Price Pass-through Dependence on the Source of Cost Increases: Evidence from the European Gasoline Market

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Motivation

A huge literature investigates the response of retail gasoline price to changes in upstream input prices.

This literature is broad in its relevance:

- search theory
- dynamic competition (e.g., Edgeworth cycles)
- pricing
- pass-through (including from foreign exchange and tax)
- inflation dynamics
- tacit collusion and market power
- link between information and consumer demand

Literature impacts several fields including Industrial Organization, Macroeconomics, and Applied Econometrics.

Motivation (cont.)

Studies span 30 years, dozens of countries, and are very heterogenous in the research design:

- Use data at various level of spatial aggregation
  - from individual gas stations to continent-size countries (US)
- Cover periods of less than one year to longer than a decade
- Range in frequency from less than one day to a month
- Consider pre-tax or after-tax prices
  - sometimes in logs and sometimes in levels
- Most employ auto-regressive models:
  - plain autoregressive distributed lag models
  - simple error correction models

Motivation (cont.)

Passthrough estimates exhibit widely different answers.

A number of possible reasons:

- Market heterogeneity
  - markets differ along relevant characteristics, such as competitiveness
- Time heterogeneity
  - recent studies less likely to find asymmetries
- Research design heterogeneity
  - data frequency
  - spatial aggregation
  - price definition
  - minor differences in specification

Research questions

Knowing how price pass-through affects estimates is a prerequisite

1. for assessing how much heterogeneity there is in the price process across countries/time
2. for accurate comparison across studies

To do so, we need to use the same yardstick:

- Fix the type and amount of data
- Vary research design one element at a time

Relevance to Macroeconomics

The adjustment speed of inflation and CPI to shocks, including input price shocks, linked to individual price adjustments.

Oil shock effects on output and inflation differs across countries (e.g., Kilian 2008). Upstream to downstream pass-through plays a role.

Many studies have looked at a broad range of prices.

Relevance to Macroeconomics (cont.)

Paper's value not limited to helping us understand the effect of oil price changes on inflation.

$\longrightarrow$ This effect is rather small (see Alvarez et al, 2011).

It improves our general understanding of heterogeneity in price pass-through estimates compared to exchange rate fluctuations.

This heterogeneity and data dependence is of relevance for a broad swath of industries.

In aggregate, these have a material impact on inflation transmission.

Contribution

1. Use a single parent dataset to measure the variability of
   - the passthrough estimates
   - measured asymmetries
2. Identify linkages between those estimates and
   - the data configuration
   - the estimation window
   - the estimation technique and specification
3. Relate the price passthrough rates to demand (currency fluctuations and growth, consumer search, asymmetric responses) and supply side explanations (non-linear responses, euro factors, differential persistence of shocks, contractual factors).

Data

Retail Gasoline Price, $R_{j,t}$:

- Weekly country average
- Pre-tax and after-tax
- Source: Weekly Oil Bulletin, European Commission

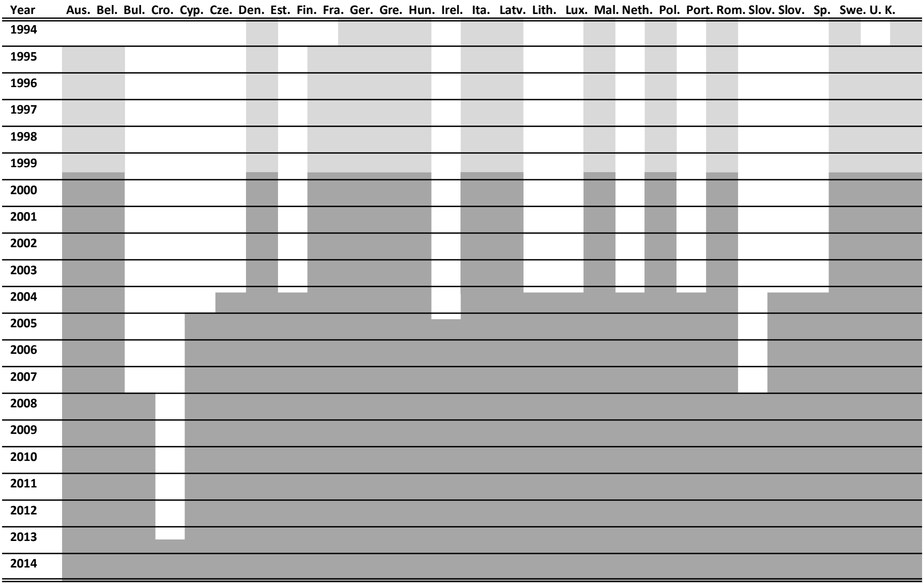
Upstream Input Price, C_t:

