10th Postal Economics Conference on E-commerce, Digital Economy and Delivery Services
Institut D'Economie Industrielle Université Toulouse, March 29-30, 2018

Some Further Results from the UK on the Impact of E-substitution on the Demand for Mail[1]

Frank Rodriguez (Oxera) and Soterios Soteri (Royal Mail)

1. Introduction

The demand for letters has been in decline for several years because of electronic (e)-substitution. Some communication that would have taken place previously through letter mail has been replaced by electronic media, much of this process being associated with the expansion and growing use of the Internet. However, there is a dearth of published information on the detail and extent of losses in mail due to e-substitution. Even where data on mail volumes are published it seems likely that the trends observed cannot be explained adequately by the negative effects of e-substitution alone for the impacts from other variables that historically have influenced volumes, such as economic activity (GDP), prices and quality of service, appear to remain in place (Jarosik et al., 2013).

In two earlier papers we explored trends in the e-substitution of business to consumer (B2C) business or transactional mail in the UK up to 2012 and examined longer term prospects for the volume of such mail (Rodriguez et al., 2016 and 2017). One area emphasised in that work was that the speed and distribution of the effects of e-substitution on business mail have not been uniform across different segmentations of traffic. In particular, we disaggregated trends in e-substitution by content type (e.g. bills, financial statements and business letters), sender group (e.g. banks, government and utilities) and age group of the recipients of business mail. Following Nikali (2008) our framework for examining trends and prospects for B2C business mail emphasises the importance of both the ability and the willingness of recipients to accept communication by electronic means as well as the willingness of senders to reduce their use of letter mail. In that previous work we found evidence of substantial differences in the advance of e-substitution across these segmentations.

In the current paper we examine these issues further and extend our earlier analysis of trends in the UK by another four years to 2016. We focus again on segmentation of traffic of B2C business mail by content type, sender group and age group and develop our previous framework to reflect more fully in our estimates the impacts of differential rates of economic growth by industrial sector and of population growth by age group. We report updated estimates of the extent of e-substitution disaggregated by these three segmentations up to 2016 and discuss reasons for variations in e-substitution at this disaggregated level. We conclude by drawing together the main points from our empirical results and highlighting potential areas for future work. Section 2 outlines our method for estimating the overall trend of e-substitution of business mail and updates estimates of this trend to

[1] The views expressed in this paper are those of the authors and may not necessarily reflect those of their affiliated organisations.

2016. Section 3 sets out our approach to assessing the e-substitution of B2C business mail at a disaggregated level while Section 4 reports our results on recent trends in e-substitution at this level. Section 5 concludes.

2. Estimates of the Trend in the E-substitution of Business Mail

Our approach to estimating the overall impact of e-substitution on B2C business mail is outlined in Rodriguez, Soteri and Tobias (2016) (RST). The estimates we report in the current paper incorporate also results from an updated version of the econometric model set out in Veruete-McKay et al. (2011). This used annual data on traffic for the UK from Royal Mail and has performed reasonably well outside of its sample period. That model estimated three equations, respectively for commercial mail, advertising mail and social mail and, as in RST, we use the coefficients from the equation for commercial mail in developing the estimates of e-substitution that we report in the current paper. In addition to business mail, the commercial mail time series included also relatively small volumes of publishing material and lightweight parcels while about three quarters of business mail is B2C so we consider the commercial mail model estimates to be good proxies for their B2C business mail subset.

As explained in RST, the estimates of the extent of e-substitution derived from the econometric model for commercial mail (applied here for B2C business mail) make use in particular of unexplained time trends estimated by that model. They include also estimates of price effects although quantitatively these are of much less importance. The results from the econometric model were reported in full in RST (at Table 1 of the paper) and are not repeated here but they included also estimates of coefficients on other variables in the model, such as GDP and demographics, which have a positive impact on mail volumes. The estimated coefficients from these time trends can be converted into an e-substitution index in year t, E_t . The index is defined as E_t = (1 – proportionate loss of mail to e-substitution) where ($0 < E_t \leq 1$). Here E_t = 1 represents a year where there had been no overall net negative impact on mail volumes from e-substitution. From the econometric model, the last year for which this was estimated to have been the case for commercial mail is 2001. The index declines as the extent of e-substitution increases with E_t = 0 implying a year when all such mail would have been lost to e-substitution.

