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 (VATs). First, using all VAT reforms from 1996 to 2015 across all European countries we show that prices respond 3 to 4 times more to VAT increases than decreases. Second, using a plausibly exogenous VAT reform, we show that the asymmetry persists over several years. Third, we document several empirical features of this asymmetry that are inconsistent with the standard incidence model. We provide evidence consistent with firm behavior driving the asymmetry.

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Value-Added Taxes (VATs) affect a large share of the world's economies: all member countries of the Organization for Economic Co-operation and Development (OECD), except for the United States, have adopted some form of VAT.[1] In the European Union (EU), VATs raise 30% of total tax revenue or 12% of GDP, which amounts to the largest source of government revenue. U.S. politicians and think tanks have often mentioned using the VAT as a national sales tax or as a replacement for the corporate tax.[2] During the 2016 US presidential election, two Republican candidates proposed adopting a VAT.[3] It was also recently considered as a possible source of funding for health care costs by the Obama administration.[4] 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 VATs by empirically showing that there is a consistently higher pass-through to prices for tax increases than for tax decreases. Using all VAT reforms from 1996 to 2015 across all EU countries – which amounts to 2,832 commodity-specific changes – we find that prices respond 3 to 4 times more to VAT increases than VAT decreases.

We address several potential concerns including the fact that VAT changes may be correlated with underlying economic conditions. This could result in VAT hikes occurring during periods when prices are elastic and VAT cuts when prices are inelastic. To mitigate this concern, 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 reforms that are plausibly exogenous to underlying economic conditions, 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 Finnish hairdressing services in January 2007 and a subsequent 14 percentage

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

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

[3] Senators Ted Cruz of Texas and Rand Paul of Kentucky.

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

point increase in the same sector in January 2012.[5] 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. Using micro price and corporate tax data, we compare hairdressing services to a control group consisting of beauty salons – which were unaffected by the VAT changes – and find four main results.

First, we confirm our finding of asymmetric pass-through: on average prices respond substantially more to the 14 p.p. VAT increase than to the 14 p.p. VAT decrease. This further mitigates our concern that the asymmetry is driven by business cycles. Second, we find that prices respond immediately to both VAT increases and decreases and do not exhibit any evidence of convergence towards symmetry even 3.5 years after the VAT rate is adjusted. Third, we uncover an additional layer of asymmetry: the underlying distribution of price changes for the VAT increase is substantially different from that of the VAT decrease. Following the VAT 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 approximately 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. Importantly, these distributional results are difficult to reconcile with predictions from standard incidence theory. Fourth, we find that the asymmetry mostly benefits firm owners and is paid for by consumers. Both firm profits and markups increase following the VAT decrease. However, they decrease by half as much following the VAT increase and remain higher than their pre-reform level relative to the control group. This implies that during the VAT cut period, the government is transferring money to firms and consumers through lower VAT rates, but when the VAT cut is repealed, as profits and markups are higher than the pre-VAT cut levels, consumers are now paying for these higher profits through higher prices. Overall, this suggests that the market equilibrium depends on the history of tax changes. We provide evidence that this persistent asymmetry is not specific to Finnish hairdressers but exists in other

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

sectors and countries.

What explains the asymmetry? In the short run, we show that if adjusting prices upwards is more costly than adjusting them downwards – possibly because firms are concerned about losing customers – then posted prices will tend to be lower than optimal prices. When VAT changes occur, firms pass through both the VAT change and the difference between posted prices and optimal prices, which tends to be positive, leading to larger pass-through for VAT increases than decreases. We simulate this model and show that it quantitatively matches the empirical patterns described above. This explanation also predicts that firms with eroded profit margins are more likely to behave asymmetrically, which is supported by empirical evidence we gather using the Finnish hairdressing reforms and corporate tax data. In the long run, we provide evidence of limited firm entry and price competition, which could explain the absence of convergence of prices towards symmetry. Finally, we show that our findings are inconsistent with any explanation that would simply assume different demand and supply elasticities for VAT increases and decreases such as explanations based on convex demand/supply curves, capacity constraints and collusion.

The findings of this paper are important for four main reasons. First, although the VAT is one of the most important taxes, there is limited work analyzing it.[6] This paper contributes to our understanding of its effect on the economy along with other papers such as Feldstein and Krugman (1990), Hines and Desai (2005), Slemrod (2011), Naritomi (2013), Benedek et al. (2015), Benzarti and Carloni (2015), Kosonen (2015) and Pomeranz (2015).[7] Second, 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

[6] A Proquest search of the expression "Value-Added Tax" returns 17,979 scholarly peer-reviewed articles while "Income Tax" returns 140,408 such articles.

[7] Notably, Benedek et al. (2015) estimate the pass-through of VATs 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 VATs. There are also some significant differences in the two approaches as we consider a larger set of commodities, countries and years.

for when defining tax incidence. Third, 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. Fourth, given that prices adjust upwards but not downwards, using temporary VAT cuts to stimulate demand may have the opposite effect, resulting in a higher equilibrium price once the VAT cut is repealed and mostly benefiting firm owners at the expense of consumers.

This paper also 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), Kopczuk et al. (2016) and Tazhitdinova (2016). More broadly, it is related to a literature in Public Finance that estimates the incidence of various taxes.[8] Our paper is the first to provide systematic evidence on the asymmetric pass-through of 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 EU 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

[8] Kotlikoff and Summers (1987) and Fullerton and Metcalf (2002) provide a survey of the tax incidence literature.

[9] The published version is in French: see the working paper version (Carbonnier (2005)) for an 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.

moratorium on a 5% gasoline tax in 2000.[11] Two possible reasons could explain the symmetric response found 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 of soaring gasoline prices 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.

Our findings are also related to a literature in industrial organization that tests for 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 for 1 month in Borenstein et al. (1997) and 3 to 5 months in Peltzman (2000). Instead, we observe that prices respond immediately to VAT cuts and find no evidence of convergence 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 is likely to affect fast food restaurants more than Michelin star restaurants. Conversely, changes in VATs affect all restaurants similarly, as taxes are a percentage of the final price. Second, variation in VAT rates is 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 consumer uncertainty over current and future levels of input costs. This has also led this literature to 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 notes 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

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

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

be some of the reasons that tax incidence analysis in the public finance literature seldom considers the possibility of asymmetric pass-through of taxes in spite of the evidence gathered in the industrial organization literature.

This paper is also related to a literature in macroeconomics that analyzes the responses of prices to various economic shocks.[13] In particular, Ball and Mankiw (1994) and Karadi and Reiff (2016) use a menu cost model with trend inflation to predict downward price rigidity. Karadi and Reiff (2016) estimate this model using two 5 percentage point VAT changes in the processed food sector in Hungary. While our empirical results show that VAT pass-through is asymmetric for both small and large VAT changes, their model only predicts asymmetry for large shocks.

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 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 for the results. Section 6 concludes and offers policy implications.

1 Data and Institutional Background

1.1 Institutional Background

The VAT applies to the value added of goods and services sold and is included in consumer prices in the EU. Firms remit the VAT they collect from consumers to the government and claim credits for the VAT they pay 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.

Member countries of the EU generally have several VAT rates in place, including a standard rate that applies to the majority of commodities and a reduced rate for basic necessities such as food, heating and passenger transport, while

[13] See, for example, Nakamura and Steinsson (2008).

some commodities are tax exempt and others zero-rated.[14]

1.2 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.[15]

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.[16] Eurostat first collects the data from surveys conducted separately by each member country of the EU. Then, Eurostat constructs price series, which are harmonized to account for country-specific sampling procedures.[17] These data represent the single most reliable source of information on inflation across countries in the EU.

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 VATs.

Because the reports only contain information on current members of the EU, the dataset starts in 2004 for the Czech Republic, Cyprus, Estonia, Latvia, Lithuania, Hungary, Malta, Slovenia and Slovakia and in 2007 for Bulgaria and Romania. We exclude Croatia because it only became a member of the EU in 2013. The EC reports are missing information on some labor-intensive commodi-

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

[15] Eurostat is an organization of the European Commission responsible for collecting and harmonizing data to provide statistical information about Member States of the EU.

[16] Appendix Tables A.5 and A.6 list all the COICOP categories used in our analysis.

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

ties for some countries in the period 1996-1999.[18] We exclude them from our analysis when the data are 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. However, 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 would lead to some attenuation bias for both VAT increases and decreases, but should not affect the asymmetry. Third, the EC documents are only published once per 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 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.[19]

We perform our analysis on the full sample of reforms, which is composed of

[18] 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.

[19] See Panel a. of appendix Figure A.14.

all commodities that experience either an increase or a decrease in the VAT rate between 1996 and 2015.[20] This corresponds to 2,832 commodity-specific VAT changes spanning 48 commodities across 22 countries. 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.

2 Asymmetric Pass-Through

2.1 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.[21]

Figure 1a plots the un-weighted average price of all commodities considered in the *full sample* for VAT increases and decreases separately and the average VAT changes. It shows that prices increase discontinuously in the month following a VAT increase but do not decrease as much when VATs decrease.[22] 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 in pass-through is 318% – and Furnishings, Household Equipment and Routine Household Maintenance (COICOP group number 5) – for which pass-through is small for both

[20] Table 1 provides summary statistics on the reforms we consider.

[21] 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 one another 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.

[22] Figure 1b shows comparable evidence for the *restricted sample*, in which we only include commodities that experience both a VAT increase and decrease over time.

VAT increases and decreases.[23] We also find similar levels of asymmetry for commodities subject to the standard VAT rate (Figure 1c) and the reduced VAT rate (Figure 1d).

2.2 Empirical Approach

To estimate the pass-through to prices of VAT increases and decreases, we follow the approach of Evans et al. (1999), who estimate the pass-through of cigarette taxes using different tax changes across US states over time. We run the following fixed effect regression:

$$\Delta \log(p_{ict}) = \beta_0 \Delta \log(1+\tau_{ict}) + \sum_{k=-10, k\neq 0}^{k=10} \beta_k \Delta \log(1+\tau_{ic(t+k)}) + \Delta\lambda_t + \gamma \Delta X_{ct} + \epsilon_{ict} \quad (1)$$

where i denotes the commodity, c the country and t the month in which the price is observed, λ_t time fixed effects, p_{ict} the price, τ_{ict} the tax rate and ϵ_{ict} the error term. We control for a given country's nominal interest rate and unemployment rate with X_{ct}. For each of $x_t = \{\log(p_{ict}), \log(1+\tau_{ict}), \lambda_t, X_{ct}\}$, Δx_t is equal to $x_t - x_{t-1}$.

In equation (1), $\beta_0 \in [0,1]$ identifies the pass-through of a VAT change in the month when the change occurs: for example, if $\beta_0 = 0$, then the price does not respond to a VAT change, and if $\beta_0 = 1$, the price responds one to one to a VAT change. The second term of the equation estimates any forward- or backward-looking responses of prices to changes in VAT rates, β_{-5}, for example, estimates the response of prices at time t to VAT changes that will occur at time $t+5$.

The fixed effect regression generalizes a difference-in-differences regression with multiple periods, commodities and countries, and its main identification assumption is the same as that for difference-in-differences regressions: absent the tax change, there would have been no change in the prices of the treated relative to the un-treated commodities. Figure 1a shows a sharp change in prices at the time of the reform, which supports this identification assumption. The identification is obtained from within-country-specific commodity variation in VAT

[23] The disaggregated series for these groups are plotted in appendix Figures A.12, A.13 and A.14.

rates over time.

The results of the fixed effect regression are reported in Table 2. Columns (1) and (2) of Table 2 correspond to VAT increases and decreases respectively. The first row of each regression (labeled β_0) corresponds to the pass-through of the VAT change to prices one month after the reform; it takes values between 0 and 1 and is equal to 0 for 0% pass-through and 1 for 100% pass-through. β_{+i} corresponds to the response of prices to VAT changes i months after the reform took place, while β_{-i} corresponds to the response of prices i months before the reform took place. Figure 3 plots the coefficients from the fixed effect regression and shows that the pass-through to prices of VAT increases is equal to 33% while that of VAT decreases is equal to 6.3% one month after the reform, and both are statistically significant. There are no significant price changes in any months within a 10-month window around the VAT increases and decreases.[24]

2.3 Endogeneity Concerns

While we are confident that a significant share of the VAT changes we analyze 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 exclude the possibility that some tax changes are not. This raises three possible concerns that are addressed below.

The first concern is that VAT reforms and economic conditions could change in precisely 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 rates 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 in July 2009. For this reason, it is unlikely that governments have the ability to precisely time

[24] We also run specification (1) on the restricted sample of reforms (commodities that experience both a VAT increase and decrease) and find similar results. See Table 3.

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 that is also present during non-reform times and can be reasonably attributed to inflation. Inflation is unlikely to cause large upward biases because it is small relative to the VAT changes that we consider. Prices increase by approximately 0.1 to 0.2 percentage points per month because of inflation, whereas the VAT changes we consider are much larger: on average 2 percentage points for VAT increases and 3 percentage points for VAT decreases. In addition, this upward trend in prices does not appear to be significant anymore once we control for additional factors using the fixed effect specification (1) as shown in Figure 3 and Table 2.

A third concern is that tax increases could occur 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 occur 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 three ways. First, if VAT increases and decreases occur during different economic times and are correlated across countries, then adding time and country fixed effects would affect the pass-through coefficient. These are included in our main specification (1).[25] 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 equation (1) on each sample. The pass-through results are reported in Table 3.[26] The asymmetry is present in both subsamples: the pass-through for VAT increases is 34% in periods of high growth and 48% in periods of low growth; the pass-through for VAT decreases is

[25]Country fixed effects are implicitly included in equation (1): since we regress differences in log prices on differences in log tax rates, any country fixed effects would be differenced out and therefore accounted for.

[26]We also report the full regression in appendix Tables A.9 and A.10.

6.9% in periods of high growth and 2.4% in periods of low growth. Figures 2a and 2b graphically show similar levels of asymmetry using unconditional means on the same subsamples. Third, we consider plausibly exogenous VAT changes in section 3 and find that the pass-through is also asymmetric.

2.4 Heterogeneity Analysis

Reform Size: In standard incidence theory, the size of VAT changes is irrelevant. However, it can be relevant 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 (1) on above- and below-median VAT changes and compare VAT increases to decreases. The results are reported in Table 3 and Figures 2c and 2d: although the pass-through is larger for both increases and decreases we find that it is still asymmetric.

Standard and Reduced VAT Rates: 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. Changes in the standard rate are often more salient and more likely to generate general equilibrium effects as they affect most commodities in the economy. If we believe that salience or general equilibrium effects generate some of the asymmetry, we should observe less asymmetric pass-through for standard rate changes. Figures 1c and 1d show that the asymmetry is similar in both cases. And Table 3 reports a pass-through for VAT increases of 39% for the standard VAT rate and 27% for the reduced VAT rate. For VAT decreases, the pass-through is 11% for the standard VAT rate and 1.7% for the reduced VAT rate.

3 Finnish Hairdressing Services Case Study

In this section, we focus on two plausibly exogenous reforms and use micro price and corporate tax data to further our understanding of how prices, markups and profits 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.

3.1 Data and Institutional Background of the Reforms

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 VATs on prices and employment.[27] 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 European Commission (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. Finland took part in the second wave of the experimentation program which was set to start in January 2007 (Council directive 2006/112/EC) and agreed prior to January 2007 to revert the rate to its original level in January 2012. This resulted in a reduction in the VAT rate on hairdressing services from 22% to 8% in January 2007 and a subsequent increase from 9% to 23%.[28] 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 mitigates concerns of the asymmetry being driven by large monopoly or monopsony power. Second, there is nothing particular about the hairdressing sector in Finland 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 bar-

[27] See European Commission (1999), European Commission (2006) and a summary in Kosonen (2015) for more detailed institutional background.

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

riers to entry. Similarly, the sector does not benefit from any particular status relative to other sectors in the Finnish economy.[29]

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's haircuts, complicated haircuts, short hair permanent waves (perms), long hair permanent waves, short hair coloring, long hair coloring and complicated coloring. The prices collected are the "menu" prices rather than transaction prices but we also have information on whether coupons or discounts are offered in each particular location. 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.

