A Regime Switching Analysis of Exchange Rate Pass-through

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Changes in the Exporters' Pricing Policies

- Question
  What are the economic factors that affect the exporters' pricing policies, especially their choice of exchange rate pass-through (the elasticity of their price w.r.t. the exchange rate)?

- Motivation
  Several recent studies document a decline in the exchange rate pass-through: Campa and Goldberg (2005); Ihrig, Marazzi and Rothemberg (2006); Marazzi and Sheets (2007); Frankel, Parsley and Wei (2005)

- Determinants of the Choice of Optimal Degree of Pass-through
  - **Market Concentration:** Krugman (1986), Froot and Klemperer (1989), Bodnar, Dumas and Marston (2002)
  - **Exporting Country's Market Share:** Feenstra, Gagnon and Knetter (1996), Bacchetta and van Wincoop (2005)
  - **Monetary Stability:** Taylor (2000), Devereux, Engel and Storgaard (2004)

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Our Approach

- We collected data on automobile imports into the US in order to study the factors that have led to changes in the exchange rate pass-through.
- We theoretically illustrate how changes in the pass-through elasticity emerges together with changes in other factors in the optimal export price, such as the marginal cost pass-through and the degree of strategic complementarity.
- We assumes that in every period exporters set prices by following either a “high pass-through” or a “low pass-through” pricing policy, where all the parameters are allowed to be different across the pricing policies.
- The transition from one policy to the other is governed by a Markov process, whose transition probabilities are driven by economic fundamentals (market concentration, exchange rate volatility, etc.).
- We estimate the model following Diebold, Lee and Weinbach’s (1994) methodology.

Main Results

- We find that the “low pass-through” regime is characterized by:
  - a low exchange rate pass-through,
  - lower response to misalignments in the firm’s relative price,
  - lower volatility of technology and preference shocks,
  - higher duration of the pricing regime.
- We also find that the year-to-year variations in the average exchange rate pass-through can be explained by
  - market concentration: $\sim$40%
  - exchange rate volatility: $\sim$37%
  - cross-country inflation differential: $\sim$22%
  - exporting country’s market share: less than 2%.

The Optimal Price Equation

- At time $t-1$, the exporting firm chooses its baseline price and the degree of indexation to the exchange rate shocks in order to maximize its expected real profits. The log-linearized optimal price equation is

$$\hat{p}_{\ell t} = \beta^{s}_{\xi_{\ell t}} \hat{s}_t + \beta^{\psi}_{\xi_{\ell t}} E_{t-1} \hat{\psi}_{\ell t} + \beta^{P_{\mathbb{L}}}_{\xi_{\ell t}} E_{t-1} \hat{P}_{\mathbb{L}t} + E_{t-1} \hat{Y}'_{\ell t} \beta^{y}_{\xi_{\ell t}}$$

where

$\hat{s}_t$: exchange rate shocks

$E_{t-1}\hat{\psi}$: expected marginal cost

$E_{t-1}\hat{P}_{\mathbb{L}t}$: expected industry price index

$E_{t-1}\hat{Y}$: other factors, e.g., US disposable income.

- The regime switching framework (with time-varying transition probabilities) allows us to estimate two sets of pricing equation parameters, as well as the probabilities of changing pricing policies.
- The empirical pricing equation we postulate is:

$$\Delta \hat{p}_{\ell t} = \beta^{s}_{\xi_{\ell t}} \Delta \hat{s}_t + \beta^{\psi}_{\xi_{\ell t}} \Delta \hat{\psi}_{\ell t} + \beta^{P_{\mathbb{L}}}_{\xi_{\ell t}} \Delta \hat{P}_{\mathbb{L}t} + \Delta \hat{Y}'_{\ell t} \beta^{y}_{\xi_{\ell t}} + \varepsilon_{\xi_{\ell t}}$$

where $\varepsilon_{\xi_{\ell t}} \sim N(0, \sigma_{\xi_t})$ and

$$\xi_{\ell t} \in \{0, 1\}$$

follows a two-state Markov process.