- Rotterdam price (A-R-A), daily value
- New York Gasoline, daily value.
- Source: Platt's and US Energy Information Administration

Notes:

- All price series are in nominal values.
- All prices converted to EURO (ECU), per 1000 liters.

Country/Year Coverage



Empirical Framework

Autoregressive distributed lag model (ARDL):

$$\Delta\log\left(R_{j,t}\right) = a_j + a_s + \sum_{l=0}^{L} b_l \Delta\log\left(E_{j,t-l}\right) + \sum_{l=0}^{L} \beta_l \Delta\log(\Gamma_{t-l}) + \varepsilon_{j,t}$$

where α_j, α_{s_t} are country and month dummies, and L is lag length.

Error Correction model (ARDL + error correction term):

$$\Delta\log\left(R_{j,t}\right) = a_j + a_s + \sum_{l=0}^{L} b_l \Delta\log\left(E_{j,t-l}\right) + \sum_{l=0}^{L} \beta_l \Delta\log(\Gamma_{t-l}) +$$
$$\sum_{l=1}^{L} c_l \Delta\log\left(R_{j,t-l}\right) + d\left(\log\left(R_{j,t-1}\right) - k_j - m\log(C_{t-1})\right) + \varepsilon_{j,t}$$

Estimated as a panel, or country-by-country.

The above models are also estimated in levels

Sampling Framework

Time period 1994-2015, EU-28 Countries

Unbalanced panel dataset of pre-tax retail gasoline prices

We use the full data set

The weekly series for the upstream prices is obtained by averaging the daily values for the preceding week

We perform the same conversion for the daily US dollar to Euro/ECU exchange rate to arrive at the weekly exchange rate

We use certain macroeconomic time series and information about web searches (GDP, Google trends, HCPI)

A small but noticeable difference between ERPT and price pass-through, especially in the first few weeks.

Changes in the world price (in dollars) are passed through somewhat faster than ERPT

The joint test of the differences $b_l \neq \beta_l$ for all nine lags and the contemporaneous term is statistically significant for both specifications.

Similar findings hold for the cumulative pass-through of a cost change, which is given by the sum of the individual differences

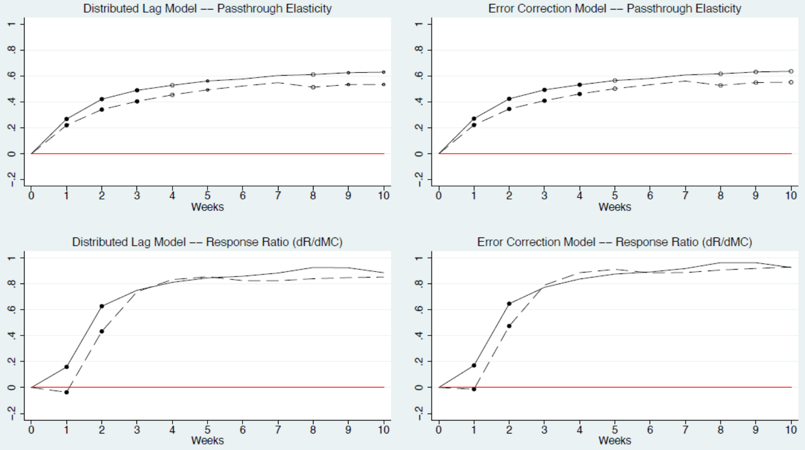
The results do not drastically change when we estimate the models (ARDL & ECM) in levels

Table 1. Retail Price Elasticity with Respect to Changes in the World Price and the Exchange Rate.

