Evaluating demand for letter price elasticities and technology impacts in an evolving communications market

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Background and introduction

- A rich econometrics literature exists on the demand for mail, In recent times the focus of these studies has tended to concentrate on three key aspects:
  - The impact of the economy - Substitution of letter mail by ecomms. Letter price elasticities
- Estimates for each of these factors vary between studies. But overall, with a few exceptions, they yield broadly similar conclusions
- Recently there has been a debate in the UK that these findings could be misleading. In particular, whether standard econometric time series techniques could be systematically attributing too much of the decline in mail volumes to structural factors and too little to price effects
- We have examined issues concerning the demand for letters in an evolving communications market in previous papers. *Fève et al. 2010* explored how we can learn about the nature of ongoing structural changes via *outcome versus projection* analysis. In *Fève et al. 2012* we provided an empirical example of the scale of uncertainty inherent in long term projections
- In this paper we examine how an applied econometrician may attempt to estimate the demand for mail using standard econometric techniques and partial information at different stages of the evolution of the communications market using a simple stylised model and simulation analysis to assess whether standard econometric techniques could be systematically misleading

The theoretical model (1)

A simple stylised model of the demand for mail is adopted which considers:

- Demand for letters and ecommunications through a sequence of time periods t=1,…,n consisting of:
  - Letter mail receivers ("Lpeople") who do not use the internet and may only be contacted by letter mail
  - Electronic mail receivers ("Epeople") who can be contacted by letter or digital mail
- At each point in time, t, it is assumed that there are N^L Lpeople and N^E Epeople
- The model is based on the demand for mail by senders such that they match receiver preferences to communicate by post or electronic means
- Underpinning the model is an assumption that senders of mail, which are mainly businesses sending transactional mail, can influence receiver communication preferences (similar to DeDonder et al. 2012). This is captured in the model in two key ways:
  - The impact of price variables for letters (P_L) and digital communications (P_E)
  - The increasing number of individuals over time who have access to technology to substitute letter mail (that is via the rising number of N^E)

The theoretical model (2)

1. Demand for letters to communicate with Lpeople

$$Q_{Lt}^{L} = N_t^L \, C_0 \, P_{Lt}^{\beta} \, Y_t^{\beta l} \, \varepsilon_t^u$$

2. Demand for letters to communicate with Epeople

$$Q_{Lt}^{E} = N_t^E \, C_1 \;\; P_{Lt}^{\beta 0} \, P_{Lt-1}^{\beta 1} \, P_{Et}^{\gamma} \, Y_t^{\beta le} \, \varepsilon_t^v$$

3. Demand for digital mail to communicate with Epeople

$$Q_{Et}^{E} = N_t^E \, C_2 \, P_{Et}^{\delta} \, Y_t^{\beta ee} \, \varepsilon_t^w$$

4. Population is fixed (*N*) and comprises of Lpeople & Epeople

$$N_t^L + N_t^E \equiv N$$

5. Evolution of Epeople is non-zero from period T onwards

$$N_{Et} = 0 \text{ for } t<T, \text{ otherwise } N_{Et} = C_3 \, \frac{e^{\propto(t-T)}}{1+e^{\propto(t-T)}} + C_4$$

6. Letter prices are set equal to total UK addressed inland mail
7. Economic activity (*Y*) set equal to UK GDP
8. Ecommunication prices

$$P_{Et} = \phi P_{Et-1} + \varepsilon_t^x$$

Hypothetical true parameters for theoretical model

Illustrative parameters for endogenous model variables

Demand for letters to communicate with Lpeople (Q_L^L)

$C_0 = 4$ $\beta = -0.4$ $\beta l = 1.0$ u~ N(0, $(0.03)^2$)

Demand for letters to communicate with Epeople (Q_L^E)

$C_1 = 2$ $\beta 0 = -0.25$ $\beta 1 = -0.5$ $\beta 1e = 1.0$ $\gamma = 0.25$ v~ N(0, $(0.03)^2$)

Demand for ecommunications to communicate with Epeople (Q_E^E)

$C_2 = 2$ $\delta = -0.4$ $\beta ee = 1.0$ w~ N(0, $(0.02)^2$)