- The components of the transition probability matrix are:

$$g^{00}_{\ell t} \equiv \Pr(\xi_{\ell t} = 0 | \xi_{\ell t-1} = 0) = \mathfrak{B}(\underline{z}'_{\ell t-1} \phi_0),$$
$$g^{11}_{\ell t} \equiv \Pr(\xi_{\ell t} = 1 | \xi_{\ell t-1} = 1) = \mathfrak{B}(\underline{z}'_{\ell t-1} \phi_1)$$

and $g^{10}_{\ell t} = 1 - g^{00}_{\ell t}$ and $g^{01}_{\ell t} = 1 - g^{11}_{\ell t}$.

The Log-likelihood Function and Estimation

- The contribution of the unit ℓ to the *complete-data* likelihood function can be written as:

$$L_\ell(\theta) = \prod_{t=1}^{T} f\left(\Delta\hat{p}_{\ell t}|\xi_{\ell t}; \beta_0, \beta_1, \sigma_0, \sigma_1\right) Pr(\xi_t|\xi_{t-1}, z_{t-1}; \phi_0, \phi_1)$$

- Assuming that the Markov processes are independent across the automobile lines, we get the complete-data conditional log-likelihood function of all units as:

$$L(\theta) = \sum_{\ell=1}^{N} \log L_\ell(\theta)$$

- We use the SEM algorithm to maximize the likelihood function, where we estimate the probability of being in one of the two regimes as well as the parameters of the pricing policy.

Data Sources

- We collected data on cars imported to the US: *Ward's Automotive Yearbook*: model year 1980-2004.
- Selection of 35 car lines:
  - have information for at least ten consecutive years of prices.
  - have information on quantities sold.
  - know the input sources and content of production.
- Seven exporting countries: France, Germany, Italy, Japan, Korea, Sweden and the United Kingdom.
- Information on total quantities sold in the market helps us construct measures for market concentration and country market share.

The Dependent Variable

- We use the *manufacturer's suggested retail price* (in U.S. dollars) at the port of entry.
- Our prices:
  - are at the port of entry, which implies pass-through at the dock, and not the pass-through to the final consumer price.
  - do not include destination charges.
  - do not include domestic costs added by the dealer through optional equipment.
  - do not include potential discriminatory practices of the dealer.
  - do not include state or local taxes.
  - include ocean freight and U.S. import duty.
- We have physical attributes: size, horse power, cylinders, dimensions, etc., that allow us to obtain and use *quality-adjusted prices in our estimations*.

Parameter Estimates

		Specification of the Probability Equation (variables in vector Z): constant model 1	market concentration model 2	country share model 3	inflation model 4	volatility of exch.rate model 5
Parameters in Pricing Equation						
Exchange Rate Surprise	*LPT*	0.0492**	0.0414**	0.0677**	0.0811**	0.0390**
		(0.0148)	(0.0158)	(0.0184)	(0.0238)	(0.0133)
	HPT	0.1487**	0.1484**	0.1631**	0.1400*	0.1482**
		(0.0621)	(0.0071)	(0.0730)	(0.0779)	(0.0585)
Industry Price Index	*LPT*	0.5048**	0.5203**	0.5522**	0.6243**	0.4858**
		(0.0461)	(0.0596)	(0.0563)	(0.0238)	(0.0480)
	HPT	0.8599**	0.8511**	0.9121**	0.9186**	0.8112**
		(0.2514)	(0.2650)	(0.2928)	(0.3280)	(0.2323)
Marginal Cost		0.0690**	0.0729**	0.0644**	0.0707**	0.0683**
		(0.0153)	(0.0142)	(0.0197)	(0.0233)	(0.0145)
Income		-0.2826**	-0.2427**	-0.3055**	-0.1416	-0.3119**
		(0.1321)	(0.1217)	(0.1487)	(0.2267)	(0.1342)
Parameters in Probability Equation						
Constant	*LPT*	0.5507**	0.1988**	1.2017**	0.3049**	0.1442
		(0.2264)	(0.0969)	(0.3170)	(0.0000)	(0.3615)
	HPT	0.4057*	0.0518	1.0474**	-0.5076	-0.4657
		(0.2183)	(0.1153)	(0.3228)	(0.4774)	(0.3524)
Z_1	*LPT*		-2.6939**	-0.0186**	1.3204**	2.1758
			(1.1329)	(0.0079)	(0.0000)	(1.8347)
	HPT		-3.9574**	-0.0573**	1.3135	6.0476**
			(1.2400)	(0.0099)	(1.5503)	(2.1397)
Z_2	*LPT*				0.1036	
					(1.0084)	
	HPT				0.6505	
					(0.9797)	
Variances of Pricing Errors						
σ_0^2	*LPT*	0.0002**	0.0002**	0.0004**	0.0005**	0.0002**
		(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0001)
σ_1^2	*HPT*	0.0128**	0.0125**	0.0146**	0.0150**	0.0121**
		(0.0015)	(0.0000)	(0.0018)	(0.0020)	(0.0013)
Average Duration *LPT*		2.73	2.25	3.06	3.54	2.63
Average Duration *HPT*		2.50	2.07	1.81	2.34	2.60
Log-likelihood		539.3208	545.3112	550.9166	536.6366	548.1131
Obs.		583	583	583	583	583