We supplement the price data with corporate tax data covering the entire population of firms in Finland. The data are annual and contain information on every line of profits and losses, thus allowing us to observe turnover, fixed and variable costs separately and the number of employees. Table 4 shows summary statistics for hairdressers and beauty salons.

3.2 Results

3.2.1 Response Timing and Long Term Asymmetry

Figure 4 uses time series from Statistics Finland from January 2005 to November 2015 to show the evolution of hairdressing prices and beauty salon prices. Prior to the January 2007 reform, the VAT rate for hairdressing services and beauty salons were the same. In January 2007, the VAT was decreased by 14 percentage points for hairdressing services and held fixed for beauty salons. In January 2012, the VAT rate for hairdressing services was 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-year period. Second, the largest response of hairdressing prices is observed during the first

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

month for both the VAT decrease and increase, thus contradicting explanations based on adjustment frictions due, for example, to capacity constraints. Third, after the VAT rate for hairdressing services was returned to the same level as that for beauty salons, hairdressing prices remained higher than beauty salon prices without any signs of convergence. This suggests that the asymmetric responses of prices to VAT rates persist over the medium run – in this case, after 3.5 years.

3.2.2 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 6a and 6c plot the distribution of ρ_i for the VAT decrease and increase, respectively, for all nine types of services combined. The distribution of pass-through for the VAT decrease is uni-modal: 61% 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: 27% of prices do not respond to the VAT increase, while 48% of prices increase by 80% to 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 the VAT increase and uni-modal distribution following the VAT decrease for each of the nine services being offered by hairdressers.[30] 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 are bi-modal, which suggests 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 6a and 6c. This finding 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. We return to

[30] See appendix Figures A.15, A.16, A.17 and A.18.

this in section 4 and show that it is likely to be driven by firms having different profit margins.

3.2.3 Asymmetric Response of Profits

Using the administrative corporate tax data on the full population of hairdressers and beauty salons, we investigate the response of profits and markups to VAT changes. We observe turnover, profits and variable and fixed costs, among other variables. As a proxy for markup, we use turnover minus variable cost divided by variable cost. This proxy is accurate as long as marginal cost is constant, which seems reasonable for hairdressers. In addition, we compare changes in the markup proxy with changes in prices using the subset of firms for which prices were collected and find that they are reasonably correlated.[31]

Figure 7a plots the coefficients from a regression of log profits on year dummies from 2000 to 2014 for hairdressers and beauty salons.[32] The graph shows that profits respond asymmetrically to VAT changes: VAT decreases result in an increase in profits of 0.2 log points, while VAT increases lead to a profit decrease of 0.1 log points. Figure 7b shows a similar graph for our markup proxy: markups increase by twice as much following the VAT decrease than they decrease following the VAT increase. And we observe no evidence of convergence of profits or markups towards symmetry 3 years after the VAT is reverted to its original level. Finally, in Figure 7c we observe no significant changes in variable costs following the VAT changes, thus suggesting that quantities are not substantially affected. These observations are consistent with firms using VAT cuts to increase profits while passing through VAT increases to prices to minimize their impacts on profits. In the next section, we investigate potential mechanisms underlying this behavior.

[31] See appendix Figure A.22.

[32] We exclude firms with less than €10,000 in turnover or €1,000 in profits to exclude small firms that are exempt from remitting the VAT.

4 Mechanisms

4.1 Main Empirical Patterns

In this section, we discuss the main stylized facts that a model would need to match and consider explanations for our empirical findings. To simplify exposition, we refer to *distributional* asymmetry as asymmetries in the underlying price distribution (documented in section 3.2.2 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* asymmetric 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 to long run.

4.2 Upward Price Rigidity and Consumer Antagonism

We build a simple model that explains the empirical findings above. The model relies on the following assumption: firms face a positive cost C of increasing prices but no cost of decreasing them.[33] As a consequence, firms fail to adjust prices upwards when faced with a cost shock smaller than C.

Firms incur a positive cost of increasing prices because such action can trigger consumer antagonism and can eventually negatively affect revenue. Shiller (1997) for example, reports that 86% of survey subjects respond "Yes" to the following question: "When you go to the store and see that prices are higher, do you sometimes feel a little angry at someone?". Okun (1981) argues that firms might

[33]The results carry through if we instead assume that the cost of increasing prices is greater than that of decreasing them.

respond to fairness considerations when setting prices because of the risk of losing some of their loyal customers, which threatens future profits. Blinder et al. (1998) provides evidence for this argument by interviewing managers at more than 11,000 firms and notes that "firms tacitly agree to stabilize prices, perhaps out of fairness to customers".[34]

We denote by p^{i*} the target price of a given firm i and by p^i its posted price. Every period, firms face a shock θ_t to their optimal price. At any given time t, firm i's price dynamics are determined by the following equations:

$$p_t^i = \begin{cases} p_{t-1}^i + \Theta_{t-1}^i + \theta_t & \text{if } \Theta_{t-1}^i + \theta_t \leq 0, \\ p_{t-1}^i & \text{if } 0 \leq \Theta_{t-1}^i + \theta_t < C^i, \\ p_{t-1}^i + \Theta_{t-1}^i + \theta_t & \text{if } C^i \leq \Theta_t^i + \theta_t, \end{cases} \tag{2}$$

where $\Theta_{t-1}^i = p_{t-1}^{i*} - p_{t-1}^i$ is the stock of shocks θ that were not passed through to price in previous periods and C^i is the cost of adjusting prices upwards for firm i. The firm passes through $\Theta_{t-1}^i + \theta_t$ if this quantity is negative because it bears no cost of adjusting prices downwards. If this quantity is positive but smaller than its adjustment cost C^i, it keeps prices fixed. It does so until this quantity becomes greater than C^i, at which point the difference between the posted and optimal price is too large and it becomes optimal to pass through $\Theta_{t-1}^i + \theta_t$.

Assume that firm i enters period t with $\Theta_t^i > 0$ and that the VAT rate increases by τ. Denote by ρ the incidence of the tax had there been no adjustment cost C and as determined by the supply (ϵ_S) and demand elasticities (ϵ_D): $\rho = \frac{\epsilon_S}{\epsilon_S - \epsilon_D}$. The firm will pass through $\Theta_t^i + \rho\tau$ when it is greater than C^i. If instead the VAT decreases by τ, the firm will pass through $\Theta_t^i - \rho\tau$ if it is smaller than zero, As a consequence, the pass-through of VAT increases and decreases is asymmetric by Θ_t^i.

To simulate the price dynamics, we use equation (2) and assume that each firm has an adjustment cost C^i, which is a random variable drawn from a given distribution F. Every period t, firms are hit by a shock θ_t, which is also a random variable drawn from a distribution G. Figure 8 shows the results of our simulation. Figure 8a shows that the pass-through of a 14 percent VAT cut is

[34] Eyster et al. (2017) discuss recent empirical evidence on customers' concerns about the fairness of prices.

significantly smaller than the pass-through of a 14 percent VAT increase.

The simulated distributions of pass-through following the VAT increase and decrease are simply given by $p_t - p_{t-1}$, where t is the time of the reforms. These distributions are plotted in Figures 8b and 8c. The simulation exhibits substantial price dispersion and distributional asymmetry following the VAT changes and roughly matches the patterns observed in Figures 6a and 6c. Overall, the simulations suggest that the model matches the three main empirical patterns outlined in section 4.1.

Two key features of the distribution of adjustment costs F are needed for the model to match the empirical patterns. First, the upper bound on the support of F needs to be sufficiently large so that the stock of shocks Θ_t is large enough when the VAT changes occur. If this upper bound is small, then firms will constantly adjust prices, which will lead to a small Θ_t and very little asymmetry. Second, there needs to be sufficient heterogeneity in adjustment costs among firms, i.e., F needs a sufficiently large variance. This ensures that there are firms with small enough adjustment costs and generates the observed inflation. The results are less sensitive to how G is specified. To generate Figure 8, we assume that F is a uniform distribution bounded by zero below and 20 above and that G is a normal distribution with mean 0.25 and standard deviation 0.1.

This model makes one key prediction which we can empirically test using the Finnish hairdressing reforms and corporate tax data: firms with low margins (i.e., high Θ_t) at the time of the VAT changes will pass through more of the VAT increase than the VAT decrease, whereas firms with high margins (low Θ_t) are more likely to behave symmetrically. We define margins as turnover minus operating costs divided by turnover, and to mitigate concerns of mean reversion, we calculate a 3-year average margin prior to each VAT change and break down our sample of hairdressers into 5 quintile groups from lowest margins to highest. Figure 9a plots the change in markup (as defined in section 3.2.3) for each quintile of margins and confirms the prediction that hairdressers in the lowest quintile take advantage of VAT cuts to increase their markups whereas firms from higher quintiles tend to behave symmetrically. These patterns are not specific to hairdressers: we find similar responses to a 9 p.p. VAT decrease for Finnish sit-down restaurants in Figure 9b. To further mitigate concerns of mean

reversion, we plot in Figure 9c a similar graph for the control group (beauty salons). We find that changes in markups are more homogenous across quintiles for the control group relative to Figures 9a and 9b.

Long-Term Persistence of the Asymmetry: Figure 4 shows that, once the VAT rate applied to Finnish hairdressers is increased back to its original level, prices remain higher than for the control group 3.5 years later in spite of the VAT rates being equal for both groups. This persistence is also present in profits and markups as shown in Figures 7a and 7b. We also provide evidence below that it exists in other markets and countries. This suggests that the market equilibrium depends on the history of tax changes. Neither our explanation above nor those outlined in section 4.3 predict long-term asymmetry. Instead, if markets operate competitively, the rent generated by the VAT changes should be reduced to zero. Our data suggest two possible failures of competition that could explain the long term asymmetry.

The first is that we observe very little entry of new firms. Standard theory predicts that firms would enter the market to capture the windfall generated by the VAT decrease or to charge lower prices following the VAT increase. This increased entry should reduce prices until they reach their competitive levels. We detect no evidence of increased entry (or exit) in the number of hairdressers following the VAT changes.[35] This is especially puzzling because the hairdressing sector is one where barriers to entry should be among the lowest in the Finnish economy. In Finland, hairdressers face no particular institutional barriers to entry (they are not required to obtain a license or special training) and startup costs are relatively low.

The second failure of competition is that firms do not appear to be strongly reacting to one another's prices. We calculate the density of hairdressers for each zipcode and generate five quintiles, the first including zipcodes with the lowest density of hairdressers and the fifth the most hairdresser-dense zipcodes. We then test whether markups are more likely to respond differently to changes in VAT in denser zipcodes because of increased competition. We find that hairdresser density does not affect the response of markups to the reforms.[36] Overall, both

[35]The results are reported in appendix Figure A.23.

[36]The results are reported in appendix Table A.15. Except for an increase in markups for

of these explanations suggest that, in contrast to what standard incidence theory usually assumes, these markets do not seem to be operating competitively.

This persistence is not a peculiarity of Finnish hairdressers, as we observe it in other sectors and countries. To provide additional evidence of this persistence in asymmetry – and because we are considering long-run horizons – we need large VAT changes and sectors where prices are relatively stable; otherwise, the VAT changes would be masked by natural variation in prices. VAT reductions that would bring the rate below 15% are restricted by the European Commission to avoid VAT competition.[37] In addition to the experimentation program described above, the European Commission approved an application to re-classify sit-down restaurants from the standard to the reduced VAT rate.[38] Both France and Finland took advantage of this new law. This led to a 14 p.p. VAT cut for French sit-down restaurants and a 9 p.p. cut for Finnish ones. While the VAT rate was not reverted to its original level, we exploit smaller increases in the reduced VAT rate: 1.5 and 3 p.p. increases in France and a 1 p.p. increase in Finland. Figures 10a and 10b show that the asymmetric pass-through persists over several years both in Finland and in France and results in prices net of taxes being relatively higher than for the control groups.

Further, we find evidence that the persistence in asymmetry holds across a wide range of commodities beyond restaurants and hairdressers. To show this, we use Hungary's standard rate VAT cut from 25% to 20% in January 2006 and increase from 20% to 25% in January 2009. Figure 10c shows the response of commodities that are subject to the standard rate in Hungary compared to a set of control countries.[39] We find that the asymmetry persists over several years after the VAT rate is returned to 20%. Because the standard VAT rate applies to a wide range of commodities, this mitigates our concern that the long-term

the most dense zipcode following the VAT decrease – which seems to be due to a decrease in costs – we find no significant effect of density on changes in markups.

[37]Member States need to submit an application to the European Commission if they want to reduce rates below 15 percent.

[38]Following a campaign promise by then French President Jacques Chirac, France applied for an authorization to re-classify sit-down restaurants from the standard to the reduced VAT rate in 2002. The application was approved for all Member States in January 2009.

[39]We included every commodity subject to the standard VAT rate with the exception of diesel and gasoline because of strong volatility. Details on the list of commodities and control group countries can be found in appendix section A.

persistence in asymmetry only exists in specific sectors.

4.3 Alternative Explanations

Standard Incidence Theory: Standard incidence theory makes a clear prediction regarding 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 for and supply of good x, respectively.

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

is the effect of a small tax increase/decrease on the 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 the VAT rate the same way. Instead, denote by ρ^i and ρ^d the pass-through for increases and decreases in the VAT rate and F_i and F_d the respective distributions of ρ^i and ρ^d. Assume that supply and demand elasticities are different for increases and decreases in the VAT rate and denote by 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.

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

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

For a decrease in the VAT, we have:

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

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 6b and 6d. Instead, we observe that the pass-through distributions are asymmetric for VAT cuts and hikes – as shown in Figures 6a and 6c – which implies that the asymmetry cannot be explained by different demand and supply elasticities and suggests a gap in standard incidence theory.

Convex Demand and/or Supply Curves: Elasticities are different along convex supply and demand functions. Locally, these differences 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 could lead to large differences in pass-through. However, this explanation is inconsistent with the evidence presented in section 2.4: Figures 2c and 2d and Table 3 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 or *distributional* 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.[40] 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. Assume that 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. By contrast, if the tax rate increase is large enough that it would increase price enough to reduce quantities produced up to the point where the capacity constraints are no longer binding, firms will be producing on the portion of the supply curve where $\epsilon_S > 0$ and

[40] See appendix Figure A.24 for a graphical illustration of this explanation.

should only bear part of the VAT rate increase. In this case, we should observe a post-tax price increase. If instead there is a tax decrease and firms are producing at the 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.

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 does not seem to fit the data. First, we should observe asymmetric pass-through for large VAT changes but not for small changes. This is inconsistent with Figures 2c and 2d and Table 3: 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, this explanation does not predict any price dispersion and therefore does not match the second empirical pattern. Fourth, it 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 doing so leads to higher profits. This could match the first and third empirical patterns: 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. This explanation is unlikely to hold in our setting for two reasons. First, collusive behavior is unlikely to be sustainable in markets with a large number of small firms. Second, if firms were colluding, we should not observe the price dispersion that we find in Figure 6.

5 Conclusion

In this paper, we show that prices respond asymmetrically to VAT changes. We use monthly price variation for the entire spectrum of commodities across European countries from 1996 to 2015 and find that prices respond systematically more to VAT increases than VAT decreases. Further, using Finnish hairdressing services as a case study, we find that pass-through distributions are also asymmetric in ways that are difficult to rationalize with standard incidence theory. We also find no evidence of convergence towards symmetry even 3.5 years after the last VAT change.

Prior to the writing of this paper, a debate was held in the French Parliament on October 30, 2012, regarding increasing the VAT rate on sit-down restaurants from 7% to 19.6% after it was decreased from 19.6% to 5.5% in July 2009 and increased from 5.5% to 7% in January 2012. Christian Eckert – who was at the time a Member of Parliament – concludes after analyzing the response of prices to each reform: "What should we do now? Given the strong price elasticity for increases, which is surprisingly much higher than the price elasticity for decreases, we cannot consider going back to [a VAT rate of] 19.6%." This highlights the political concern some have over the asymmetric responses of prices to VAT changes.