Illustrative parameters for exogenous model variables

Evolution of Epeople

$C_3 = 0.78$ $C_4 = -0.025$ $\alpha = 0.34$ $t = 1,2, \ldots,50$

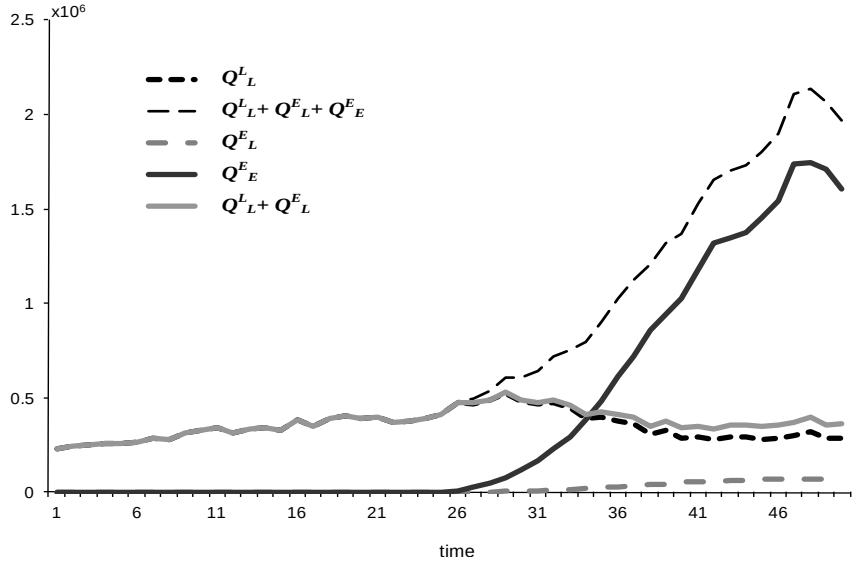
Price of ecommunications (P_E)	Price of letters (P_L)	Economic activity (Y)
$\phi = 0.97$ x~ N(0, 0.05)	Equal to UK total addressed inland letter traffic prices[1]	Equal to UK GDP[2]

Note:

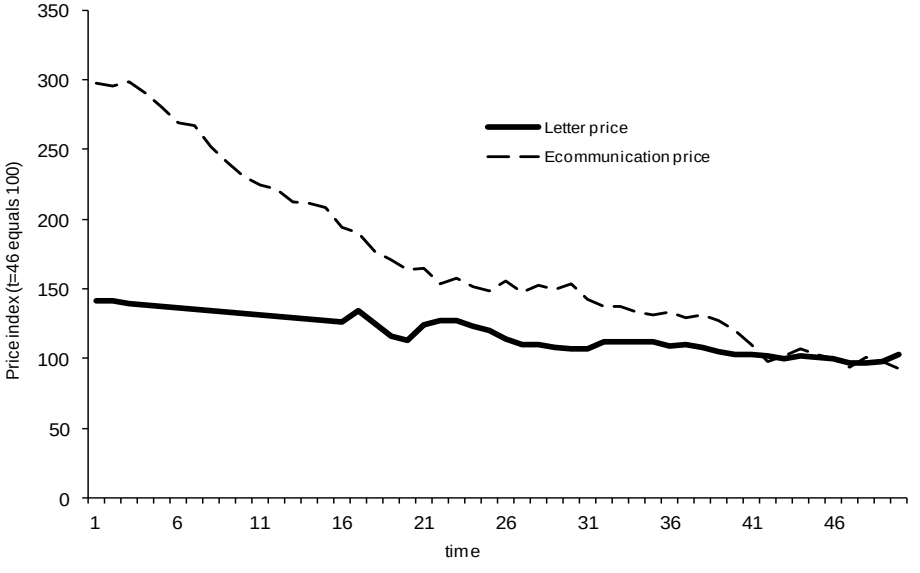
1. For periods t=16 to t=50 letter prices set equal to estimates for UK total addressed inland letter traffic prices for the financial year period 1976/77 to 2010/11. For periods t=1 to t=15 letter prices were assumed to follow a downward trend.
2. Equal to UK GDP for the period 1960 to 2009