	Distributed Lag Model		Error Correction Model	
	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Δlog(Rotterdam Price in USD)	0.268	*0.008*	0.271	*0.008*
Δlog(Rotterdam Price in USD)_{t-1}	0.153	*0.006*	0.168	*0.007*
Δlog(Rotterdam Price in USD)_{t-2}	0.068	*0.006*	0.093	*0.007*
Δlog(Rotterdam Price in USD)_{t-3}	0.039	*0.006*	0.058	*0.008*
Δlog(Rotterdam Price in USD)_{t-4}	0.033	*0.006*	0.051	*0.007*
Δlog(Rotterdam Price in USD)_{t-5}	0.016	*0.006*	0.035	*0.008*
Δlog(Rotterdam Price in USD)_{t-6}	0.027	*0.005*	0.041	*0.007*
Δlog(Rotterdam Price in USD)_{t-7}	0.008	*0.005*	0.025	*0.007*
Δlog(Rotterdam Price in USD)_{t-8}	0.014	*0.005*	0.027	*0.007*
Δlog(Rotterdam Price in USD)_{t-9}	0.004	*0.005*	0.015	*0.007*
Δlog(Exchange Rate)	0.221	*0.018*	0.222	*0.018*
Δlog(Exchange Rate)_{t-1}	0.121	*0.019*	0.131	*0.019*
Δlog(Exchange Rate)_{t-2}	0.063	*0.018*	0.078	*0.019*
Δlog(Exchange Rate)_{t-3}	0.050	*0.019*	0.063	*0.019*
Δlog(Exchange Rate)_{t-4}	0.039	*0.018*	0.054	*0.018*
Δlog(Exchange Rate)_{t-5}	0.029	*0.018*	0.045	*0.019*
Δlog(Exchange Rate)_{t-6}	0.026	*0.016*	0.040	*0.017*
Δlog(Exchange Rate)_{t-7}	-0.035	*0.018*	-0.020	*0.019*
Δlog(Exchange Rate)_{t-8}	0.020	*0.018*	0.025	*0.019*
Δlog(Exchange Rate)_{t-9}	0.000	*0.017*	0.007	*0.018*
Δlog(Retail Price in Local Currency)_{t-1}			-0.126	*0.013*
Δlog(Retail Price in Local Currency)_{t-2}			-0.063	*0.013*
Δlog(Retail Price in Local Currency)_{t-3}			-0.035	*0.012*
Δlog(Retail Price in Local Currency)_{t-4}			-0.039	*0.013*
Δlog(Retail Price in Local Currency)_{t-5}			-0.037	*0.013*
Δlog(Retail Price in Local Currency)_{t-6}			-0.020	*0.013*
Δlog(Retail Price in Local Currency)_{t-7}			-0.030	*0.010*
Δlog(Retail Price in Local Currency)_{t-8}			-0.018	*0.010*
Δlog(Retail Price in Local Currency)_{t-9}			-0.007	*0.011*
log(Retail Price in Local Currency)_{t-1}			-0.043	*0.004*
log(Rotterdam Price in USD)_{t-1}			0.030	*0.003*
Monthly Dummies (p-value)	0.3476		0.0775	
Country Dummies (p-value)	1.0000		0.0000	
Equality of Rott. price and XR (p-value)	0.0311		0.0112	
Cumulative Rott. and XR effects	0.0954	*0.0466*	0.1384	*0.0472*
Disturbance autocorrelation	-0.1331	*0.0066*	-0.0008	*0.0067*
R-squared	0.2956		0.3286	