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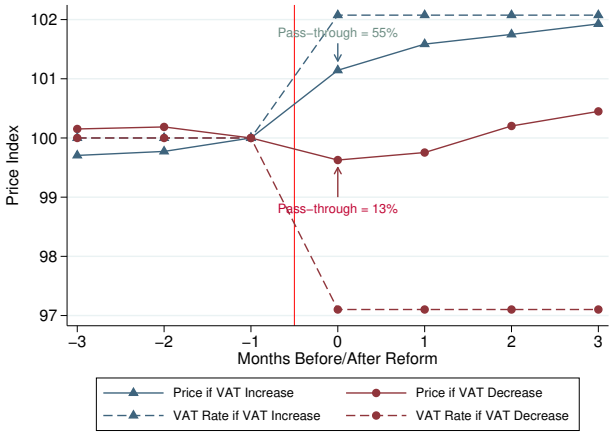
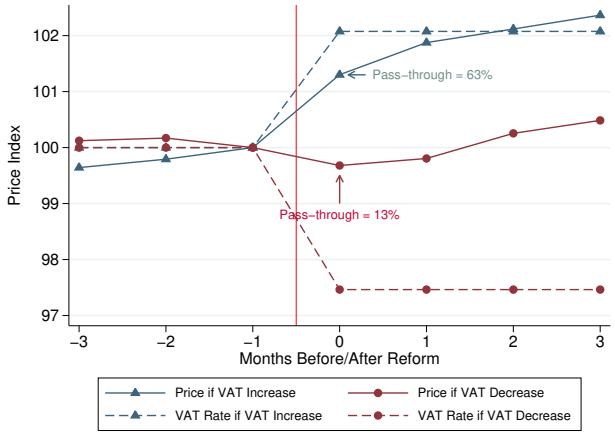
Figure 1: Asymmetric Response of Prices to VAT Changes

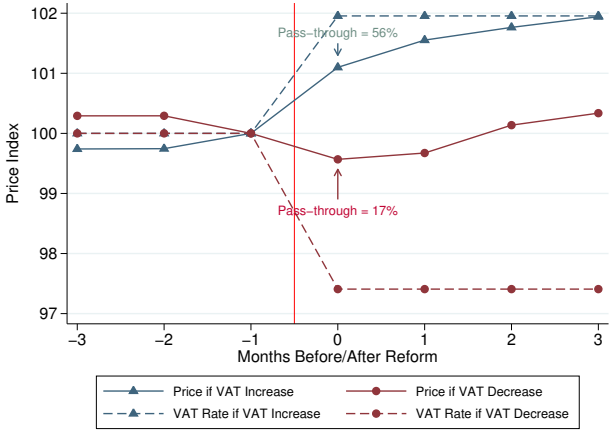
(a) Full Sample



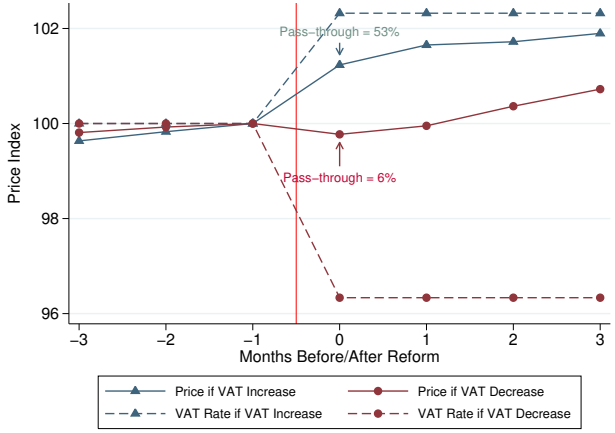
(b) Restricted Sample



(c) Standard VAT Rate



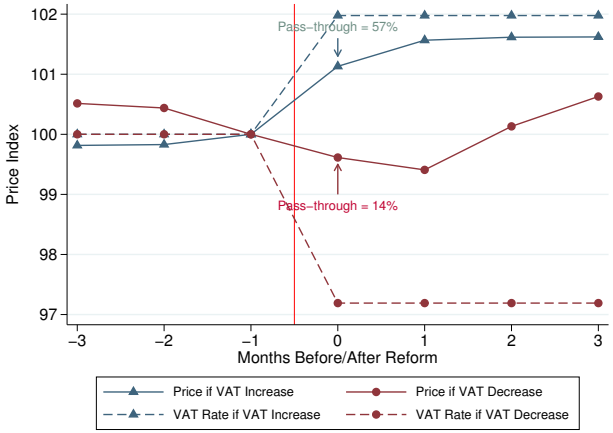
(d) Reduced VAT Rate



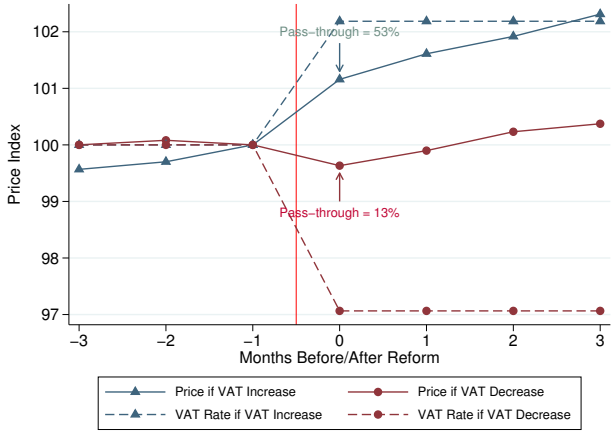
Notes: These figures plot the response of prices to VAT increases and decreases. The underlying dataset consists of 3-month window price and VAT time series around each VAT reform from 1996 to 2015. We average out and normalize each series to 100 one month before the reform. Figure 1a considers the full 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)

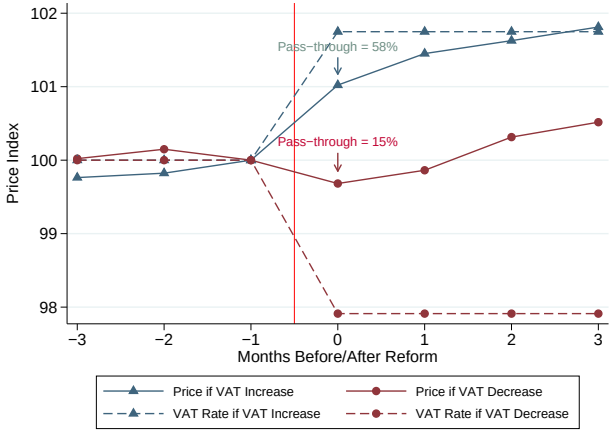
(a) Low Growth



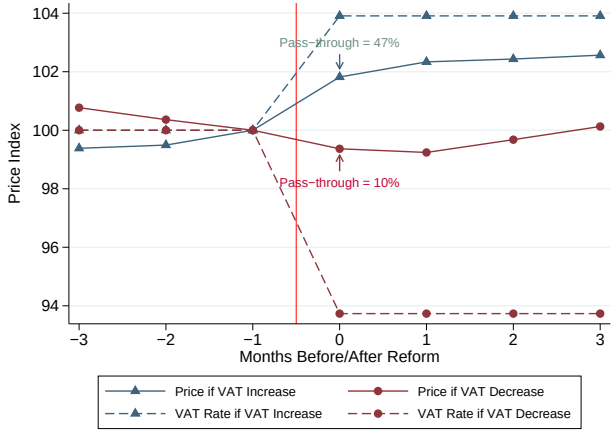
(b) High Growth



(c) Small VAT Changes

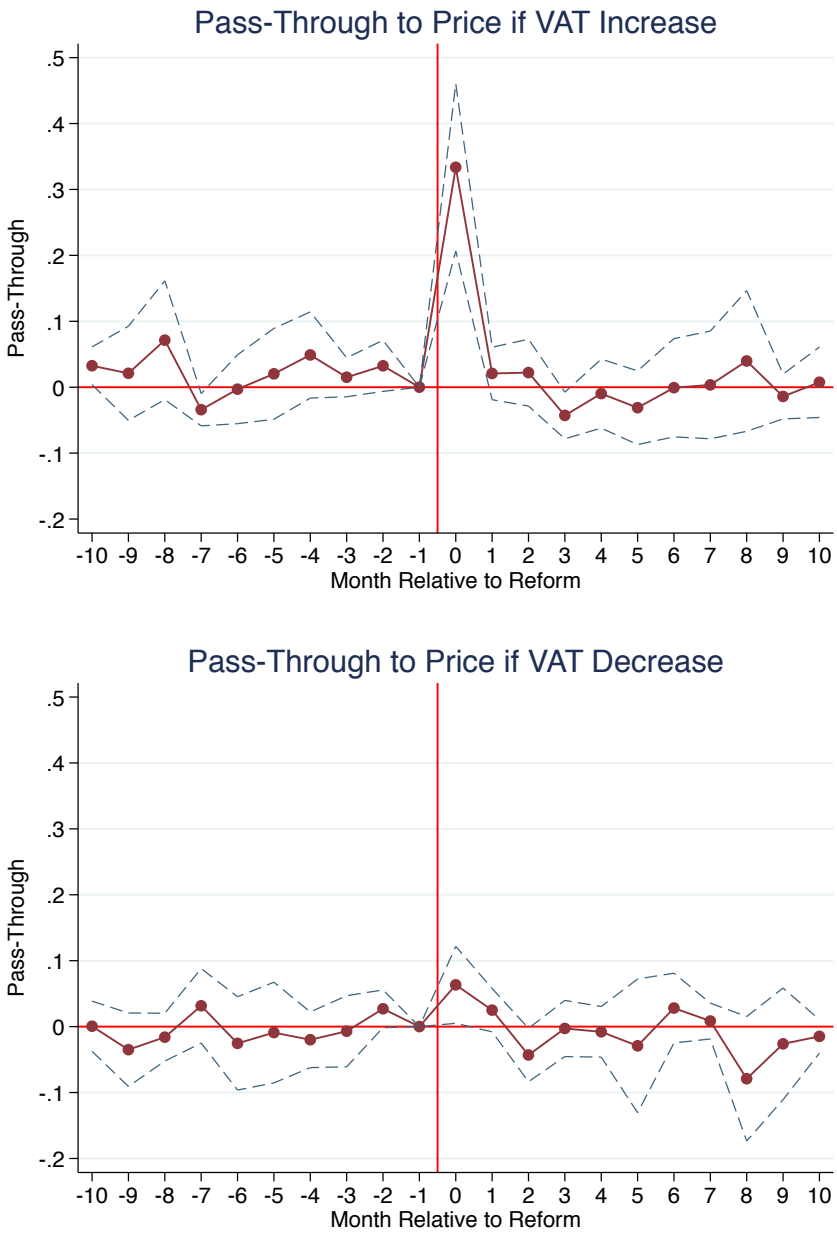


(d) Large VAT Changes



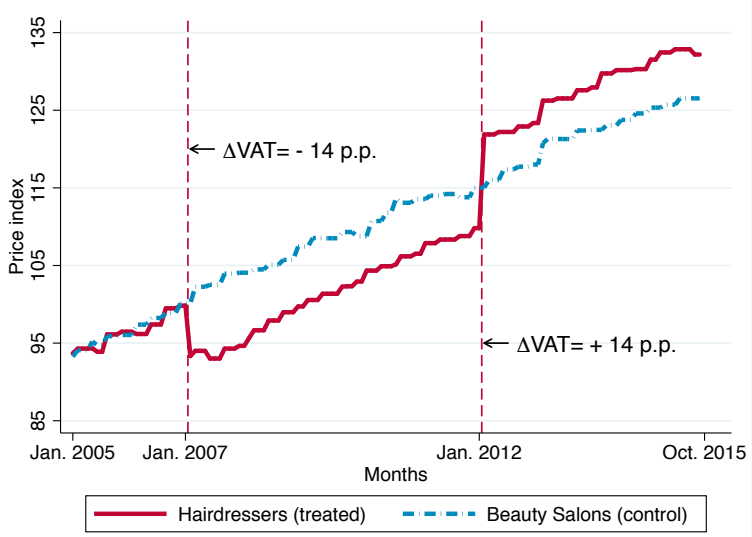
Notes: These figures plot the response of prices to VAT increases and decreases. The underlying dataset consists of 3-month window price and VAT time series around each VAT reform from 1996 to 2015. We average out and normalize each series to 100 one month before the reform. Figures 2a and 2b consider 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: Fixed Effect Regression Lead and Lag Coefficients



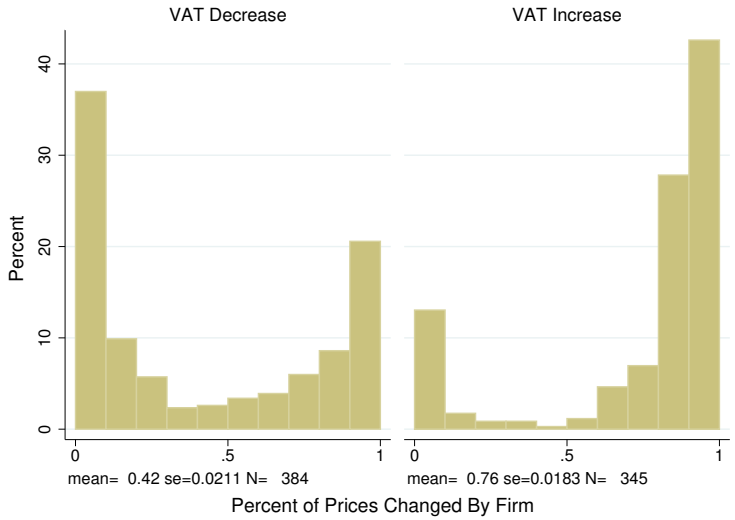
Notes: These figures plot the coefficients from the fixed effect regression (1) for VAT increases (first panel) and VAT decreases (second panel) on the full sample of reforms and includes 10 month leads and lags.

Figure 4: Finnish Hairdressing Sector VAT Reforms



Notes: This figure shows the price of 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.

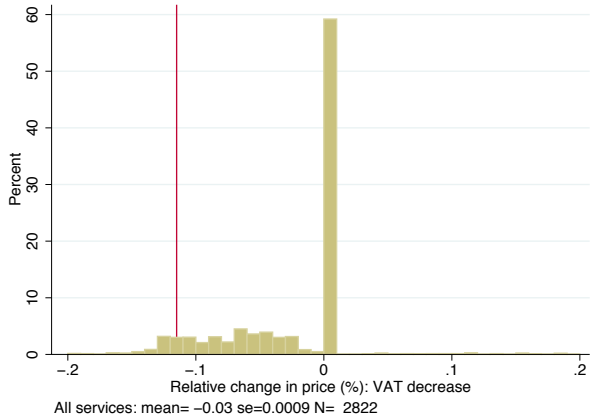
Figure 5: Proportion of Prices Changed by Hairdresser



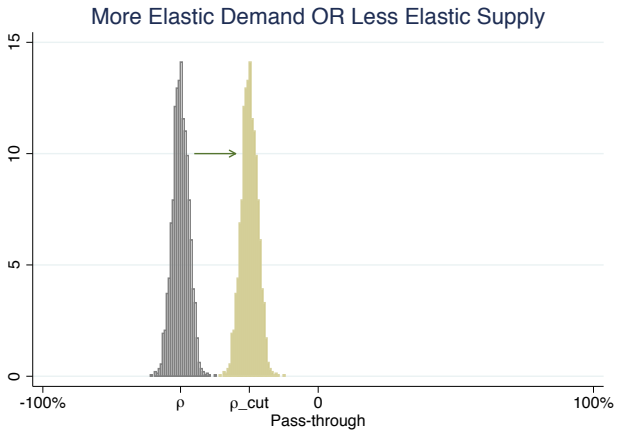
Notes: This figure plots the distribution of the within-hairdresser ratio of services for which prices are changed over total services offered following the VAT cut and hike.