Fraction of Firms in Low Pass-through

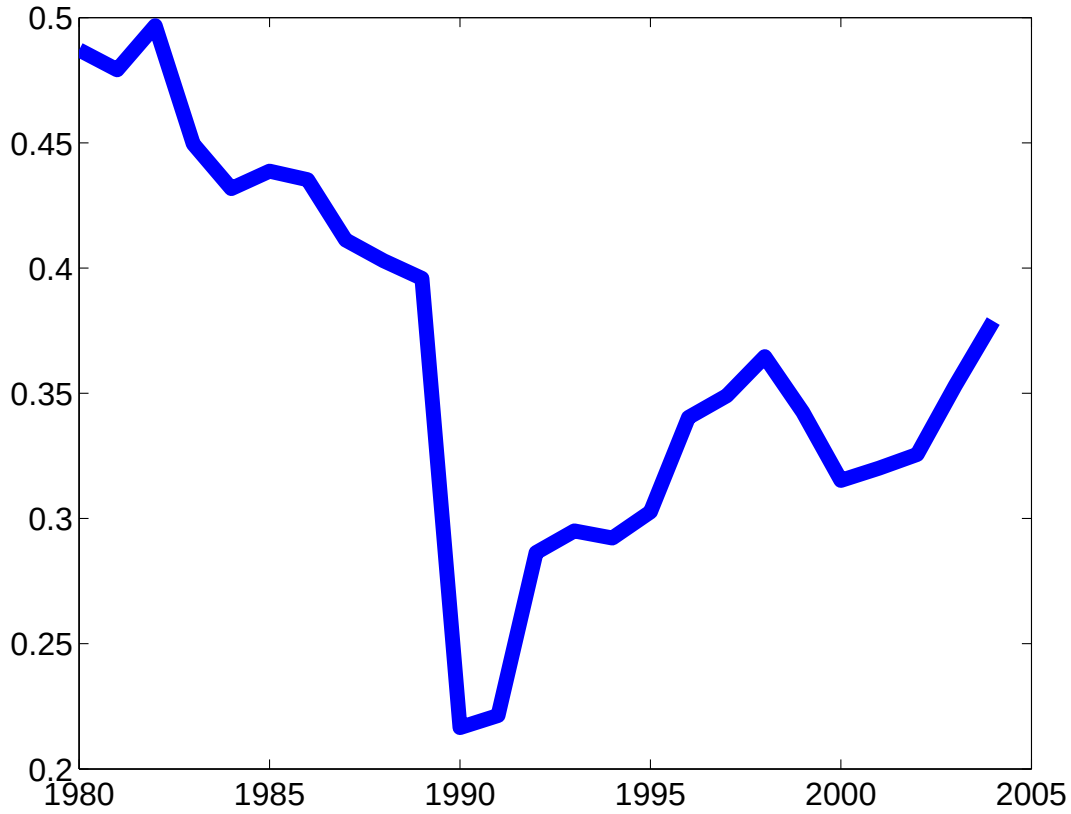
- Assume that there is a continuum of mass one of firms exporting to the US.
- In t, the fraction Λ_t is subject to the "low pass-through" policy.
- Then the evolution of Λ_t is

