Apple Product Prices, the Law of One Price and Real Exchange Rate Dynamics

SAMNET workshop

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Refresher: Basic LOP / PPP Theory

Where $P_t^{i_x}$ represents the price of good x in the case of LOP (or $\forall x$ in PPP) in country i at time t and E_t^{iUS} is the nominal exchange rate between country i vs the USD at time t, then:

$$\frac{P_t^{i_x}}{P_t^{US_x}} = E_t^{iUS}$$

The generalised equation in logarithmic form becomes:

$$p_t^{i_x} - p_t^{US_x} = \alpha_x + \beta_x e_t^{iUS} + \varepsilon_t^{i_x}$$

For *relative* LOP (or PPP) to hold re product x: $\beta_x = 1$

For *absolute* LOP (or PPP) to hold: $\alpha_x = 0$ and $\beta_x = 1$

The real exchange rate is simply:

$$q_t^{i_x} = p_t^{i_x} - p_t^{US_x} - e_t^{iUS}$$

Why Apple Product Price datasets?

1. Homogenous
2. Products are tradable
3. No 'product' or 'time aggregation' bias
4. Derived RERs can be measured in price levels
5. Products distributed internationally
6. Imported from China and Taiwan and then distributed
7. Easier to net out transaction costs
    - Taxes, tariffs shipping costs can be accounted for

Panel Regressions Summary: Exchange Rate Passthrough

As per analyses of Click (1996) on Big Macs

$p_t^{i_x} - p_t^{US_x} = \alpha_x + \beta_x e_t^{iUS} + \epsilon_t^{i_x}$					
Coefficients	CPI	Big Mac	iPods	iPads	iPhones
α_x	0.7714 (0.0380)***	0.6097 (0.0640)***	0.3131 (0.0336)***	0.2152 (0.0265)***	0.5500 (0.0411)***
β_x	0.5727 (0.0193)***	0.6293 (0.0269)***	0.9903 (0.0110)***	0.9922 (0.0097)***	0.7647 (0.0333)***
R^2 Overall	0.8142	0.8680	0.9919	0.9929	0.9340
Obs	49 Countries, 14 Years N = 686	31 Countries, 14 Years N = 434	46 Countries, 11 Years N = 506	45 Countries, 10 Years N = 450	39 Countries, 9 Years N = 351
Effects	Entity, Time	Entity, Time	Random	Random	Entity, Time

Standard Errors in Parenthesis: $^{*}p<0.10$; $^{**}p<0.05$; $^{***}p<0.01$

Panel Regressions Summary: Exchange Rate Passthrough

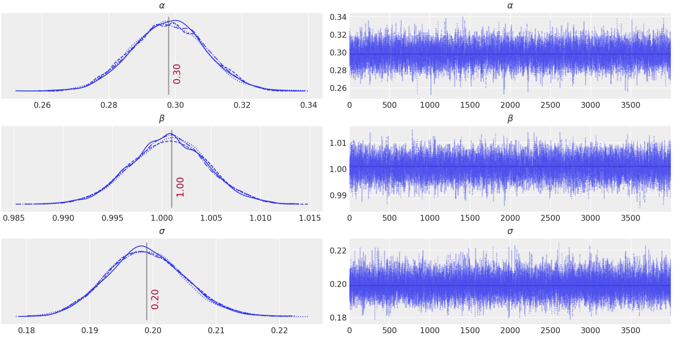
$$\alpha_x + \beta_x e_t^{iUS} + \delta_{x1} \ln\left(\frac{1+\tau_{i_x t}}{1+\tau_{US_x t}}\right) + \delta_{x2} \ln\left(\frac{1+\iota_{i_x t}}{1+\iota_{US_x t}}\right) + \delta_{x3} \ln\left(\frac{\lambda_{i_x t}}{\lambda_{US_x t}}\right)$$