Figure 6: Distributional Asymmetry

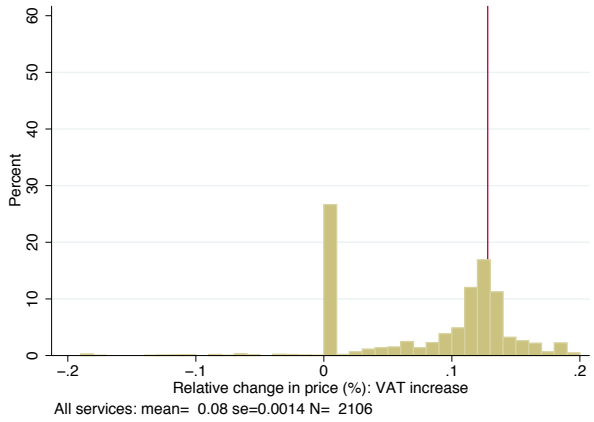
(a) VAT Decrease (Observed)



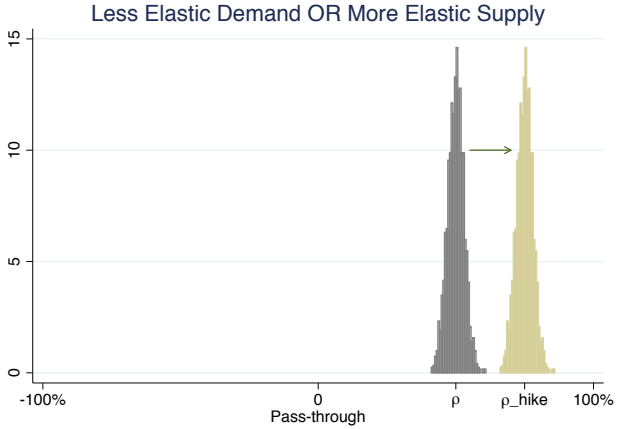
(b) VAT Decrease (Incidence Theory)



(c) VAT Increase (Observed)



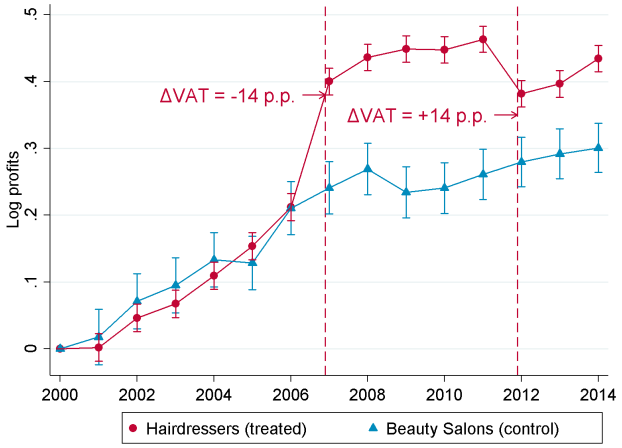
(d) VAT Increase (Incidence Theory)



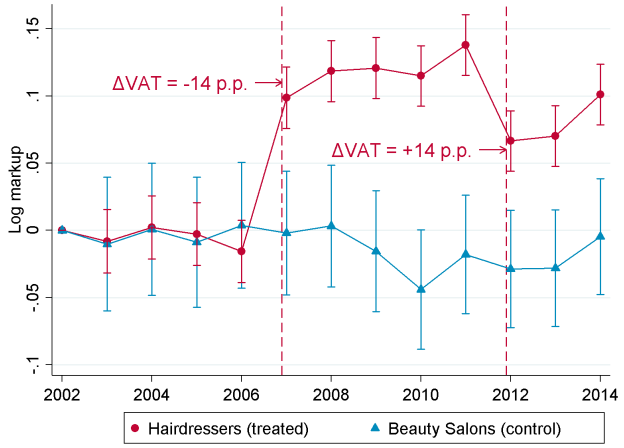
Notes: These figures compare the observed pass-through distributions following the VAT decrease (Figure 6a) and VAT increase (Figure 6c) for hairdressing services to the pass-through distributions predicted by the standard incidence model for VAT decreases (Figure 6b) and increases (Figure 6d). Standard incidence theory with different elasticities for VAT increases and decreases would predict shifted but otherwise symmetric pass-through distributions, which is inconsistent with the observed pass-through distributions.

Figure 7: Profits, Markups and Costs

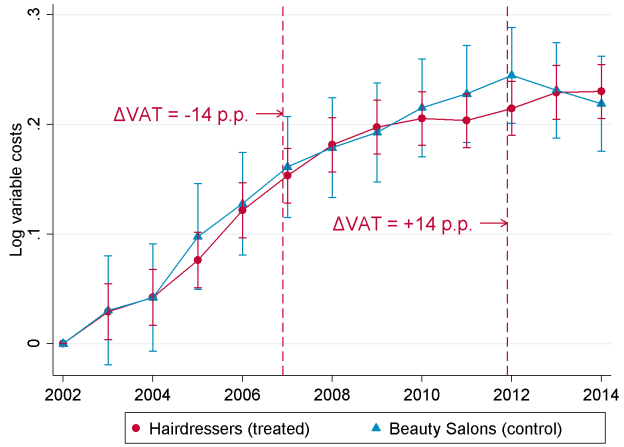
(a) Profits



(b) Markups



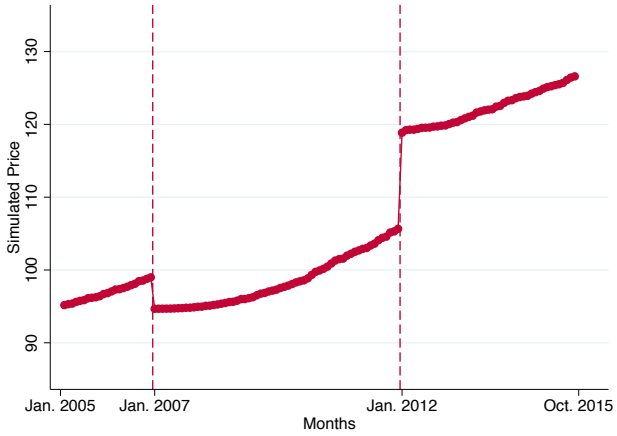
(c) Variable Costs



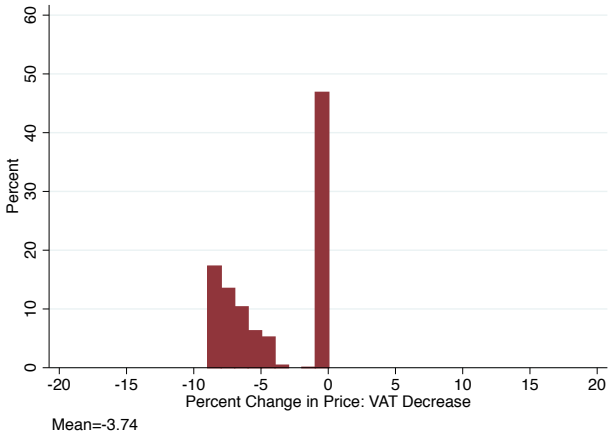
Notes: Figures 7a, 7b and 7c plot the coefficients from a regression of log profits, log markups and log variable costs, respectively, on year dummies for Finnish hairdressers and beauty salons.

Figure 8: Consumer Antagonism Model

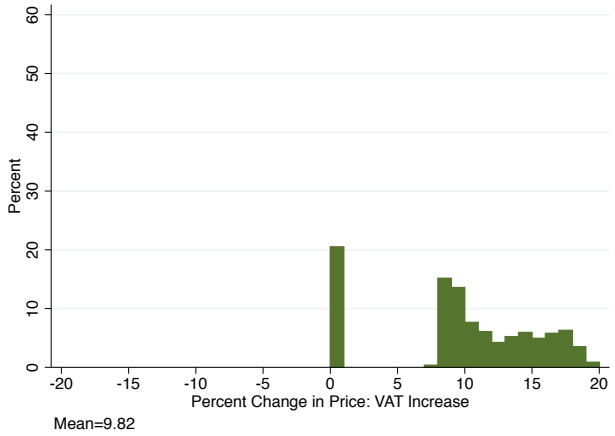
(a) Time Series Simulation



(b) VAT Decrease Distribution Simulation



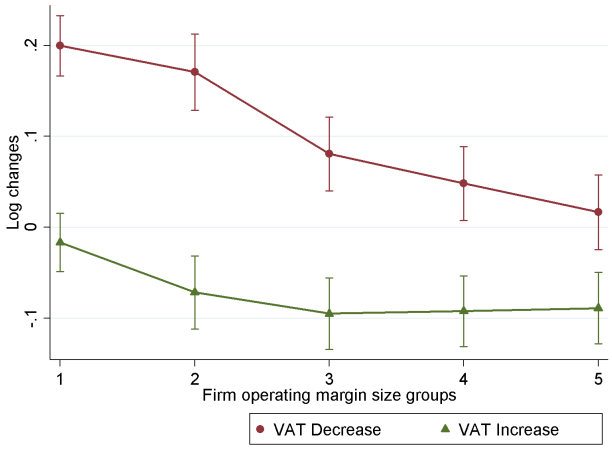
(c) VAT Increase Distribution Simulation



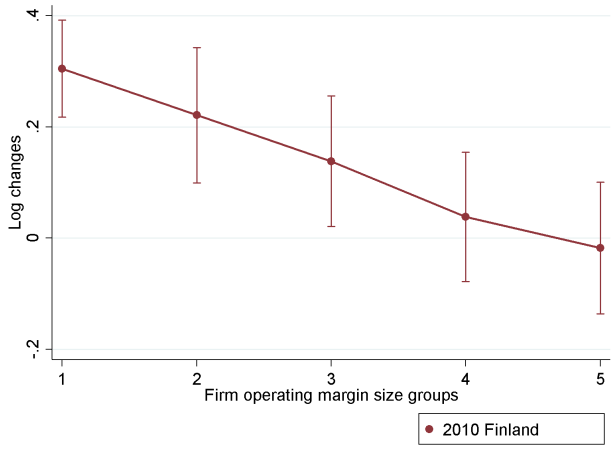
Notes: Figures 8a, 8b and 8c plot results of the simulation of the model from section 4.2 respectively for the time series and pass-through distributions for VAT decreases and increases.

Figure 9: Changes in Markups by Quintile of Operating Margins

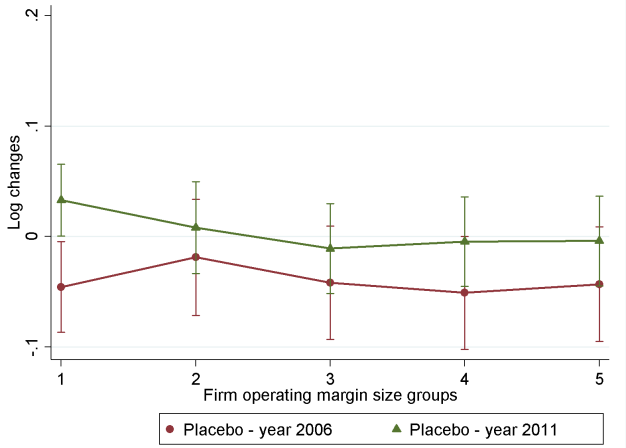
(a) Finnish Hairdressers



(b) Finnish Restaurants



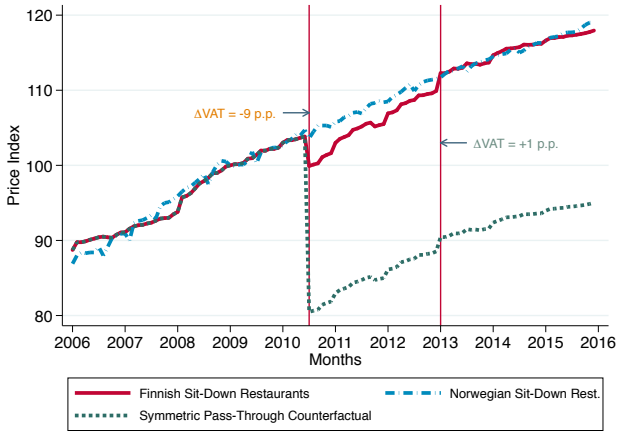
(c) Control (Finnish Beauty Salons)



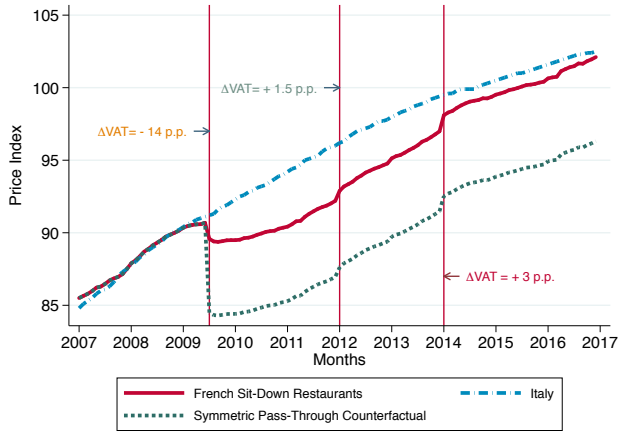
Notes: To generate these graphs we break down the sample of firms into 5 quintiles with respect to operating margins (turnover minus deductible costs divided by turnover), with 1 being firms with the smallest operating margins. For each quintile we plot changes in their markup following changes in VAT. Figure 9a considers the 14 p.p. VAT increase and decrease for Finnish hairdressers. Figure 9b considers the 9 p.p. VAT decrease for Finnish restaurants. Figure 9c considers Finnish beauty salons (which we use a control group for hairdressers).

Figure 10: Long Term Persistence

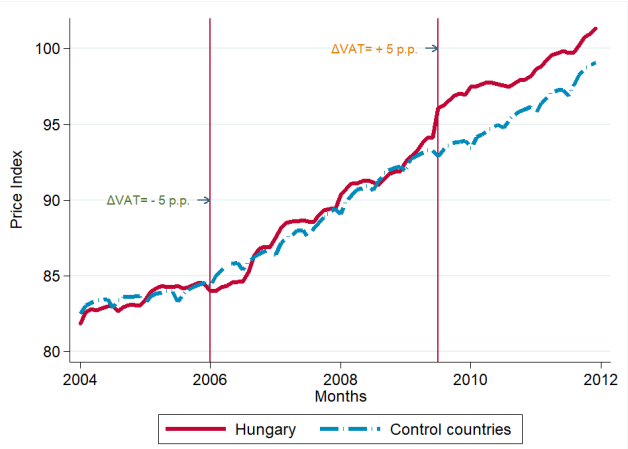
(a) Finnish Restaurants



(b) French Restaurants



(c) Hungary's Standard VAT Rate Changes



Notes: The first figure plots the response of Finnish sit-down restaurants to a 9 p.p. VAT decrease and a 1 p.p. VAT increase compared to a control group of Norwegian sit-down restaurants. The second figure plots the response of French sit-down restaurants to a 14 p.p. VAT decrease and a 1.5 p.p. and 3 p.p. VAT increases relative to a control group of Italian restaurants. We also include a counterfactual that uses the VAT increase pass-through for VAT decreases. The third figure plots the response of all commodities subject to the standard VAT rate in Hungary (excluding diesel and gasoline) to a 5 p.p. VAT decrease and a 5 p.p. VAT increase relative to a control group consisting of neighboring countries.

Table 1: Summary Statistics on VAT Rate Reforms

Panel A: All Commodities

	Number of VAT Changes (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 Changes (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 Changes (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 Fixed Effect Regression (Full Sample)

	Δ log Price	
	Increase	Decrease
β_0	0.33	0.063
	(0.065)	(0.030)
β_1	0.021	0.025
	(0.020)	(0.017)
β_{-2}	0.032	0.027
	(0.020)	(0.015)
β_{+2}	0.022	-0.043
	(0.026)	(0.021)
β_{-3}	0.015	-0.0070
	(0.015)	(0.027)
β_{+3}	-0.043	-0.0028
	(0.018)	(0.022)
β_{-4}	0.049	-0.020
	(0.033)	(0.021)
β_{+4}	-0.0097	-0.0079
	(0.027)	(0.019)
Unemployment Rate	-0.000050	-0.000039
	(0.000024)	(0.000026)
Interest Rate	-0.000012	-0.000024
	(0.000061)	(0.000048)
GDP	8.3e-10	5.3e-10
	(6.7e-10)	(7.4e-10)
Constant	0.00093	0.00032
	(0.00031)	(0.00027)
Time FE	Yes	Yes
R^2	0.014	0.014
Observations	388099	344265

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on the full sample of reforms. The first column shows the estimates for VAT increases and the second those for VAT decreases. Standard errors are clustered by month and are in parentheses. β_0 measures the pass-through of the VAT change at the time of the reform, and β_i measures price changes i months away from the reform.

