports the COICOP codes used by Eurostat to describe price categories.

Table B.8: Examples of 4 digit COICOP Codes

COICOP Code	Description
01.1.1	Bread and Cereals
01.1.2	Meat
01.1.3	Fish and Seafood
01.1.4	Milk, Cheese and Eggs
01.1.5	Oils and Fats
01.1.6	Fruit
01.1.7	Vegetables
01.1.8	Sugar, Jam, Honey, Chocolate and Confectionary
01.1.9	Food Products
01.1.10	Bread and Cereals

Notes: This Table reports the detailed Food category for each 4 digit COICOP code.

Table B.9: 2SLS Pass Through Estimates For Restricted Sample

IV	VAT Increase			VAT Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.36***	0.36***	0.36***	-0.11	0.0069	0.0047
	(0.083)	(0.083)	(0.082)	(0.22)	(0.14)	(0.14)
Treat	0.0098**	0.011**	0.011**	-0.011***	0.00061	0.00041
	(0.0039)	(0.0057)	(0.0054)	(0.0038)	(0.0083)	(0.0084)
After	0.00094	-0.00019	0.016*	-0.0100**	0.030*	-0.031
	(0.0021)	(0.0099)	(0.0090)	(0.0043)	(0.017)	(0.023)
log(EA19 Price)	1.01***	0.95***	0.95***	1.00***	0.72***	0.72***
	(0.17)	(0.23)	(0.22)	(0.16)	(0.23)	(0.23)
R^2	0.40	0.50	0.59	0.48	0.63	0.63
Observations	10024	10024	10024	4676	4676	4676
First Stage F-Stat	422.3	417.1	418.6	190.1	184.2	183.6
Time FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	No	Yes	No	No	Yes

Notes: The coefficients reported in the Table indicate the pass-through of the VAT to prices estimated using specification (3) on the restricted sample (i.e. commodities that experience both a VAT increase and decrease over the time period we consider). EA19 price is computed by a weighted average of prices for the same commodity in other EA19 country. Standard errors are clustered by COICOP. * p<0.10, ** p<0.05, *** p<0.01