Coefficients	CPI	Big Mac	iPods	iPads	iPhones
α_x	0.7714	0.8655	-0.0597	0.3069	0.3779
	(0.0380)***	(0.1520)***	(0.0613)	(0.1029)***	(0.0972)***
β_x	0.5727	0.6334	1.0007	0.9514	0.7748
	(0.0193)***	(0.0269)***	(0.0083)***	(0.0265)***	(0.0352)***
δ_{x1}		-0.2094	0.2307	-0.0103	0.1202
		(0.1129)*	(0.0421)***	(0.0641)	(0.0579)**
δ_{x2}			0.5293	0.1513	0.1933
			(0.1869)***	(0.3464)	(0.3907)
δ_{x3}				0.0089	0.0049
				(0.0109)	(0.0096)
R^2 Overall	0.8142	0.8650	0.9951	0.9911	0.9413
Obs	49C, 14Y	31C, 14Y	46C, 11Y	45C, 10Y	39C, 9Y
Effects	Entity, Time	Entity, Time	Random	Entity, Time	Entity, Time

Generalised Linear Model Specification:

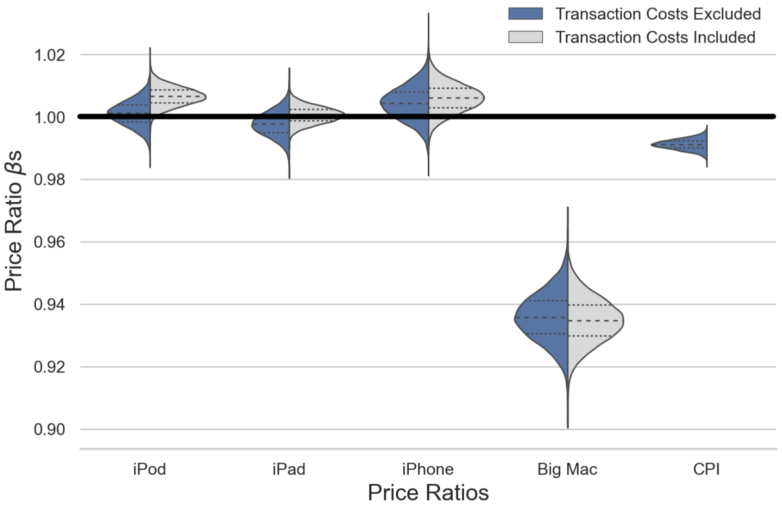
$$p_t^{i_x} - p_t^{US_x} \sim \mathcal{N}\left(\alpha_x + \beta_x e_t^{iUS}, {\sigma_t^{i_x}}^2\right)$$

Priors: $\sigma_t^{i_x} \sim HN(0,1)$, $\alpha_x \sim N(0,0.5)$ and $\beta_x \sim N(1,0.5)$
Example of posterior outputs on iPod price dataset:



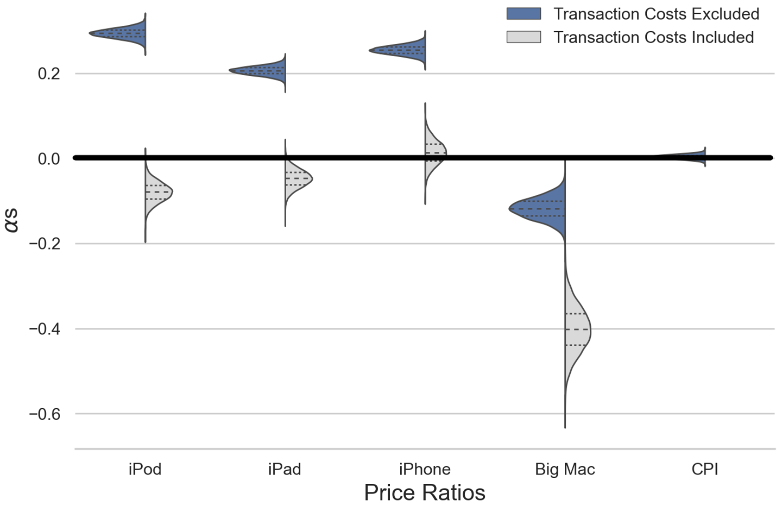
Bayesian Analyses

Violin Plots of MCMC Generated βs



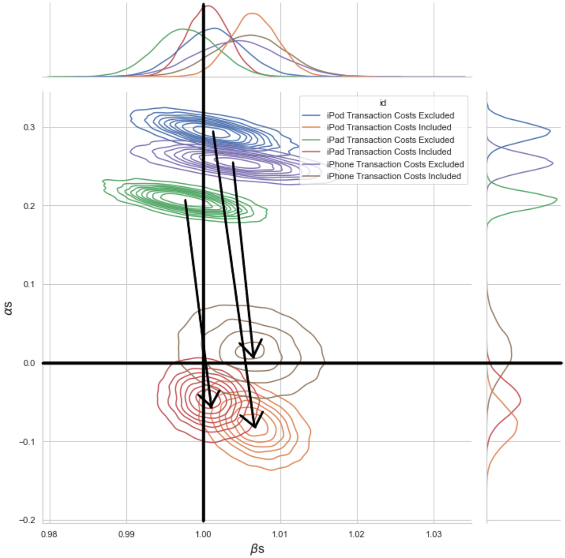
Bayesian Analyses

Violin Plots of MCMC Generated αs



Bayesian Analyses

Kernel Density Joint Plot of αs and βs Before and After Transaction Costs



h Period Changes Analyses

Source: Celements et al. (2012)

Control for heterogeneity of the parameter by using difference operators to estimate:

$$\Delta_{(h)} \left(p_t^{i_x} - p_t^{US_x} \right) = \beta \Delta_{(h)} e_t^{iUS} \; + \varepsilon_t^{i_x}$$

Where *h* is the logarithmic *h*-year change:

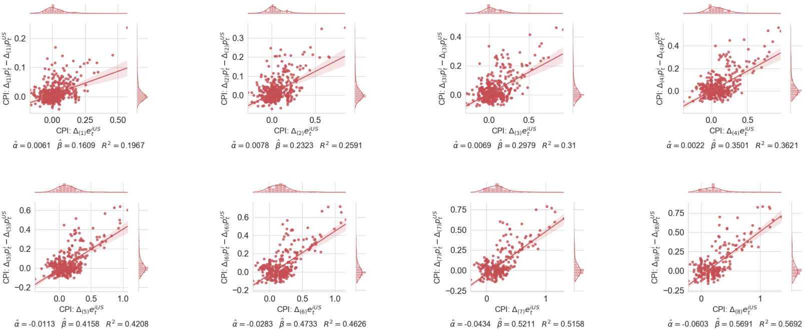
$$\Delta_{(h)} \left(p_t^{i_x} - p_t^{US_x} \right) = \left(p_t^{i_x} - p_t^{US_x} \right) - \left(p_{t-h}^{i_x} - p_{t-h}^{US_x} \right)$$