Table 3: Heterogeneity Analysis

	Δ log Price	
	Increase	Decrease
Restricted Sample	0.44	0.053
	(0.11)	(0.029)
High GDP Growth	0.34	0.069
	(0.070)	(0.031)
Low GDP Growth	0.48	0.024
	(0.081)	(0.047)
Large VAT Changes	0.29	0.044
	(0.067)	(0.029)
Small VAT Changes	0.98	0.54
	(0.20)	(0.17)
Commodity Subject to Standard VAT	0.39	0.11
	(0.068)	(0.036)
Commodity Subject to Reduced VAT	0.27	0.017
	(0.066)	(0.035)
Controls	Yes	Yes
Time FE	Yes	Yes

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on different subsamples of the reforms. The first column shows the estimates for VAT increases and the second those for VAT decreases. Standard errors are clustered by month and are in parentheses. Restricted sample considers a subsample of reforms focusing on commodities that experience both a VAT increase and decrease during the 1996-2015 period. High and Low GDP Growth refer to reforms occurring at times of high and low GDP Growth, respectively. Large and small VAT changes refer to VAT changes belonging to the largest and smallest quartiles, respectively. Appendix tables A.8, A.9, A.10, A.11, A.12, A.13 and A.14 report details of the regression table for each row. The coefficients from the regressions are also plotted in appendix Figures A.19, A.20 and A.21.

Table 4: Finnish Hairdressers and Beauty Salons Summary Statistics

	Hairdressers				Beauty Salons			
	Mean	Median	S.D.	N.	Mean	Median	S.D.	N.
Turnover	40190	25924	231039	157082	35643	18504	143747	45368
Profits	13787	11330	15193	155837	9610	5048	19365	44332
Costs	26699	13285	213093	162634	26865	11415	126093	47347
Total Assets	12841	2834	79027	112682	13065	2115	84635	36984
Nb. Employees	0.40	0	4.22	162634	0.37	0	3.53	47347
Cost of Employees	1129	0	20138	145729	766	0	10709	43649
Sole Proprietors	0.91	1	0.29	162634	0.89	1	0.31	47347
Partnerships	0.05	0	0.21	162634	0.03	0	0.18	47347
Corporations	0.05	0	0.21	162634	0.07	0	0.26	47347
Nb. of firms in 2006	12,301				3,073			

Notes: This table reports annual summary statistics on the full population of Finnish hairdressers and beauty salons using corporate tax data.

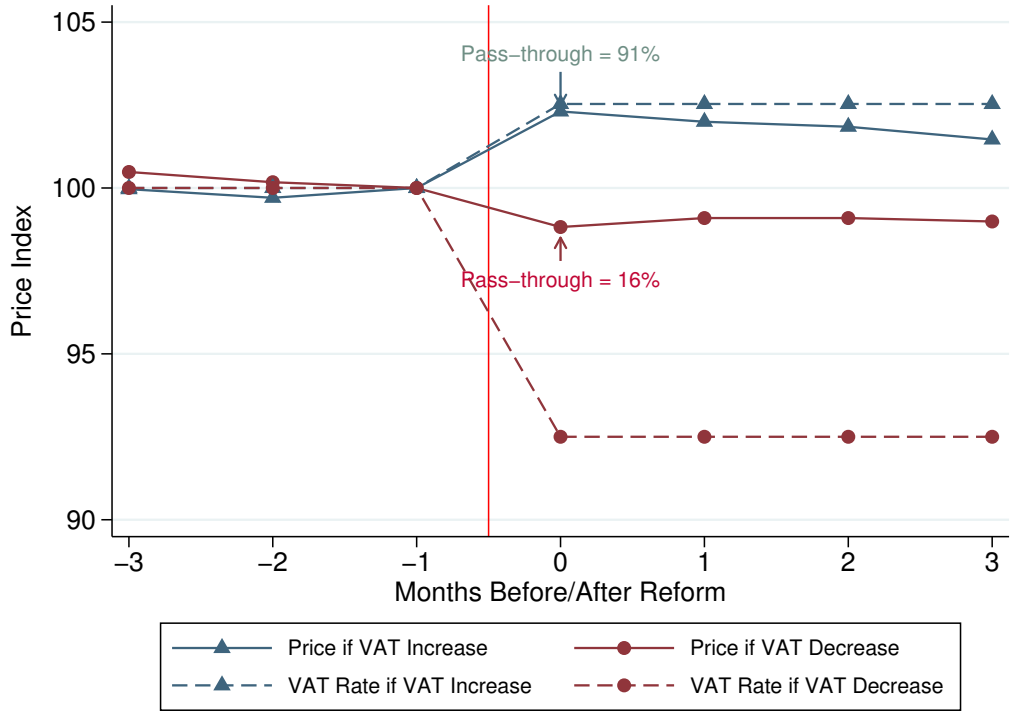
APPENDIX FOR ONLINE PUBLICATION

A Hungarian Reforms: List of Commodities and Control Group Countries

Commodities: The commodities included in Figure 10c are all commodities subject to the standard rate except for diesel and gasoline. The full list is: Actual rentals for housing, Audio-visual, photographic and information processing equipment, Books, Carpets and other floor coverings, Catering services, Clothing, Clothing materials, Electrical appliances for personal care; other appliances, articles and products, Electricity, Furniture and furnishings, carpets and other floor coverings, Glassware, tableware and household utensils, Hairdressing salons and personal grooming establishments, Household textiles, Information processing equipment, Jewellery, clocks and watches, Maintenance and repair of personal transport equipment, Maintenance and repair of the dwelling, Major durables for indoor and outdoor recreation including musical instruments, Materials for the maintenance and repair of the dwelling, Personal effects n.e.c., Pharmaceutical products, Photographic and cinematographic equipment and optical instruments, Purchase of vehicles, Refuse collection, Repair of furniture, furnishings and floor coverings, Restaurants and hotels, Restaurants, cafs and the like, Services for the maintenance and repair of the dwelling, Sewerage collection, Tools and equipment for house and garden, Water supply.

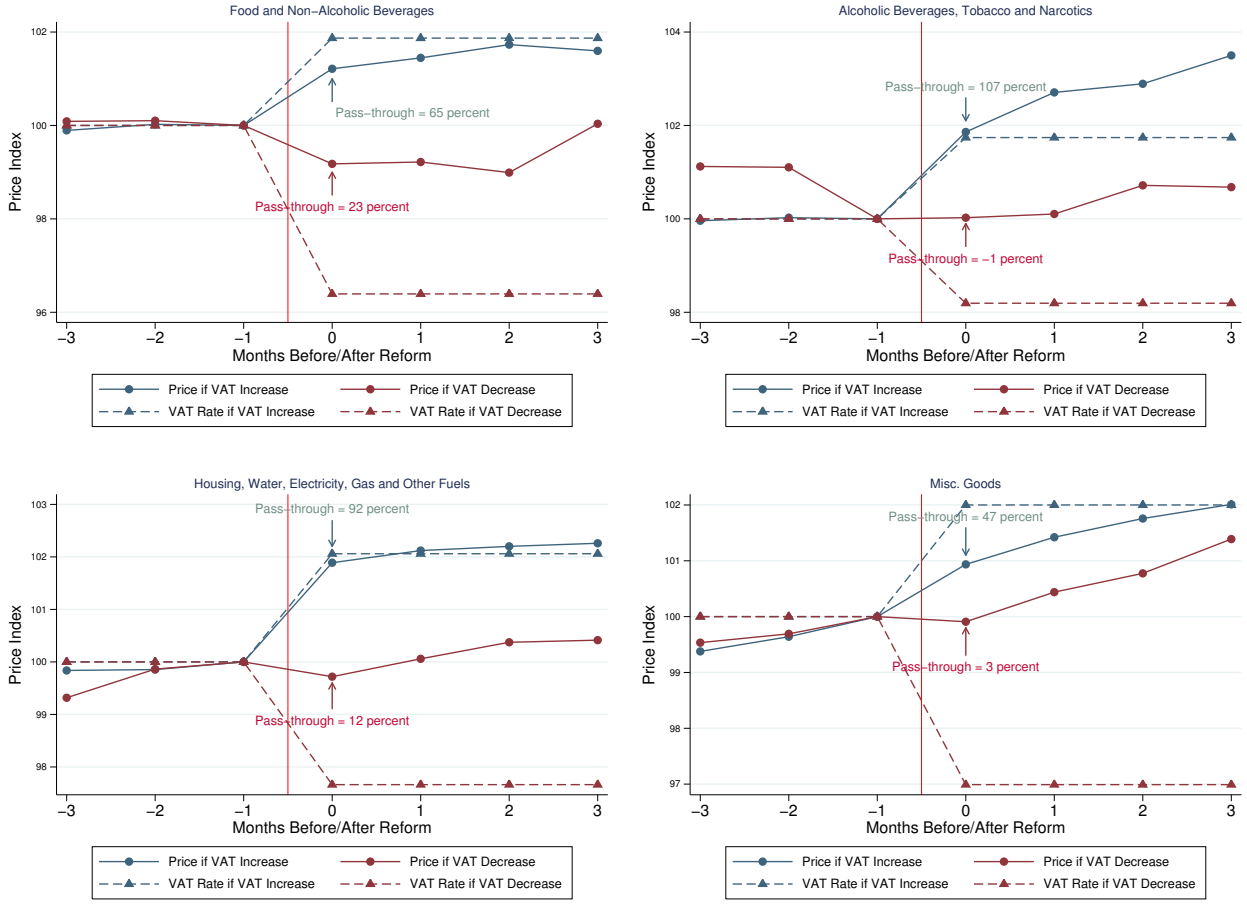
Control Group Countries: The control group countries are an un-weighted average of Austria, Belgium, Bulgaria, Estonia, Germany, Italy, Luxembourg, Norway and Romania.

Figure A.11: Asymmetric Pass-Through of VAT to Gasoline Prices



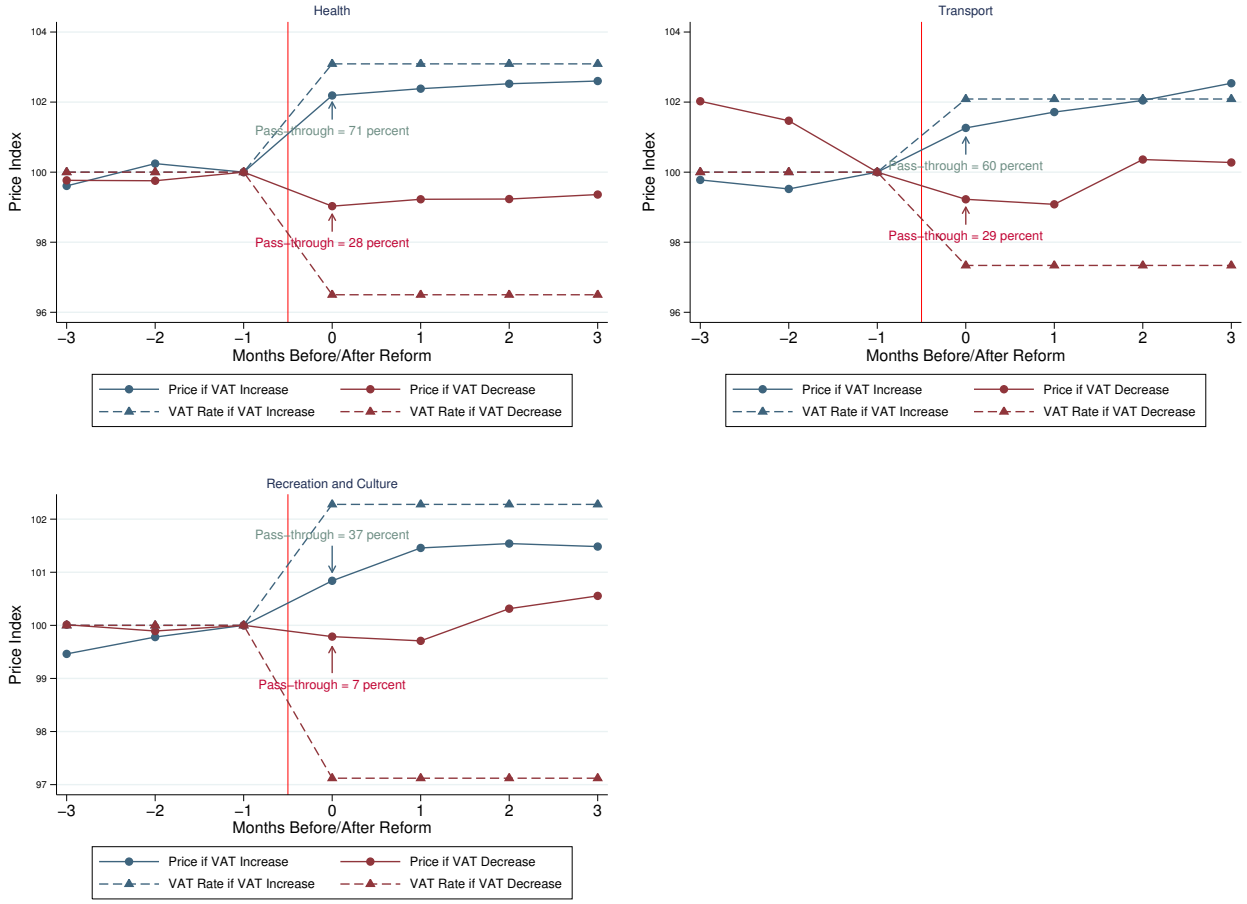
Notes: This figure shows the response of gasoline prices (COICOP category 04.5.2) to VAT increases and decreases.

Figure A.12: Asymmetric Response of Prices to VAT Changes by 2-Digit COICOP Code in the Full Sample



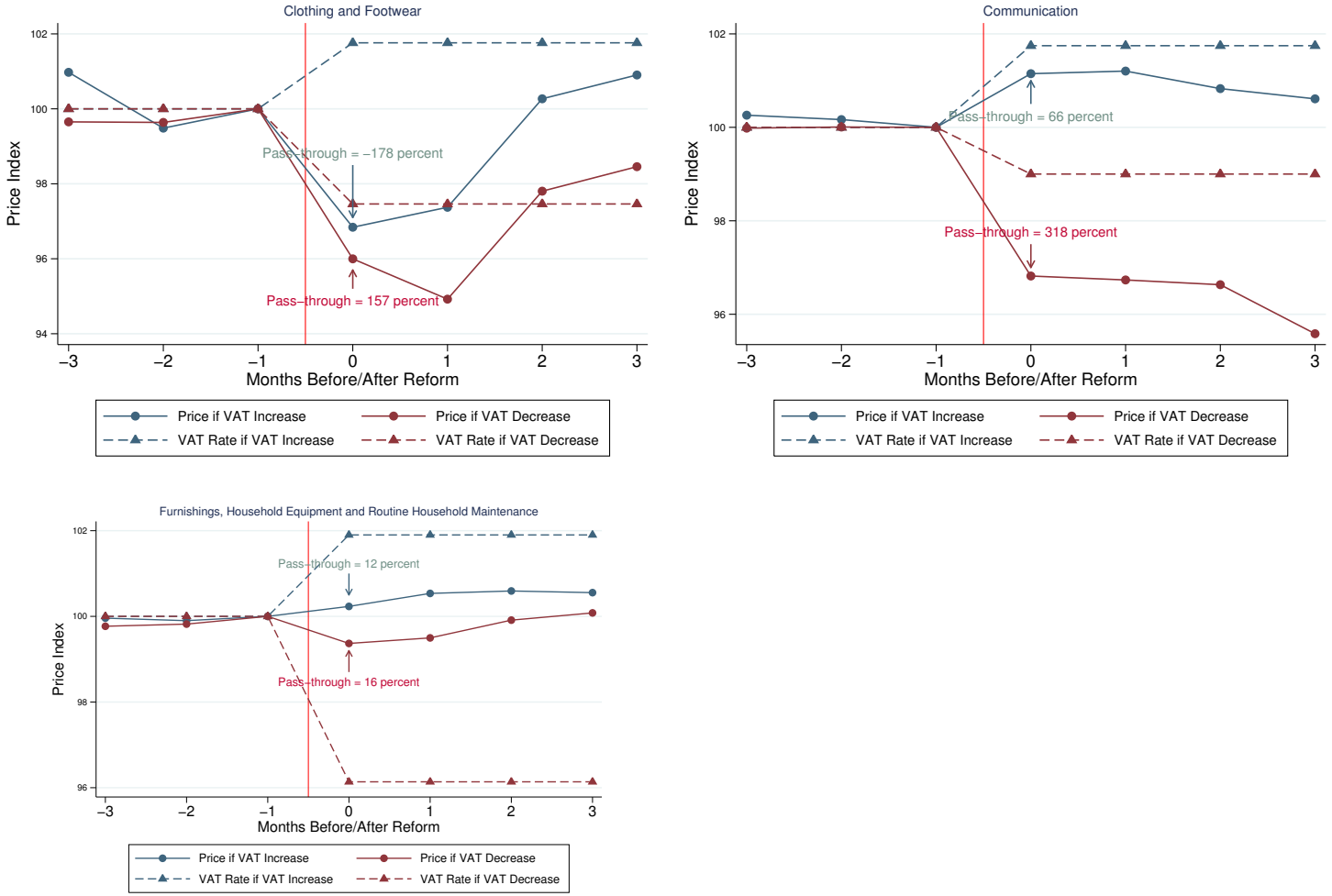
Notes: Each of these graphs is a disaggregated version of figure 1a: they plot the response of prices to variation in the VAT rate by groups of commodities.