Figure 1. Retail Passthrough from Changes in Wholesale Cost Components

Rotterdam Wholesale to European Union Retail Price



Solid line: passthrough from world wholesale price in USD, dashed line: exchange rate passthrough.
Solid marker: statistically significant difference at 1%; hollow marker: signif. at 5%; small marker: signif. at 10%

Impulse Response Functions

Pass-through to exchange rate shocks is slower and smaller

The difference is statistically significant in most weeks, more so using the ECM

The profile is almost identical between the DL and ECM

The elasticity response gap between the two series is initially small but grows to almost 0.1 for the second to fifth weeks

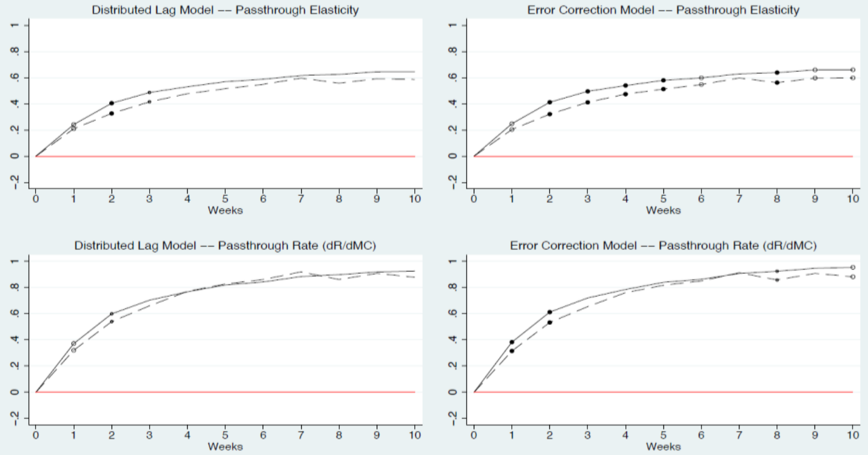
The ERPT driven cost changes is again slower than pass-through to changes in the world price.

The response difference is significant for the first two periods, but it essentially vanishes after the third week.

Passthrough Estimates: Country-by-Country Averages

Figure 2. Retail Passthrough from Changes in Wholesale Cost Components

Rotterdam Wholesale to European Union Retail Price: Country–by–Country Averages



Solid line: passthrough from world wholesale price in USD, dashed line: exchange rate passthrough.
Solid marker: statistically significant difference at 1%; hollow marker: signif. at 5%; small marker: signif. at 10%

Passthrough Estimates: Country-by-Country Averages

The log models (see top 2 panels) are similar in terms of point estimates; significance is also similar for the estimates of the ECM.

The models estimated in levels and which yield the pass-through rate, no longer have the near-zero response in the first period

Significance is stronger in the country-by-country estimates than in the panel estimates when considering the ECM.

The difference between ERPT and world price passthrough is larger for the log specifications than for the levels specifications

The gap between the two responses is short-lived (e.g., greatest in weeks 2 through 4 after the initial shock).