$$\Lambda_t = \Lambda_{t-1} g_t^{00} + (1 - \Lambda_{t-1})(1 - g_t^{11}).$$

- The dynamics of Λ_t is driven by g_t^{00} and g_t^{11}, where $g_t^{ii} = \frac{\exp(\underline{z}'_{\ell t-1}\hat{\phi}_i)}{1+\exp(\underline{z}'_{\ell t-1}\hat{\phi}_i)}$.

Figure 1: Market Concentration & % of Firms in Low Pass-trough Regime

A) Herfindahl Index



B) Fraction of Firms in Low Pass-through & Change in Herfindahl Index

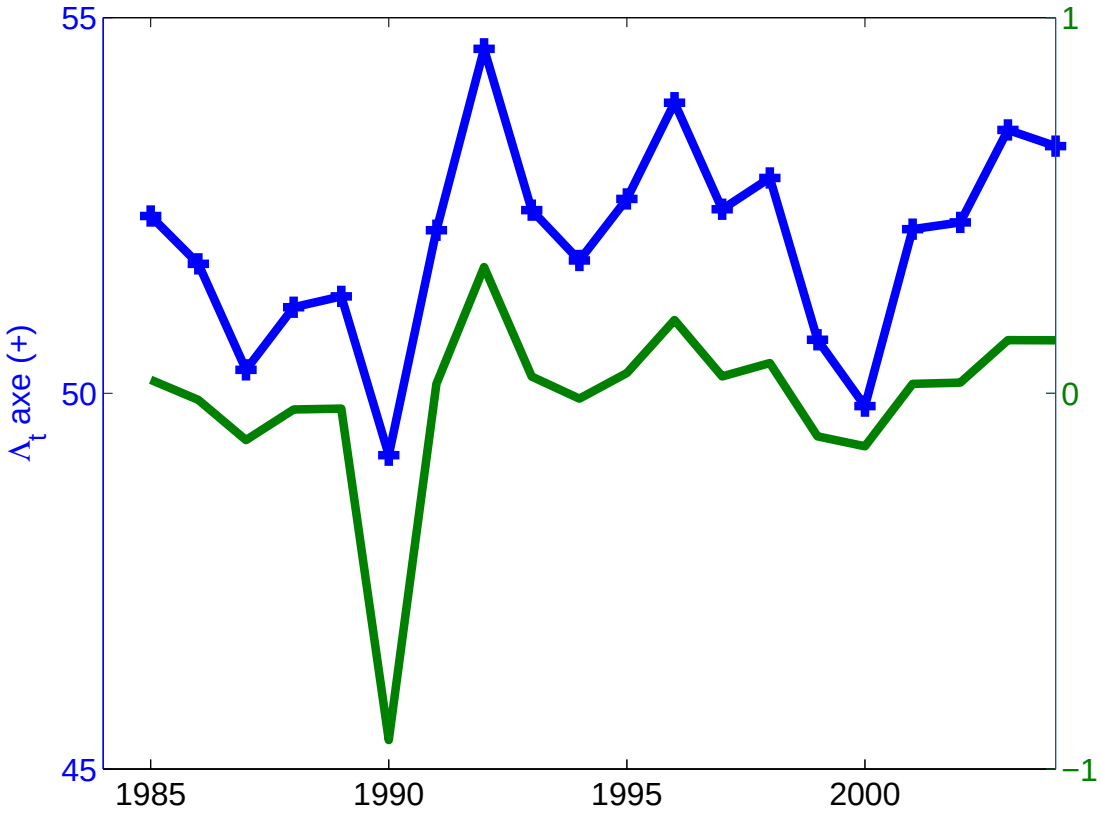


Figure 2: Exporter's Country Share & % of Firms in Low Pass-trough Regime