Figure A.13: Asymmetric Response of Prices to VAT Changes by 2-Digit COICOP Code in the Full Sample



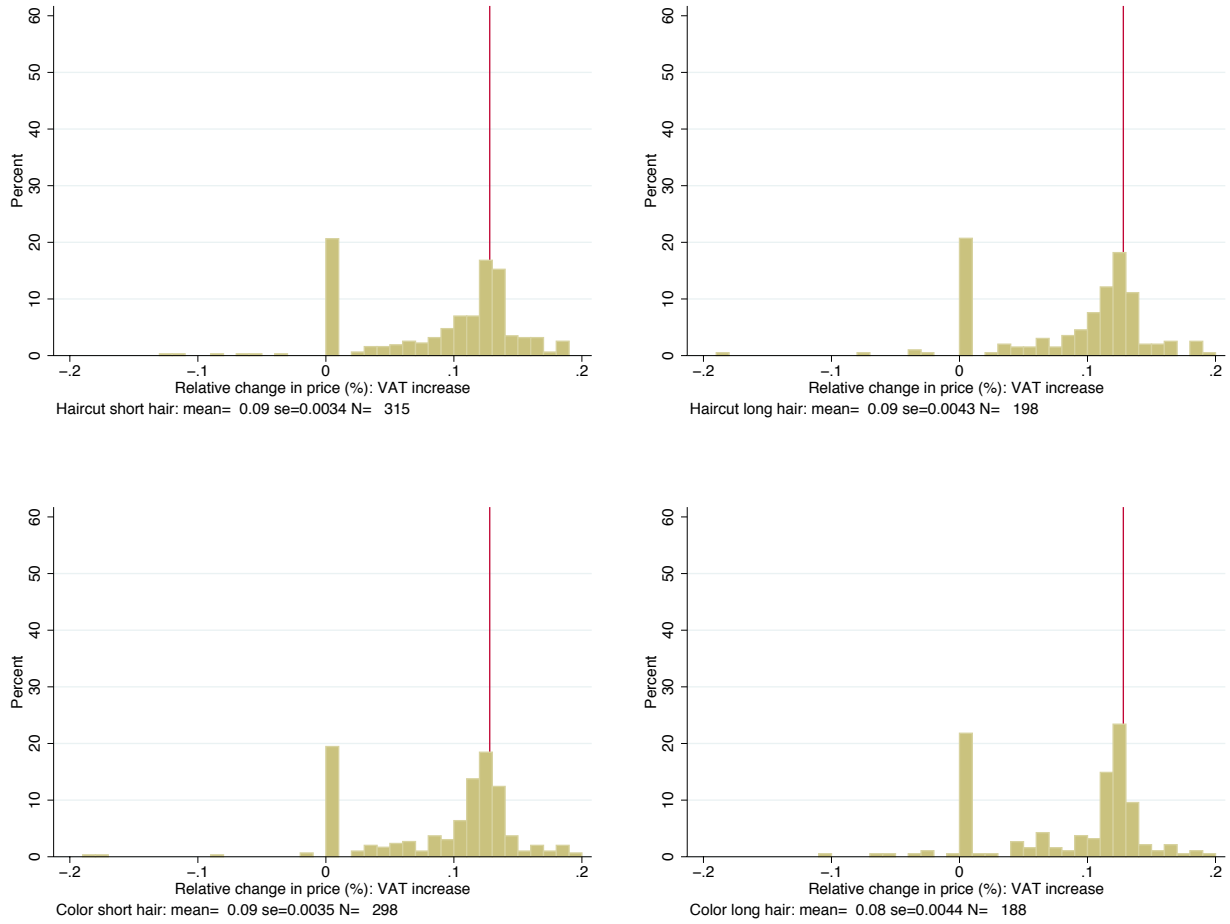
Notes: Each of these graphs is a disaggregated version of figure 1a: they plot the response of prices to variation in the VAT by groups of commodities.

Figure A.14: Commodities With No Asymmetry



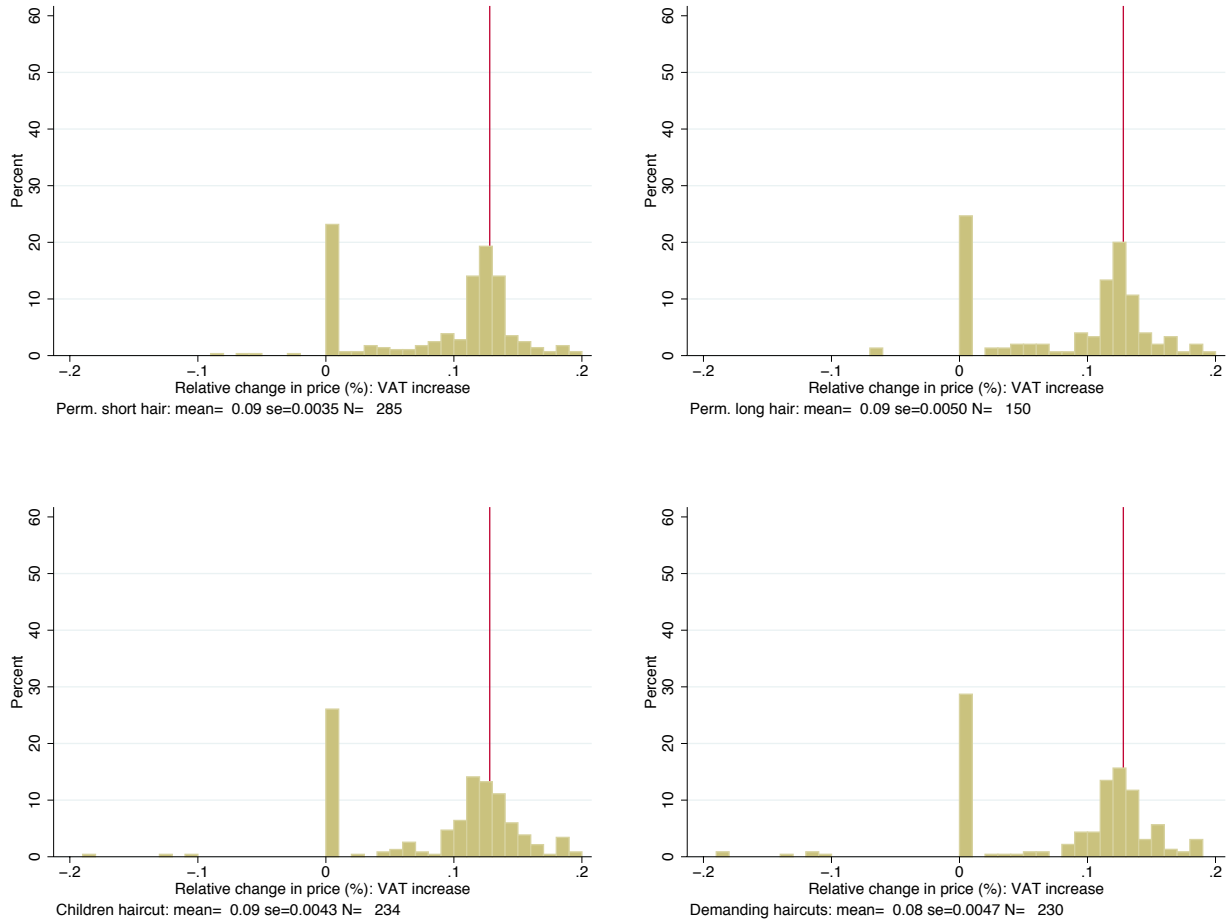
Notes: Each of these graphs is a disaggregated version of figure 1a: they plot the response of prices to variation in the VAT by groups of commodities. This panel shows the commodities for which there is no asymmetry. Clothing and Footwear shows a price decrease for both VAT increases and decreases consistent 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 A.15: Pass-Through Distribution By Service: VAT Increase



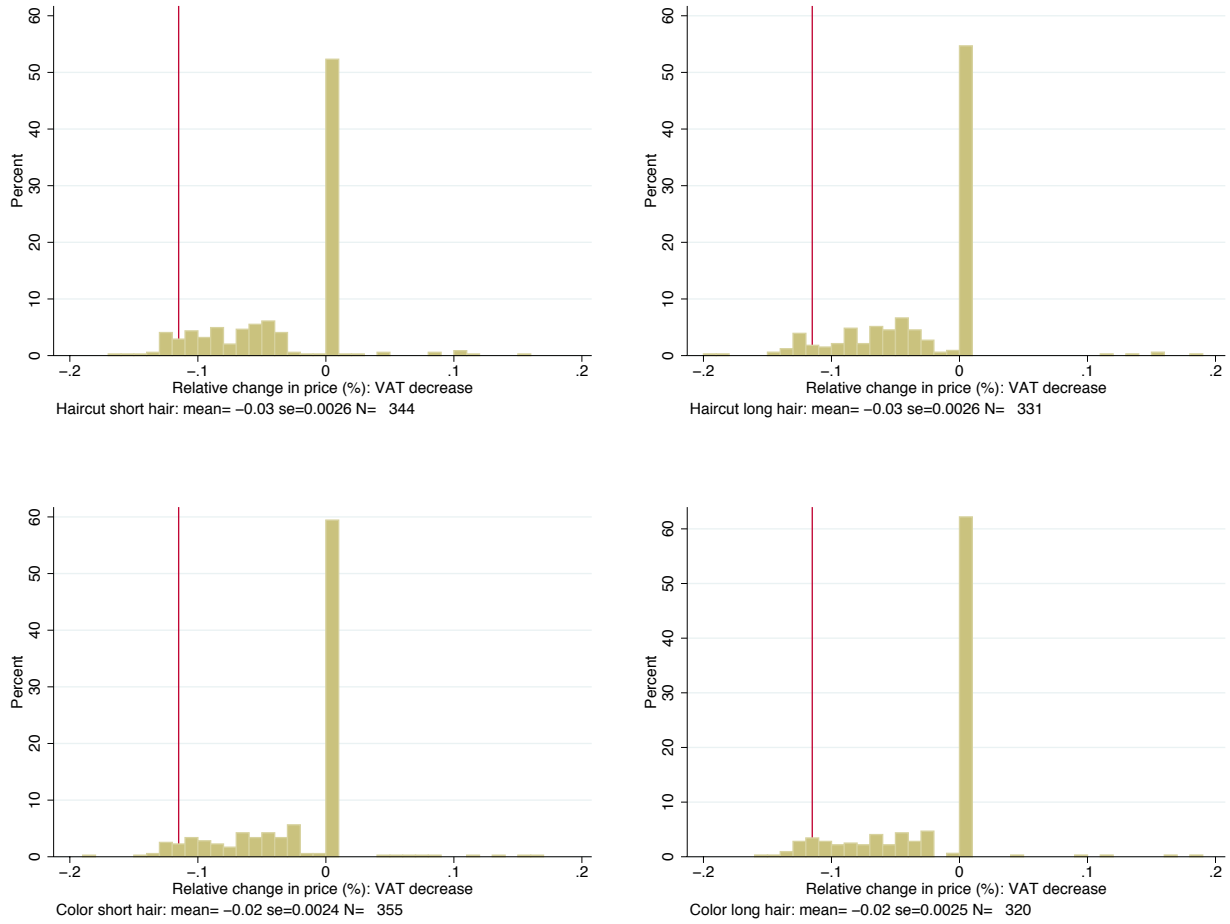
Notes: These figures are a disaggregated version of Figure 6. Each figure plots the distribution of pass-through following a VAT increase for each service offered by hairdressers.

Figure A.16: Pass-Through Distribution By Service: VAT Increase



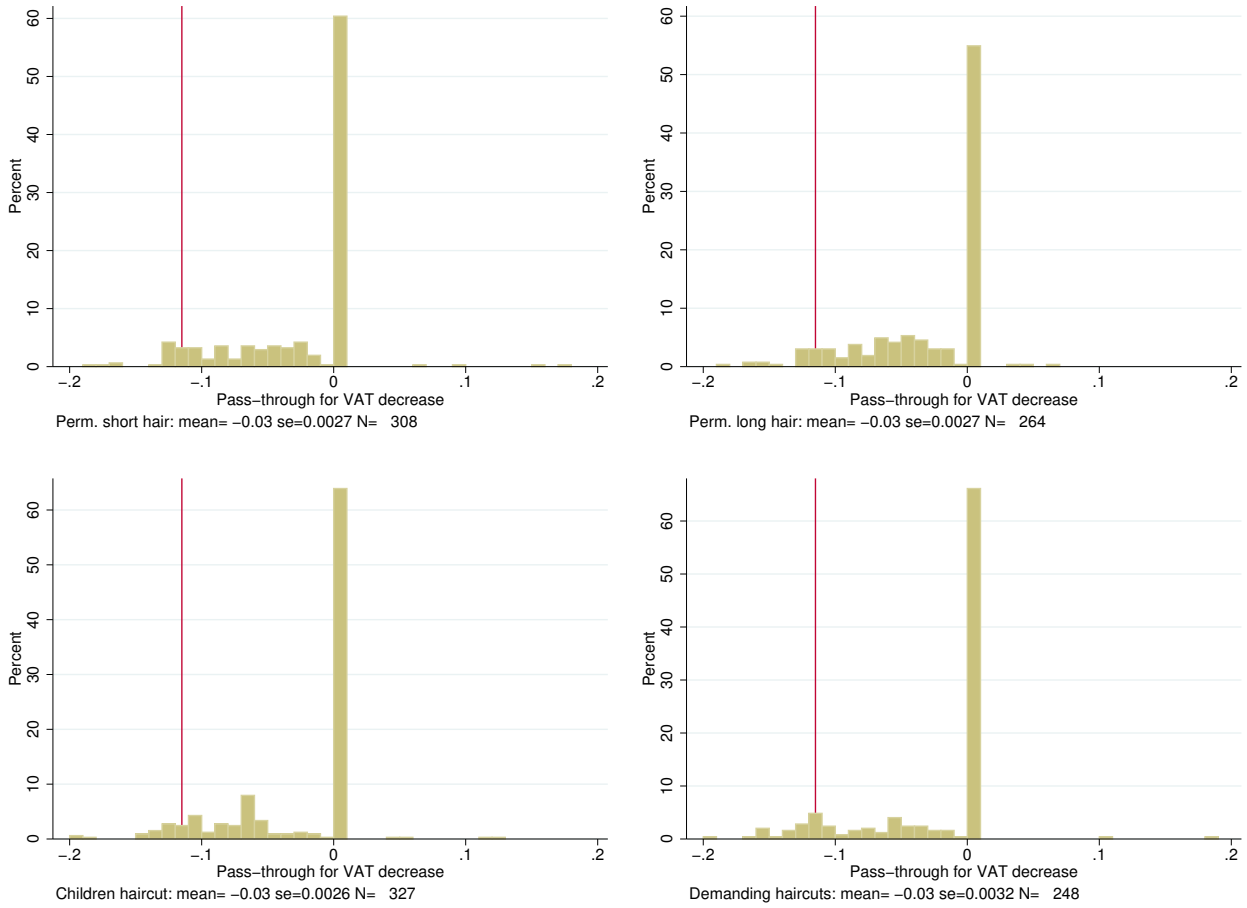
Notes: These figures are a disaggregated version of figure 6. Each figure plots the distribution of pass-through following a VAT increase for each service offered by hairdressers.