Slope heterogeneity bias is small

Supply side explanations

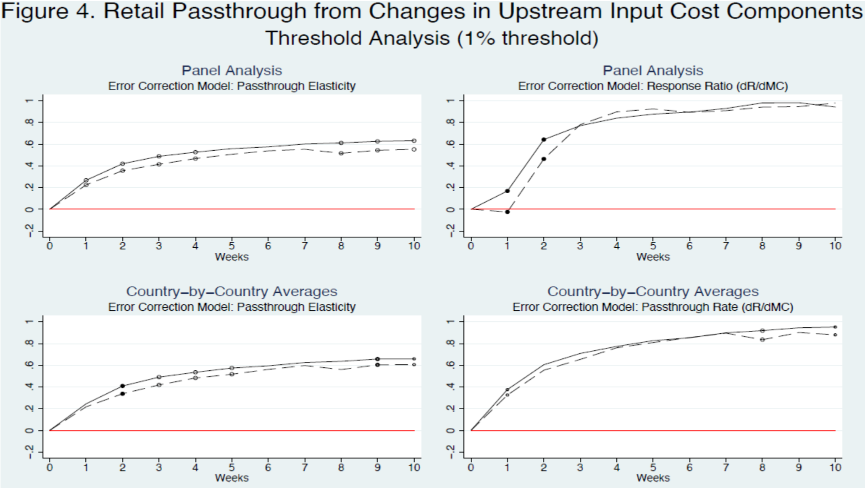
1. **Non-linear responses to the size of the shock** (e.g., menu costs, oligopolistic interaction, kinked demand curve, etc)

Estimation of a simple **threshold** response model

$$\Delta\log(R_{j,t}) = a_j + a_s + \sum_{l=0}^{L} b_l \mathbb{I}_{j,t}^{E1\%}\,\Delta\log(E_{j,t-l}) + \sum_{l=0}^{L} \beta_l \mathbb{I}_{j,t}^{\Gamma 1\%}\Delta\log(\Gamma_{t-l}) + \varepsilon_{j,t}$$

where $\mathbb{I}_{j,t}^{E1\%}$ is an indicator variable that takes the value of 1 if $|E_{j,t} - E_{j,t-1}| > 0.01\, E_{j,t-1}$ and zero otherwise, and $\mathbb{I}_{j,t}^{\Gamma 1\%}$ is an indicator variable that takes the value of 1 if $|\Gamma_{j,t} - \Gamma_{j,t-1}| > 0.01\, \Gamma_{j,t-1}$ and zero otherwise.

Supply side explanations (cont.)



Solid line: passthrough from world input price in USD, dashed line: exchange rate passthrough.
Solid marker: statistically significant difference at 1%; hollow marker: signif. at 5%; small marker: signif. at 10%

Supply side explanations (cont.)

The point estimates of passthrough are substantively the same, and the difference in passthrough rates only slightly smaller

For the country-by-country regressions, the gap in the threshold models is, 1.1 and 0.6 percentage points smaller

These small differences result in statistical significance that is noticeably lower for the threshold models

It does not appear that threshold effects explain the slower ERPT, but accounting for them somewhat reduces the response gap

Supply side explanations (cont.)

2. Euro Specific Factors

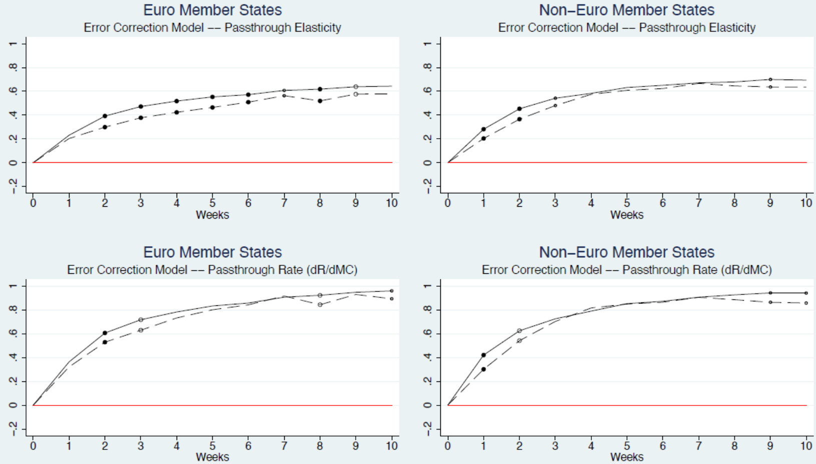
The Euro adoption affects global demand, leading to expectations of imminent changes in the price of oil that are not accounted for by the dollar price of gasoline

We have re-estimated the price adjustment regressions separately for the countries that have joined the Euro and those that have not

The general pattern for the two sets of countries is the same

Adjustment to exchange rate changes is slower and smaller than the adjustment to the dollar price of wholesale gasoline, with the difference being statistically significant in many of the post-shock weeks

Figure 5. Retail Passthrough from Changes in Wholesale Cost Components
Rotterdam Wholesale to E.U. Retail Price by Euro Membership: Country–by–Country Av.