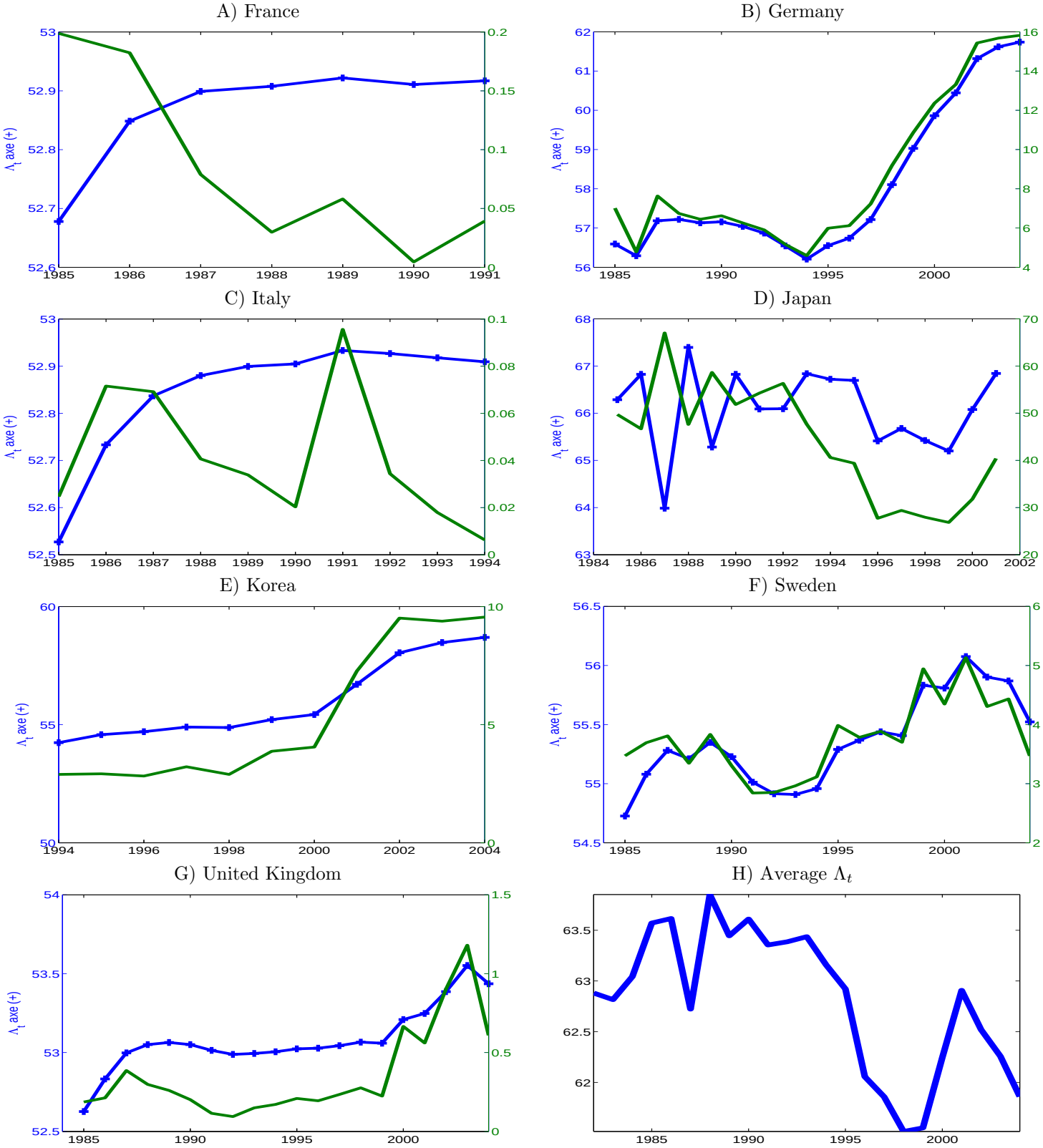


Figure 3: US inflation & % of Firms in Low Pass-trough Regime

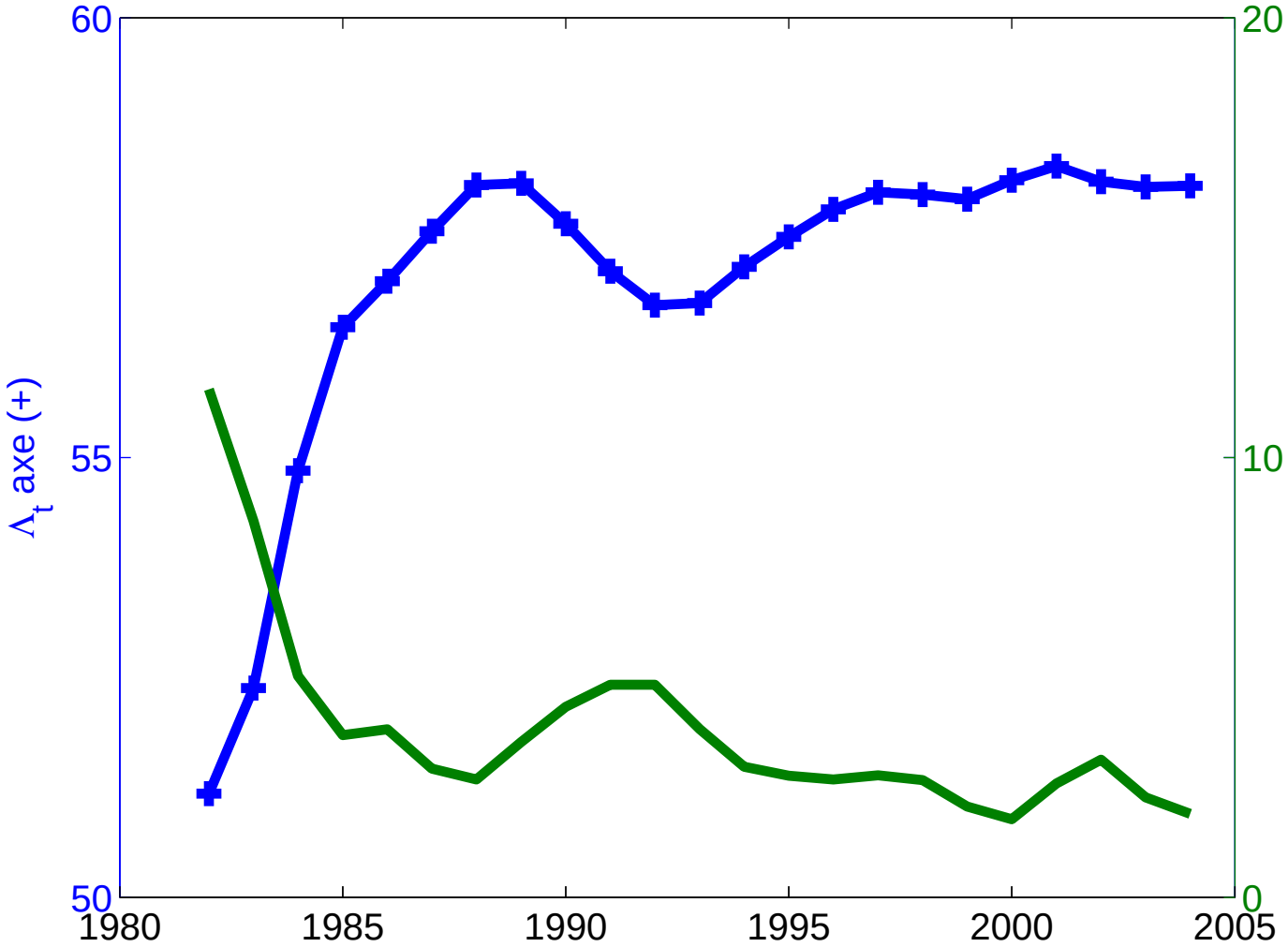
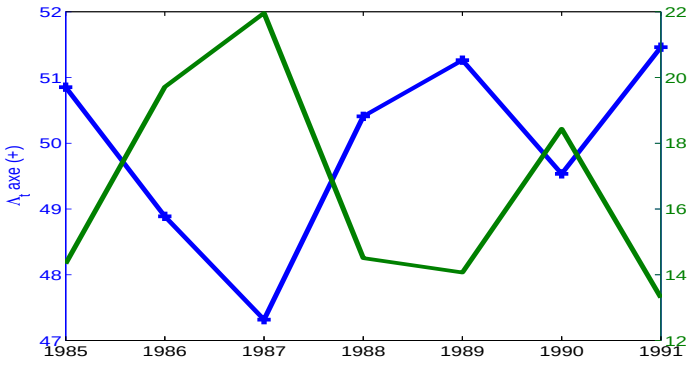
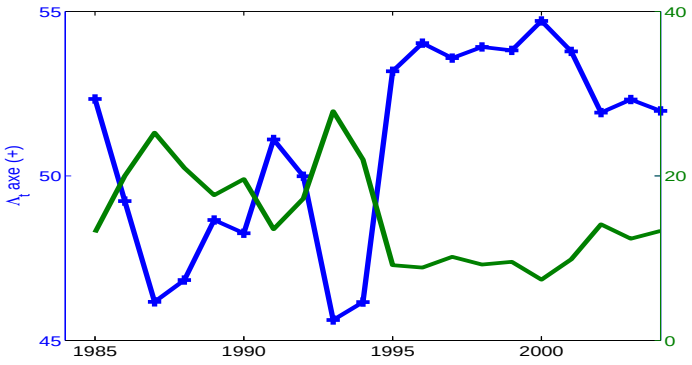