Figure A.17: Pass-Through Distribution By Service: VAT Decrease



Notes: These figures are a disaggregated version of figure 6. Each figure plots the distribution of pass-through following a VAT decrease for each service offered by hairdressers.

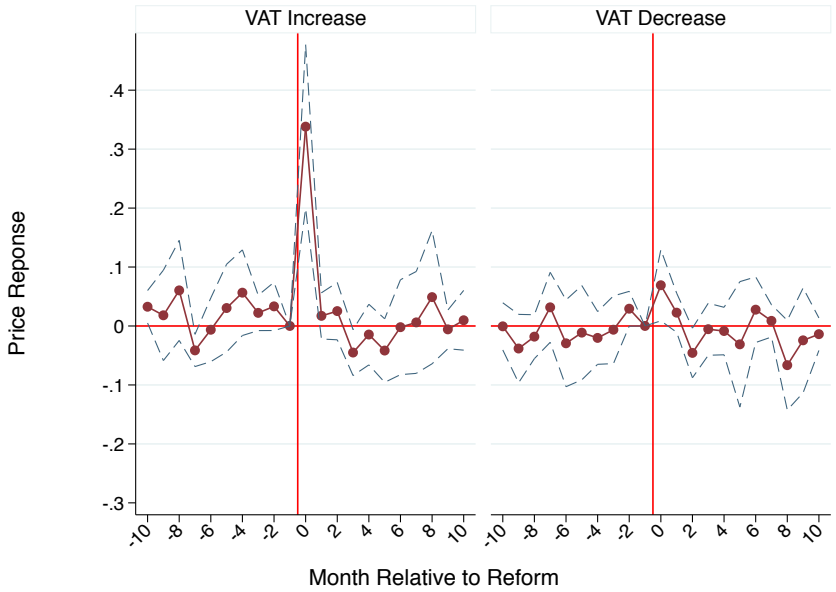
Figure A.18: Pass-Through Distribution By Service: VAT Increase



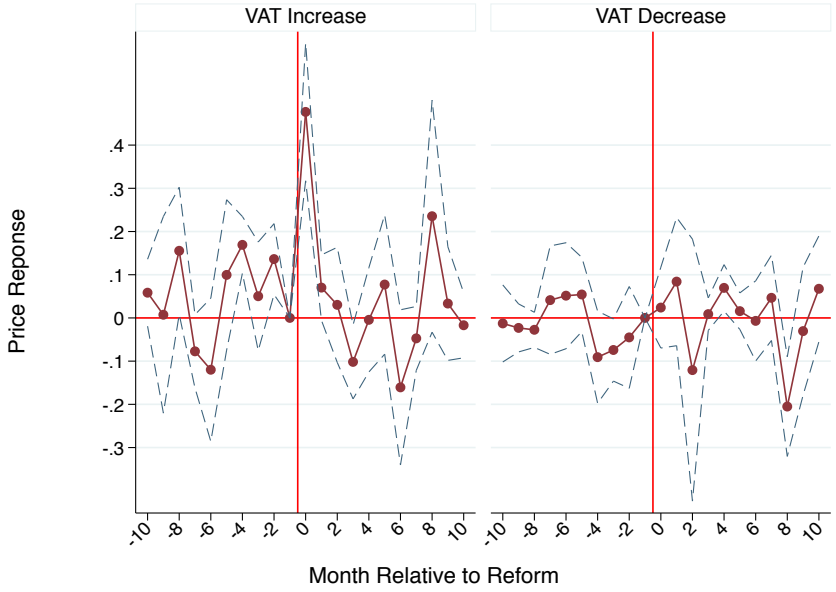
Notes: These Figures are a disaggregated version of Figure 6. Each Figure plots the distribution of pass-through following a VAT decrease for each service offered by hairdressers.

Figure A.19: Fixed Effect Regression Lead and Lag Coefficients by GDP Growth

(a) Reforms Occurring During High Growth



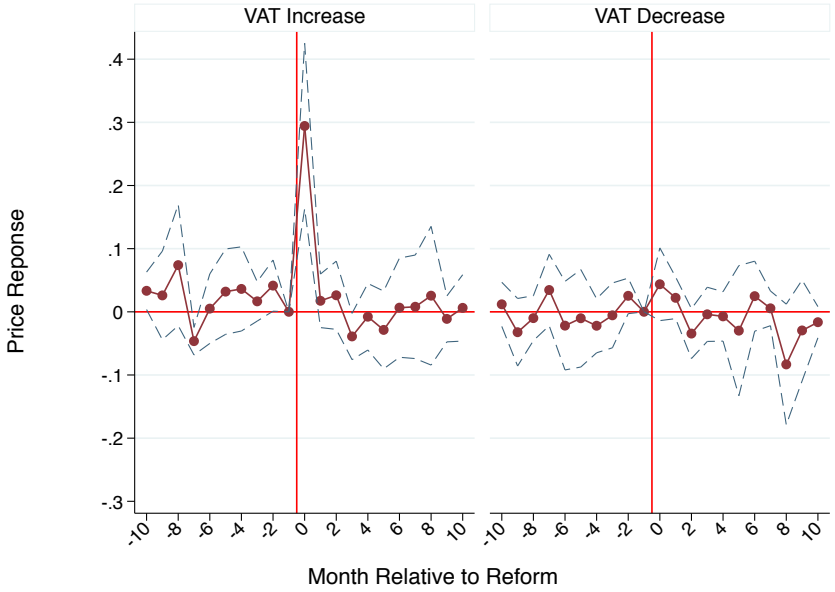
(b) Reforms Occurring During Low Growth



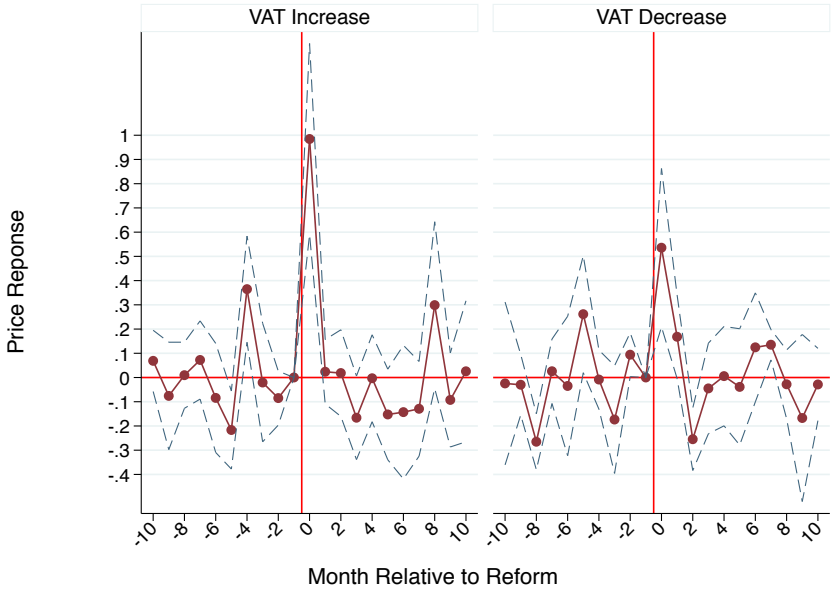
Notes: Panel (a) plots the coefficients from the fixed effect regression (1) for reforms occurring during periods of high GDP growth and panel (b) that during periods of low GDP growth. Both panels include 10-month leads and lags.

Figure A.20: Fixed Effect Regression Lead and Lag Coefficients by Size of Reforms

(a) Large VAT Changes



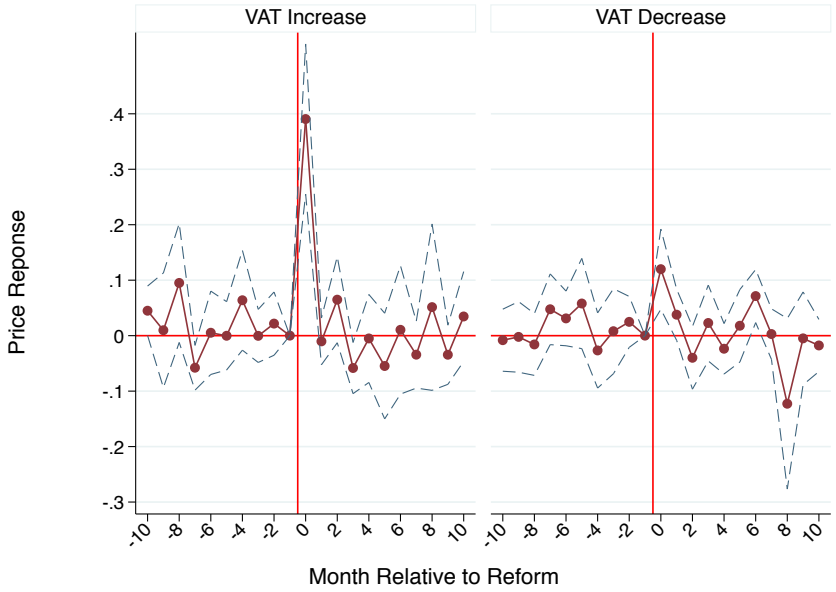
(b) Small VAT Changes



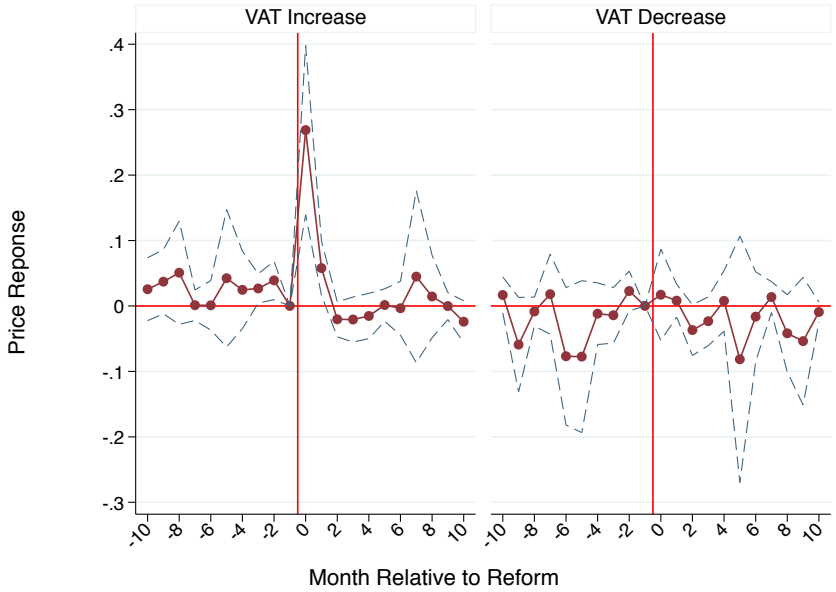
Notes: Panel (a) plots the coefficients from the fixed effect regression (1) for large VAT changes (largest quartile) and panel (b) for small VAT changes (smallest quartile). Both panels include 10 month-leads and lags.

Figure A.21: Fixed Effect Regression Lead and Lag Coefficients by Type of VAT Rate

(a) Standard VAT Rate

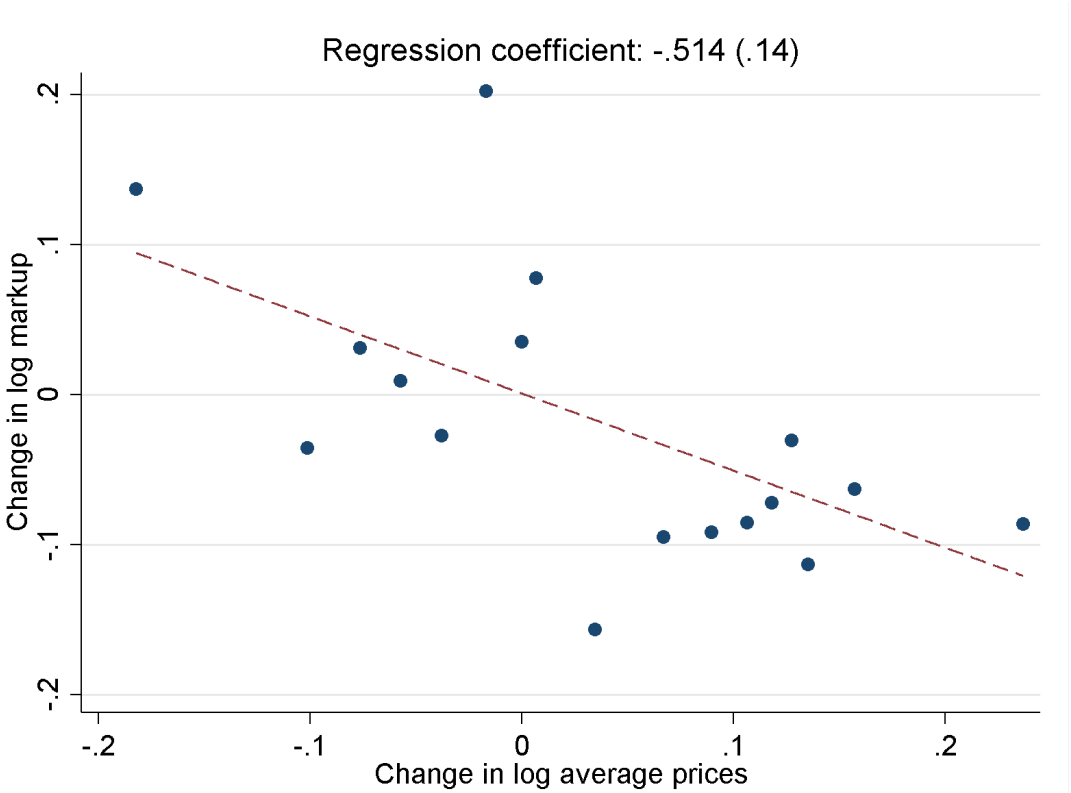


(b) Reduced VAT Rate



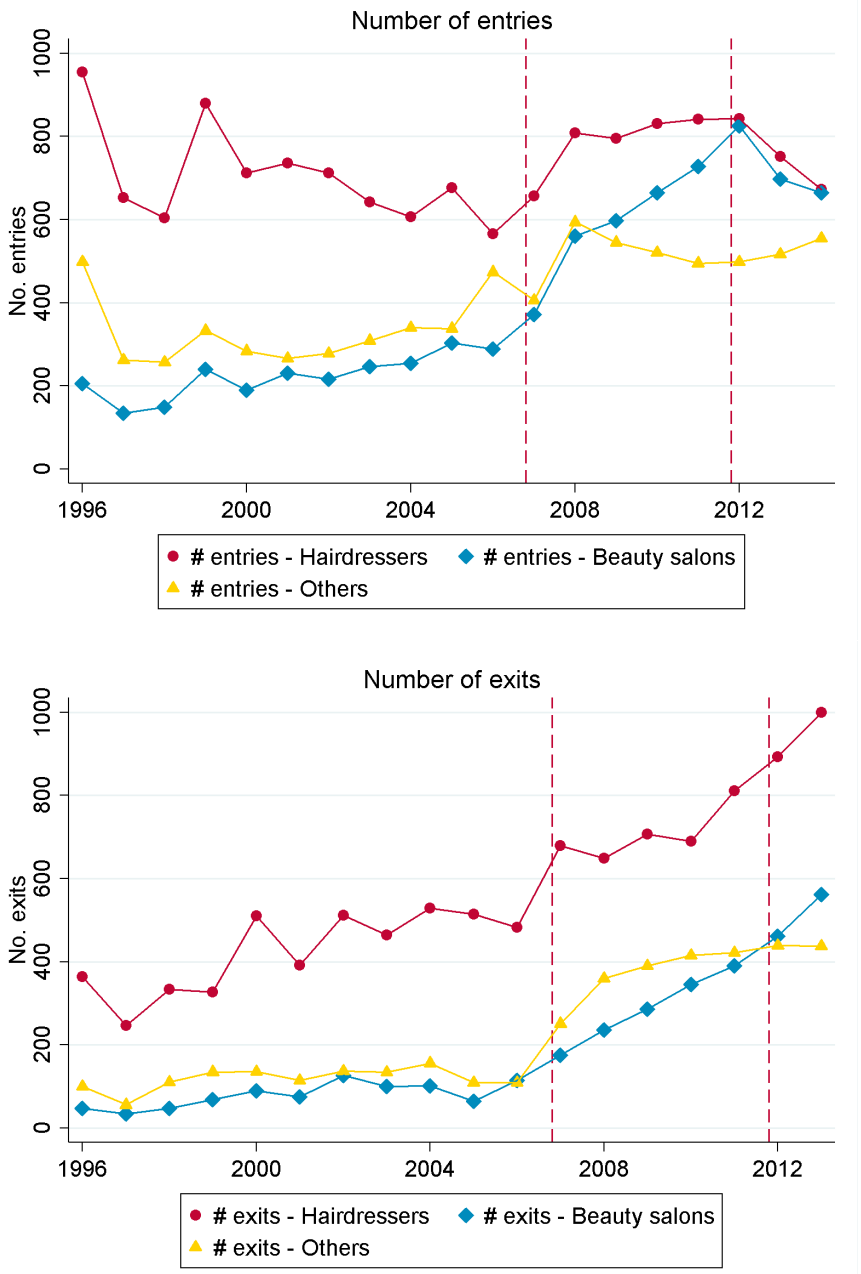
Notes: Panel (a) plots the coefficients from the fixed effect regression (1) for standard VAT rate reforms and panel (b) for reduced VAT rate reforms. Both panels includes 10 month leads and lags.