$$\Delta_{(h)} e_t^{iUS} = e_t^{iUS} - e_{t-h}^{iUS}$$

CPI Price Data over h Period Changes

β increases with h, but slowly

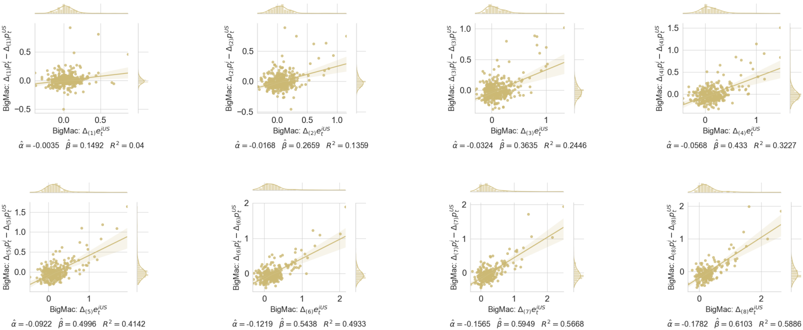
With h=8 β=0.57



Big Mac Price Data over h Period Changes

β increases with h, but also slowly

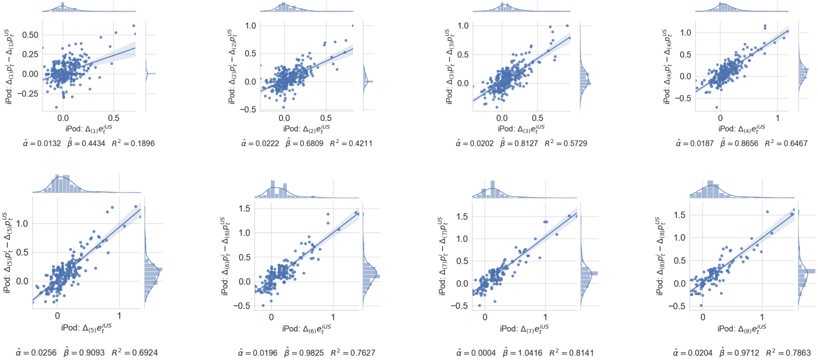
With h=8 β=0.61



iPod Price Data over *h* Period Changes

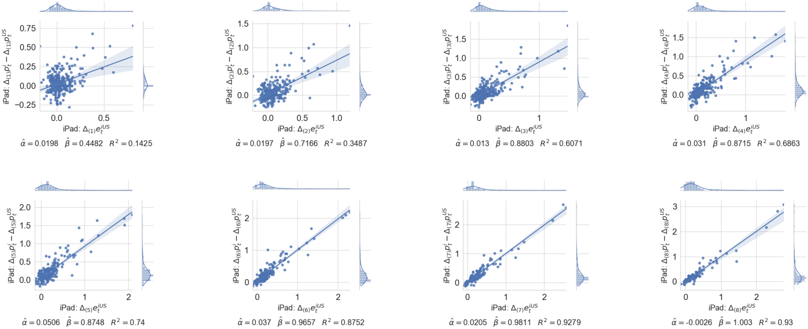
β increases with h, quicker covergence to '1'

With h=6 β=0.98



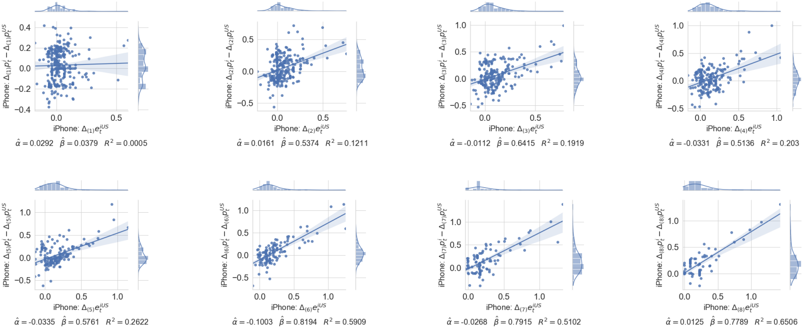
iPad Price Data over *h* Period Changes

β increases with *h*, quicker covergence to '1'



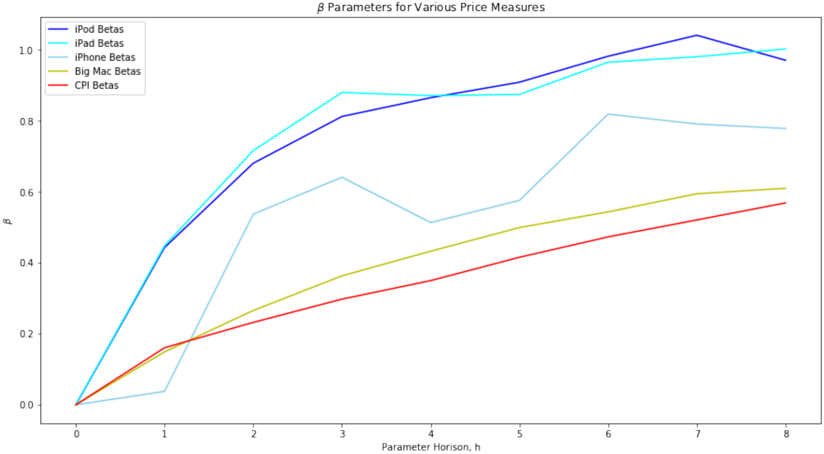
iPhone Price Data over h Period Changes

β increases with h, quicker convergence to '1'



APPs, Big Mac and CPI Betas over *h* Period Changes

β convergence to '1' quicker with APPs



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Questions?

Thank you for listening!