Hypothetical stylized model true values

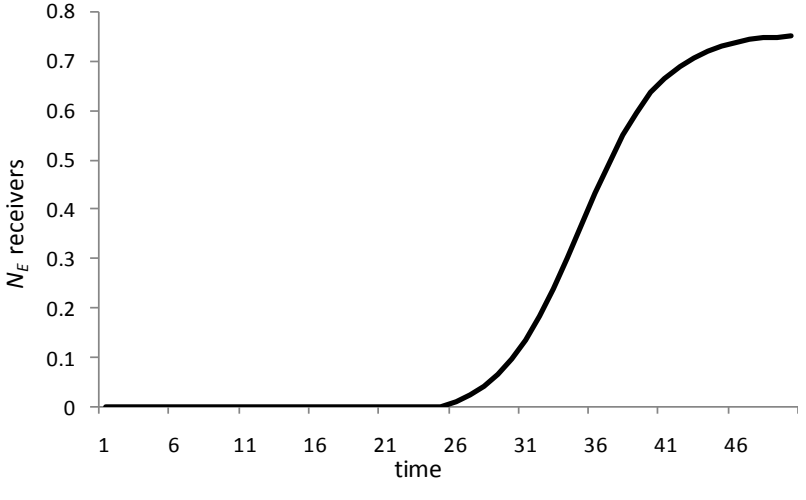
The demand for letters and ecommunications



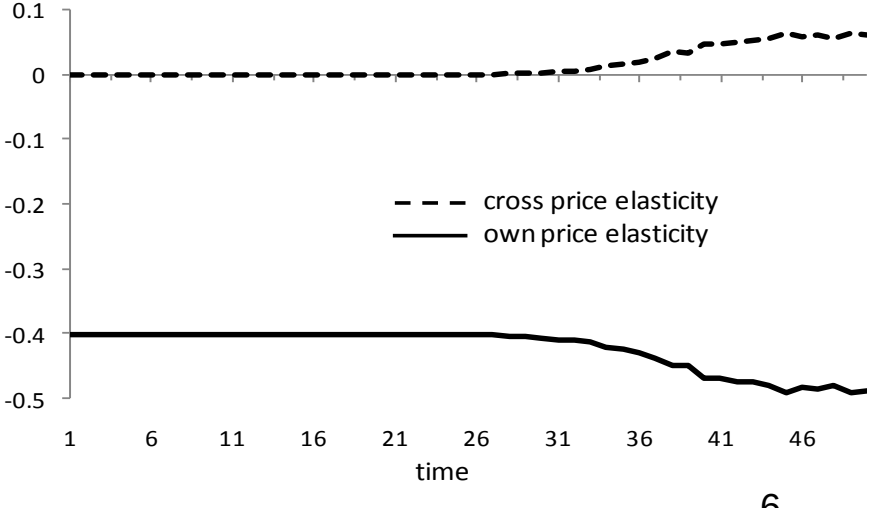
Price of letters and ecommunications



Evolution of Epeople



Letter price elasticities



Estimating the model using time series econometrics

The hypothetical econometrician:

- The econometrician does not know the true model but is assumed to have a theoretical demand for mail model framework similar to that outlined above
- In full awareness that they are unable to observe all variables the hypothetical econometrician is assumed to proceed to estimate the demand for mail using standard econometric techniques with the following observed data:
  - Total letter traffic (Q_L), which is the sum of letters received by Lpeople and Epeople,
  - The price of letters (P_L) - Economic activity (Y)
  - Proxy variables to account for people switching to digital communications
- In the knowledge that they are unable to observe
  Q_L^L, Q_L^E, Q_E^E, N_L , N_E and , P_E
- The challenges facing our theoretical econometrician and the regression analysis they adopt to estimate the demand for mail is very similar to a number of econometric time series studies (see for example, Boldron et al. (2010), Meschi et al. (2011), Nikali (2008) and Veruete-McKay et al. (2011))