Figure A.22: Markup Changes and Price Changes



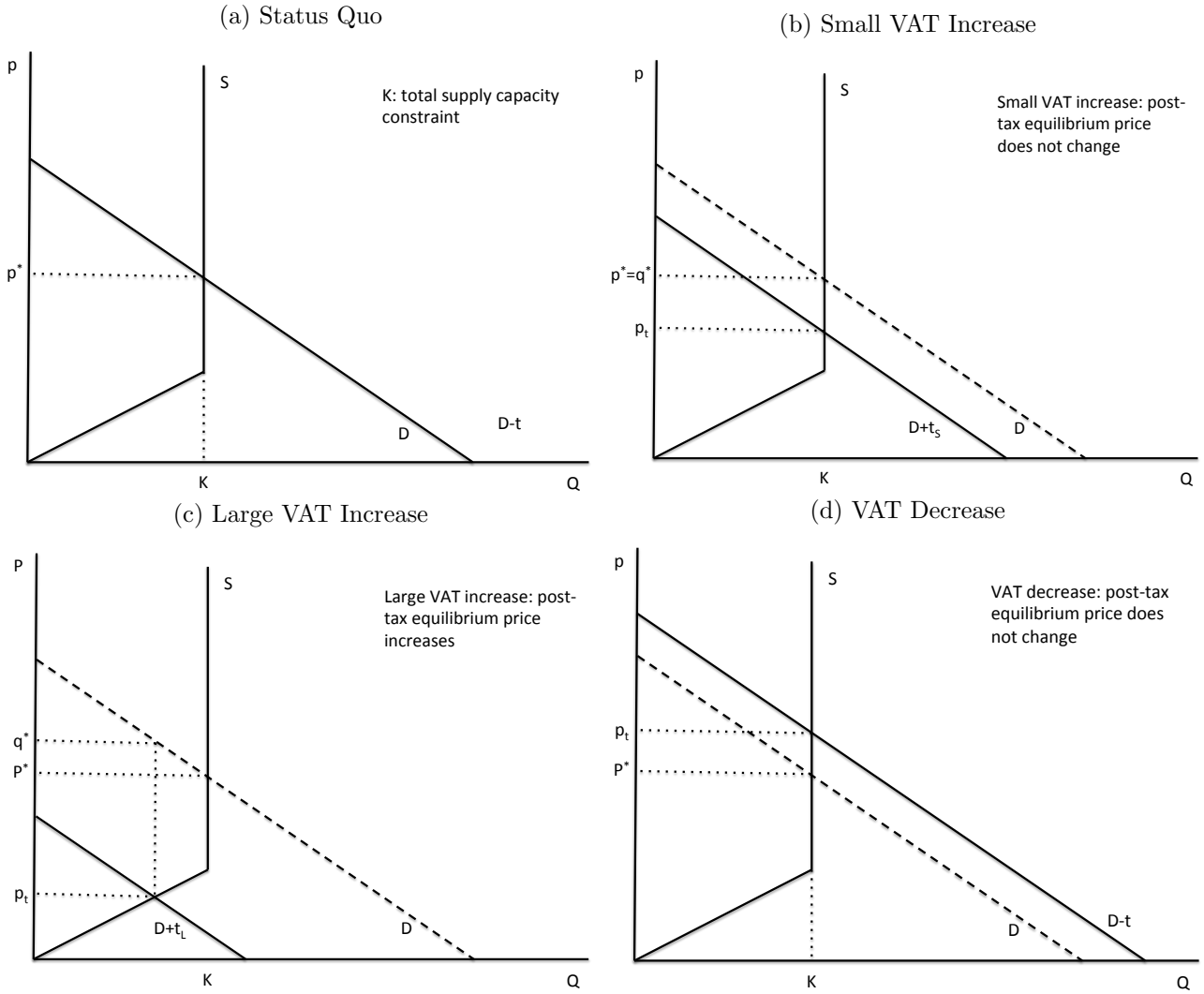
Notes: This figure presents a bin-scatter plot of changes in log markup versus changes in log average price using the linked price corporate tax data for Finnish hairdressers.

Figure A.23: Entry and Exit in Finnish Hairdressing Sector



Notes: These figures use the administrative dataset containing information on the full population of Finnish hairdressers, beauty salons, massage parlors and physical therapists to plot the number of firms entering and exiting each sector over time. Others include entry and exit in the massage parlor and physical therapy industries in Finland.

Figure A.24: Capacity Constraints



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

Table A.5: 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 by Eurostat to describe price categories.

Table A.6: 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 A.7: 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 A.8: Pass-Through Estimates: Restricted Sample

	Δ log Price	
	Increase	Decrease
β_0	0.44	0.053
	(0.11)	(0.029)
β_{+1}	0.082	0.029
	(0.093)	(0.024)
β_{-2}	0.082	0.033
	(0.047)	(0.018)
β_{+2}	0.033	-0.056
	(0.074)	(0.026)
β_{-3}	0.099	0.014
	(0.038)	(0.034)
β_{+3}	-0.062	0.0025
	(0.056)	(0.024)
β_{-4}	0.19	-0.017
	(0.060)	(0.031)
β_{+4}	-0.014	-0.041
	(0.044)	(0.019)
Time FE	Yes	Yes
R^2	0.014	0.014
Observations	349751	343875

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on the restricted sample of VAT changes (commodities that experience both a VAT increase and decrease between 1996 and 2015). The first column shows the estimates for VAT increases and the second that for VAT decreases. Standard errors are clustered by month and are in parenthesis. β_0 measures the pass-through of the VAT change at the time of the reform and β_i measures price changes i months away from the reform.

Table A.9: Pass-Through Estimates: High GDP Growth

	Δ log Price	
	Increase	Decrease
β_0	0.34	0.069
	(0.070)	(0.031)
β_{+1}	0.017	0.023
	(0.020)	(0.017)
β_{-2}	0.033	0.029
	(0.021)	(0.015)
β_{+2}	0.025	-0.046
	(0.025)	(0.021)
β_{-3}	0.022	-0.0064
	(0.015)	(0.029)
β_{+3}	-0.045	-0.0055
	(0.020)	(0.022)
β_{-4}	0.056	-0.020
	(0.037)	(0.023)
β_{+4}	-0.015	-0.0086
	(0.026)	(0.020)
Time FE	Yes	Yes
R^2	0.014	0.014
Observations	385088	344055

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on reforms occurring when GDP growth is high. The first column shows the estimates for VAT increases and the second those for VAT decreases. Standard errors are clustered by month and are in parentheses. β_0 measures the pass-through of the VAT change at the time of the reform, and β_i measures price changes i months away from the reform.

Table A.10: Pass-Through Estimates: Low GDP Growth

	Δ log Price	
	Increase	Decrease
β_0	0.48	0.024
	(0.081)	(0.047)
β_{+1}	0.070	0.084
	(0.038)	(0.075)
β_{-2}	0.14	-0.045
	(0.042)	(0.060)
β_{+2}	0.030	-0.12
	(0.068)	(0.15)
β_{-3}	0.050	-0.074
	(0.064)	(0.037)
β_{+3}	-0.10	0.0087
	(0.043)	(0.019)
β_{-4}	0.17	-0.091
	(0.033)	(0.054)
β_{+4}	-0.0045	0.070
	(0.061)	(0.027)
Time FE	Yes	Yes
R^2	0.014	0.014
Observations	339757	336987

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on reforms occurring when GDP growth is low. The first column shows the estimates for VAT increases and the second that for VAT decreases. Standard errors are clustered by month and are in parentheses. β_0 measures the pass-through of the VAT change at the time of the reform and β_i measures price changes i months away from the reform.

Table A.11: Pass-Through Estimates: Large VAT Changes

	Δ log Price	
	Increase	Decrease
β_0	0.29	0.044
	(0.067)	(0.029)
β_{+1}	0.017	0.022
	(0.022)	(0.017)
β_{-2}	0.042	0.025
	(0.021)	(0.014)
β_{+2}	0.026	-0.034
	(0.027)	(0.020)
β_{-3}	0.017	-0.0056
	(0.016)	(0.026)
β_{+3}	-0.039	-0.0040
	(0.019)	(0.022)
β_{-4}	0.036	-0.022
	(0.034)	(0.022)
β_{+4}	-0.0078	-0.0072
	(0.027)	(0.020)
Time FE	Yes	Yes
R^2	0.014	0.014
Observations	360535	339967

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on VAT changes that are larger, in absolute value, than the 75^{th} percentile of all VAT changes. The first column shows the estimates for VAT increases and the second that for VAT decreases. Standard errors are clustered by month and are in parentheses. β_0 measures the pass-through of the VAT change at the time of the reform and β_i measures price changes i months away from the reform.

Table A.12: Pass-Through Estimates: Small VAT Changes

	Δ log Price	
	Increase	Decrease
β_0	0.98	0.54
	(0.20)	(0.17)
β_{+1}	0.024	0.17
	(0.067)	(0.087)
β_{-2}	-0.085	0.094
	(0.057)	(0.046)
β_{+2}	0.018	-0.25
	(0.091)	(0.065)
β_{-3}	-0.021	-0.17
	(0.12)	(0.11)
β_{+3}	-0.17	-0.045
	(0.088)	(0.095)
β_{-4}	0.36	-0.0085
	(0.11)	(0.062)
β_{+4}	-0.0031	0.0057
	(0.091)	(0.10)
Time FE	Yes	Yes
R^2	0.014	0.014
Observations	364274	342331

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on small VAT changes (smallest quartile in absolute value). The first column shows the estimates for VAT increases and the second that for VAT decreases. Standard errors are clustered by month and are in parenthesis. β_0 measures the pass-through of the VAT change at the time of the reform and β_i measures price changes i months away from the reform.

Table A.13: Pass-Through Estimates: Standard VAT Rate

	Δ log Price	
	Increase	Decrease
β_0	0.39	0.12
	(0.069)	(0.037)
β_{+1}	-0.010	0.038
	(0.021)	(0.023)
β_{-2}	0.022	0.025
	(0.029)	(0.023)
β_{+2}	0.065	-0.040
	(0.039)	(0.029)
β_{-3}	-0.00041	0.0080
	(0.024)	(0.039)
β_{+3}	-0.058	0.023
	(0.023)	(0.035)
β_{-4}	0.064	-0.027
	(0.046)	(0.034)
β_{+4}	-0.0051	-0.024
	(0.040)	(0.023)
Time FE	Yes	Yes
R^2	0.020	0.021
Observations	256671	227730

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on commodities subject to the standard VAT rate. The first column shows the estimates for VAT increases and the second that for VAT decreases. Standard errors are clustered by month and are in parenthesis. β_0 measures the pass-through of the VAT change at the time of the reform and β_i measures price changes i months away from the reform.

Table A.14: Pass-Through Estimates: Reduced VAT Rate

	Δ log Price	
	Increase	Decrease
β_0	0.27	0.017
	(0.066)	(0.035)
β_{+1}	0.058	0.0081
	(0.021)	(0.013)
β_{-2}	0.039	0.023
	(0.015)	(0.015)
β_{+2}	-0.020	-0.037
	(0.014)	(0.020)
β_{-3}	0.027	-0.014
	(0.011)	(0.022)
β_{+3}	-0.021	-0.023
	(0.017)	(0.019)
β_{-4}	0.025	-0.012
	(0.030)	(0.024)
β_{+4}	-0.015	0.0078
	(0.018)	(0.024)
Time FE	Yes	Yes
R^2	0.013	0.011
Observations	131428	116535

Notes: The coefficients reported in this table indicate the pass-through of VAT increases and decreases to prices estimated using specification (1) on commodities subject to the reduced VAT rate. The first column shows the estimates for VAT increases and the second that for VAT decreases. Standard errors are clustered by month and are in parenthesis. β_0 measures the pass-through of the VAT change at the time of the reform and β_i measures price changes i months away from the reform.

Table A.15: Heterogeneity by Zipcode Density

	Markup (decrease)	Markup (increase)	Log variable costs (decrease)	Log variable costs (increase)	Log turnover (decrease)	Log turnover (increase)
2nd most dense*reform	0.002	-0.004	0.006	-0.002	0.019	-0.01
	(-0.021)	(-0.02)	(-0.022)	(-0.019)	(-0.014)	(-0.013)
3rd most dense*reform	0.019	0.014	-0.0188	-0.022	0.003	-0.016
	(-0.018)	(-0.021)	(-0.019)	(-0.018)	(-0.012)	(-0.013)
4th most dense*reform	-0.01	0.003	0.02	-0.021	0.020*	-0.023*
	(-0.021)	(-0.02)	(-0.021)	(-0.02)	(-0.012)	(-0.013)
5th most dense*reform	0.041**	-0.001	-0.050***	-0.005	-0.013	-0.009
	(-0.019)	(-0.019)	(-0.018)	(-0.015)	(-0.012)	(-0.013)
2nd most dense	-0.001	0.001	0.024	0.03	0.018	0.037**
	(-0.026)	(-0.026)	(-0.03)	(-0.028)	(-0.019)	-0.018
3rd most dense	-0.014	0.005	0.069**	0.05	0.061***	0.064***
	(-0.028)	(-0.033)	(-0.029)	(-0.031)	(-0.018)	(-0.019)
4th most dense	-0.023	-0.033	0.122***	0.141***	0.117***	0.136***
	(-0.025)	(-0.03)	(-0.026)	(-0.027)	(-0.021)	(-0.02)
5th most dense	-0.021	0.02	0.198***	0.148***	0.205***	0.193***
	(-0.03)	(-0.03)	(-0.056)	(-0.053)	(-0.045)	(-0.044)
VAT Increase		-0.052***		0.057***		0.030***
		(-0.015)		(-0.014)		(-0.01)
VAT Decrease	0.113***		0.136***		0.202***	
	(-0.014)		(-0.014)		(-0.009)	
Constant	0.947***	1.060***	8.833***	8.969***	10.18***	10.38***
	(-0.018)	(-0.018)	(-0.022)	(-0.02)	(-0.018)	-0.015
Observations	91,544	79,003	92,347	79,195	91,789	79,195
R-squared	0.006	0.001	0.009	0.004	0.036	0.011

Notes: This table shows the changes in the level of markups, variable costs and turnover by quintiles of zipcode density; 2nd most dense, 3rd most dense, etc. are dummies for hairdressers being located in a zipcode that belongs to the 2nd most dense quintile, 3rd most dense quintile, etc. of zipcodes. The variable 2nd most dense*reform is the interaction of the quintile density dummy with a dummy for reform year. VAT increase and VAT decrease are dummies for the years when the VAT increase and decrease occur. We use 10 years of data when we study the VAT decrease (2002-2011), 5 years before and after the reform, and 8 years of data when we examine the VAT increase (2007-2014), 4 years before and after the reforms. Standard errors are clustered by municipalities and are in parentheses. The dummy for the least dense zipcodes and the interaction of this dummy with a dummy for the reform year are both omitted.