Solid line: passthrough from world wholesale price in USD, dashed line: exchange rate passthrough.
Solid marker: statistically significant difference at 1%; hollow marker: signif. at 5%; small marker: signif. at 10%

Supply side explanations (cont.)

3. Differential persistence of shocks

Firms are less likely to respond to a cost change that will likely reverse itself within a week. Serial correlation of changes in the exchange rate and the world price of gasoline could be of relevance

We compute the serial correlation in changes in the logs of the exchange rate and the dollar price of gasoline

The exchange rate persistence is even higher when we limit it to the euro rate

The correlations are positive, and there is no reversion in the short run for either series

Limited evidence that the slower response of retail prices to exchange rates is driven by expectations that these rates will revert to their prior values

Supply side explanations (cont.)

4. Contractual Factors

Refinery contracts to retailers treat exchange rates and the world price of gasoline differentially

The contractual ex-refinery price is based on the international price of gasoline converted in domestic currency.

It responds symmetrically to changes in either component.

Both the exchange rate and the international price of gasoline as used in the calculation of the ex-refinery price in many EU countries

No evidence that the slower pass-through to exchange rate changes is driven by the retailer cost side

Demand side explanations

1. **Currency Fluctuations and Growth**

A currency depreciation is associated with weaker growth for the EU

The pass-through rate would, therefore, be tempered by the demand reduction

We measure exposure by the country's trade ratio

We estimate the following model

$$\Delta\log\left(R_{j,t}\right) = a_j + a_s + \sum_{l=0}^{L} b_{j,l}\Delta\log\left(E_{j,t-l}\right) + \sum_{l=0}^{L} \beta_l \Delta\log(\Gamma_{t-l}) + \varepsilon_{j,t}$$

where $b_{j,l} = b_{C,l} + b_{R,l}TR_{j,t-y}$, $TR_{j,t-y}$ is the country's trade ratio for the preceding year, and $b_{C,l}$ and $b_{R,l}$ are parameters to be estimated

Demand side explanations (cont.)

We also estimate the following equation

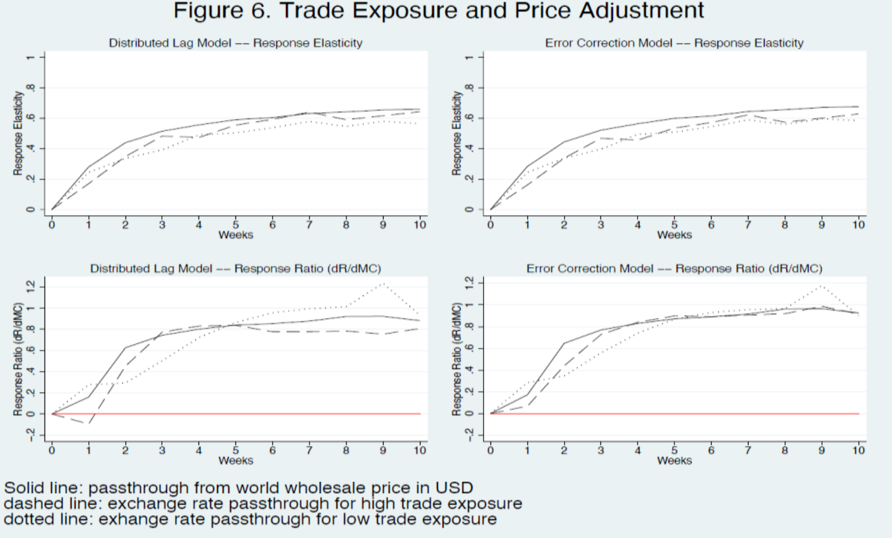
$$\Delta\log\left(R_{j,t}\right) = a_j + a_s + \sum_{l=0}^{L} b_{j,l}\Delta\log\left(E_{j,t-l}\right) + \sum_{l=0}^{L} \beta_l \Delta\log(\Gamma_{t-l}) + \sum_{l=1}^{L} c_l \Delta\log\left(R_{j,t-l}\right) + d\left(\log\left(R_{j,t-1}\right) - k_j - m\log(C_{t-1})\right) + \varepsilon_{j,t}$$