Estimating the model over time: illustrative examples

Evolution of technology	Estimated model parameters & (t-stats)			True parameters		Adjusted R^2	DW
Stage 0: Pre-E people (*t*=1 to 25)	*Y*	0.88	(7.9)	*Y*	1.00	0.9500	1.93
	P	-0.50	(-1.5)	*P*	-0.40		
Stage 1: Early adopter Epeople phase (*t*=25 to 30)	*Y*	0.86	(8.1)	*Y*	1.00	0.9650	2.04
	P	-0.65	(-2.3)	*P*	-0.40		
	T29	-0.04	(-1.7)				
Stage 2: 1st half of Epeople transition period, **single trend break** (*t*=31 to 35)	*Y*	0.88	(8.4)	*Y*	1.00	0.9624	1.98
	P	-0.55	(-2.1)	*P*	-0.40 to -0.42		
	T30	-0.05	(-7.9)				
Stage 2: 1st half of Epeople transition period**, double trend break** (*t*=31 to 35)	*Y*	0.88	(8.4)			0.9631	2.10
	P	-0.57	(-2.2)				
	T29	-0.03	(-4.4)				
	T34	-0.05	(-1.7)				
Stage 2: 1st half of Epeople transition period**, proxy for Epeople** (*t*=31 to 35)	*Y*	0.86	(8.1)			0.9611	1.99
	P	-0.71	(-2.7)				
	Eproxy	-0.85	(-7.7)				
Stage 3: Second half of Epeople transition period , **double trend break** (*t*=36 to 40)	*Y*	0.88	(8.3)	*Y*	1.00	0.9563	2.20
	P	-0.54	(-2.1)	*P*	-0.43 to -0.47		
	T30	-0.05	(-6.7)				
	T35	-0.04	(-3.1)				

Stage 2: 1st half of main Epeople transition period (*t*=31 to 35)

- HOWEVER, results are dependent on model specifications and it is important to use econometric and statistical criteria to guide the model selection strategy

Stage 2, the 1st half of the rapid Epeople transition period

	Econometric model using single trend break term										Epeople proxy	
	R4.1		R4.2		R4.3		**R4.4**		R4.5		R4.10	
	Est. Coeff	T Stat	Est. Coeff	T Stat	Est. Coeff	T Stat	**Est. Coeff**	T Stat	Est. Coeff	T Stat	Est. Coeff	T Stat
Y	0.54	3.3	0.76	6.0	0.77	6.7	**0.88**	8.4	0.85	7.3	0.86	8.1
P	-0.99	-2.3	-1.18	-3.7	-1.04	-3.6	**-0.55**	-2.1	-0.45	-1.5	-0.71	-2.7
Trend T23			-0.02	-5.3								
Trend T26					-0.03	-6.4						
Trend T30							**-0.05**	7.9				
Trend T33									-0.10	-6.6		
Epeople ratio proxy											-0.85	-7.7
R^2	0.8966		0.9456		0.9552		**0.9657**		0.9572		0.9646	
Adj. R^2	0.8901		0.9404		0.9508		**0.9624**		0.9530		0.9611	
DW.	0.74		1.47		1.70		**1.98**		1.62		1.99	

Sample period for all regressions R4.1 to R4.10 is *t*=1,2,...35

- BUT even then, when price elasticities are changing slowly over time it is difficult to identify structural breaks in the price elasticity variable
- All specifications suggest it is difficult to estimate dynamic price elasticity terms

Summary and conclusion

- This paper explored how an applied econometrician may attempt to estimate the demand for letters using standard econometric techniques in an environment where they observe partial information at different stages of the evolution of the communication market using a theoretical model and simulation techniques
- Under circumstances where advances in technology and changes in demographic trends lead to slow changes in letter price elasticities over time we show that standard econometric techniques can provide reasonable estimates for price and economic activity factors, although may not be able to identify dynamic breaks
- HOWEVER, because of the unobservable nature of how technology is actually impacting letter demand and the absence of clear proxy variables for Esubstitution effects it can be difficult to obtain reasonable estimates of the impact of substitution. Especially during early stages of the process or when the magnitude of change is variable
- The incorporation of poor proxies may adversely impact price elasticities and economic activity estimates. BUT the adoption of an econometric model selection strategy that encompasses a number of diagnostic criteria can help avoid, or at least limit the likelihood of this taking place
- The extent to which these results would hold under different scenarios and whether the estimated elasticities are themselves unbiased remain topics for future potential research