Figure 4: Exchange Rate Volatility & % of Firms in Low Pass-trough Regime

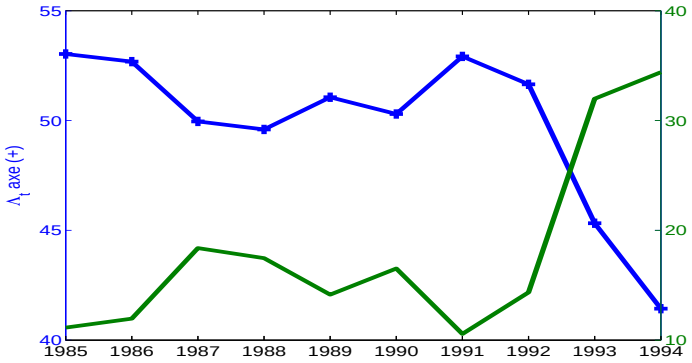
A) France



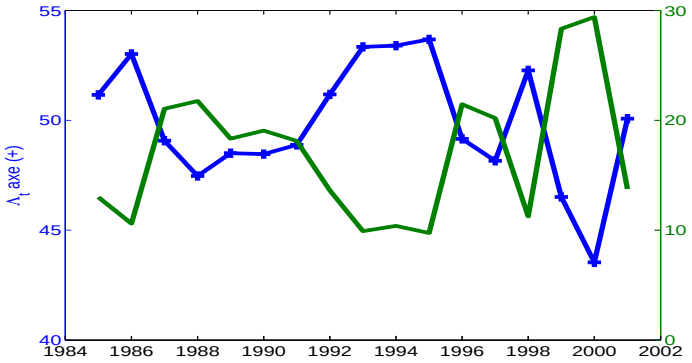
B) Germany



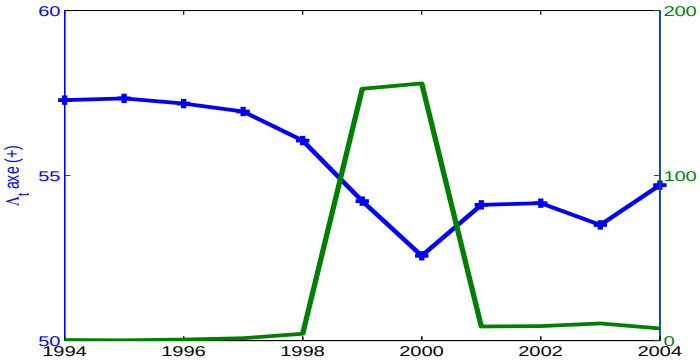
C) Italy



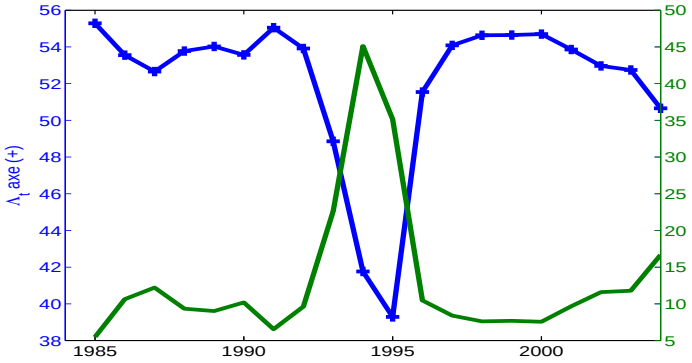
D) Japan



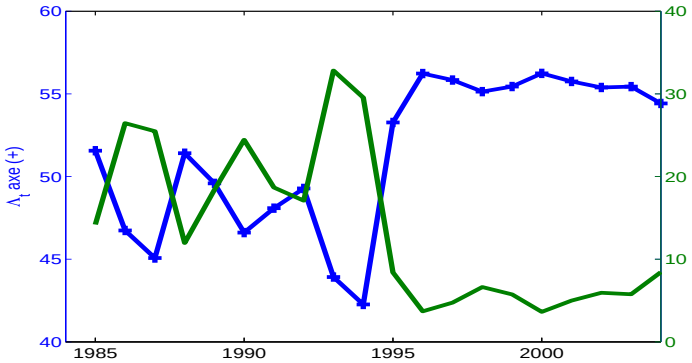
E) Korea



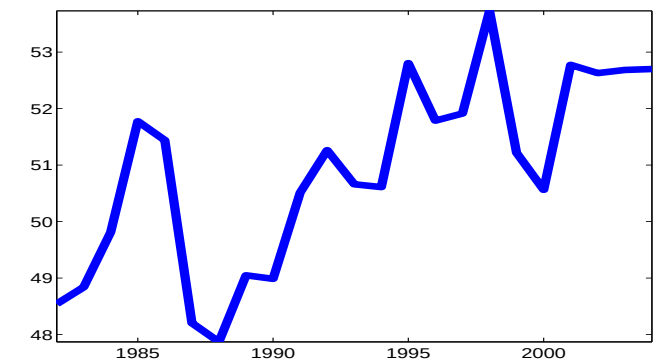
F) Sweden



G) United Kingdom



H) Average Λ_t



Decomposition of the Variations in the Exchange Rate Pass-through

- We can investigate the contribution of each factor to the year-to-year variations in the average exchange rate pass-through by estimating the model with all the factors included in the probability function.
- The decomposition is obtained by allowing each factor to vary one at a time, and keeping the others at their average values.
- The implied contributions of each factor are:

country share	market concentration	inflation diff.	vol. of exchange rate
1.7862	39.7625	21.7776	36.6737

Conclusions

- Our estimation results show that the low exchange pass-through regime is also characterized lower sensitivity to relative price misalignments, higher duration of pricing regimes and less volatile shocks.
- Both macro and micro factors are significant in determining the changes in the regime.