Using GNP as an independent variable we also estimate the models

$$\Delta\log\left(R_{j,t}\right) = a_j + a_s + \sum_{l=0}^{L} b_l\Delta\log\left(E_{j,t-l}\right) + \sum_{l=0}^{L} \beta_l \Delta\log(\Gamma_{t-l}) + g\Delta\log\left(\mathrm{GNP}_{j,t}\right) + \varepsilon_{j,t} \quad (1)$$

$$\Delta R_{j,t} = a_j + a_s + \sum_{l=0}^{L} b_l \Delta E_{j,t}\Gamma_{t-1} + \sum_{l=0}^{L} \beta_l \Delta\Gamma_{j,t} E_{t-1} + g\,\frac{\Delta\mathrm{GDP}_{j,t}}{\mathrm{GDP}_{j,t}} + \varepsilon_{j,t} \quad (2)$$

Demand side explanations (cont.)



Demand side explanations (cont.)

The estimated response in the log regressions (top panels) appears to be quantitatively indistinguishable for high and low trade exposure countries

The differences between low and high exposure countries for the analysis in levels (bottom panels) are noticeable but quite variable

Demand factors are unlikely to be a main source of the difference in price-passthrough and ERPT

Demand side explanations (cont.)

2. Consumer Search and Local Market Competition

Consumers decide whether to purchase gasoline or keep searching for a lower price based on their expectations of the retail price distribution (Lewis, 2011; Lewis and Marvel, 2011)

Currency fluctuations likely have a far smaller conditioning effect due to the multiplicity of exchange rates and lack of consumers' information

We obtain some indirect evidence from Google Trends

The search intensity for the term "oil price" is not only higher than that for "exchange rate," but it is also far more variable from year to year

Searches for the term exchange rate are highest in emerging economies than in western countries), whereas a search for "oil price" is relatively more prominent in western economies

Consumers are more aware of oil price than exchange rate fluctuations

Demand side explanations (cont.)

Panel A. Search intensity trends for "Exchange Rate" (blue) and "Oil Price" (red) as a News item.

Panel B: Geographic distribution of search intensity for "Exchange Rate" as a News item.

Panel C: Geographic distribution of search intensity for "Oil Price" as a News item.

Figure 7. Comparison of the relative search intensity for the terms "Exchange Rate" (in blue) and "Oil Price" (in red) from Google trends for the 2008 to 2019 period. The maximum value of search activity is normalized to 100.

Demand side explanations (cont.)

3. Asymmetric Responses

An extensive literature of the "*rockets-and-feathers*" hypothesis has been established (Bacon, 1991; Karrenbrock, 1991)

A rockets-and-feathers adjustment price would result in retail price passthrough being (on average) faster with respect to wholesale price changes than with respect to exchange rate changes.

The asymmetries are small and importantly of the opposite sign than the "*rockets and feathers*" pattern

Asymmetries do not contribute towards the passthrough differences we observe in the data

Conclusions

- The transmission of input price shocks in gasoline is faster, when it is driven by changes in the international price of gasoline than by changes in a country's exchange rate
- Demand-side factors are the most likely explanation
- The relatively smaller range of exchange rate swings may also be a contributing factor
- There may not always be a unique passthrough rate to cost increases