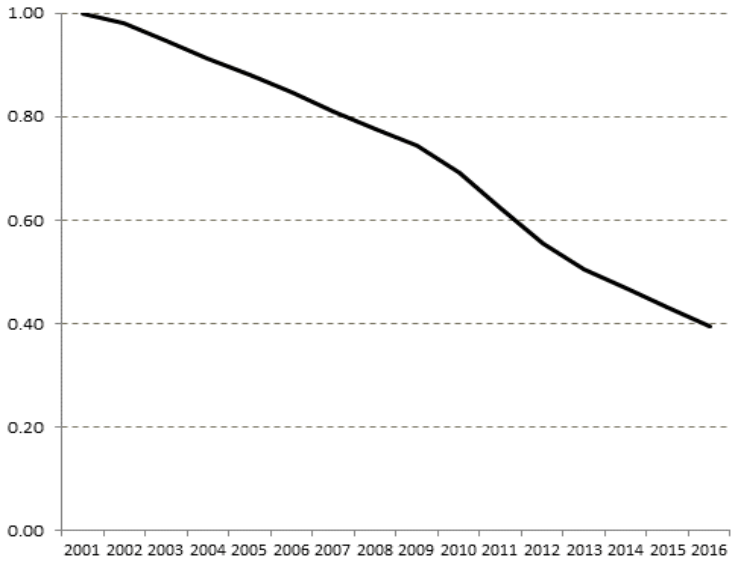
The commercial mail equation in the econometric model contains two linear time trends. The first, T_1, begins in 2002 and equals -3½ % per annum (pa). It is added to by a second time trend, T_2 , commencing in 2010 and equalling -5½% pa so that both of these effects apply jointly from 2010 (at -9% pa). In computing E_t in each year since 2001 the impact of price effects is also included so that the overall expression for the e-substitution index for business B2C mail is given by:

$$E_t = (1 + T_1)^{n1t}.(1 + T_2)^{n2t}. \prod_{t=2002}^{t}(1 + x_t) \qquad (1)$$

where $n1t$ is the number of years in year t since 2001; $n2t$ is the number of years in year t since 2009; x_t is the estimated effect of real prices on commercial mail volumes (applied here for B2C business mail) in year t expressed as a proportion and introduced in the formula for E_t as a product calculated over the years to year t from t = 2002, the first year that E_t < 1. Although not equal to unity in many years, over the period 2002 to 2016 as a whole the product of these terms in x_t is close to 1 signifying that on average the negative impact of real prices on B2C business mail volumes is estimated to have been negligible.

Figure 1 plots the path of E_t between 2001 and 2016 based principally on detailed estimates of the measure for 2009, 2012 and 2016. Note that the overall decline in B2C business mail was less than the estimated impact of e-substitution alone because of the positive impact on these volumes , in particular, of GDP and demographic factors. On average over the period 2001 to 2016 these additional factors were estimated to have offset the decline by an average of about 3% pa leading to an overall decline in B2C business mail volumes between 2009 and 2016 of about 6% pa (= -9%+ 3%).

Figure 1: Estimates of E-substitution Index, E_t , for B2C Business Mail to 2016 (2001 = 1)[1]



Source: Royal Mail

[1] E_t equals (1 – proportionate loss of mail to e-substitution) where E_t = 1 implies no e-substitution (last such year estimated as 2001) and E_t = 0 implies complete loss of all mail. Estimates for E_t based on econometric equation in Table 1 of Rodriguez, Soteri and Tobias (2016).

By 2016 E_t was estimated to have declined to 0.39 implying that, considering the effect of e-substitution alone, B2C business mail in that year was estimated to have been only about 39% of the level it would have reached in 2016 if there had been no e-substitution of such mail although, as noted above, the actual level was higher than this because of other variables which have had a positive impact on volumes. Another way to interpret this result is that if there had been no e-substitution in the period since 2001, B2C business mail volumes would have been about 2½ times higher (= 1/0.39) than their outturn in 2016. Over the period 2009 to 2016, the value of E_t fell from 0.74 to 0.39 such that B2C business mail volumes were only just over a half (= 0.39/0.74) of the level they would have reached in 2016 compared with 2009 in the absence of e-substitution. The main focus of the disaggregated results reported in the remainder of the paper is on the post-2009 period when the rate of e-substitution is estimated to have been significantly higher than in previous years.

3. Methodology for Assessing E-substitution of B2C Business Mail at a Disaggregated Level

While, as outlined in section 2, the total level of e-substitution was estimated using updated results from the econometric model reported in Veruete-McKay et al. (2011) and expressed through the index E_t , our interest is also in how different segments of B2C business mail have been impacted by the process of e-substitution since 2001. In this analysis we follow an approach similar to RST but develop it in a number of ways. The three disaggregations of B2C business mail traffic we consider are by content type, i (i = 1, ... 6: Bills, Invoices; Business Letters; Insurance/Legal/Financial

Correspondence; Financial Statements; Other Financial Correspondence; and All Other Content Types); by sender group, j (j = 1, ... 6: Banks; Government (including Health and Education); Insurance and Other Financial Companies; Retail; Utilities; and All Other Sender Groups); and by age group of recipients of B2C business mail, k (k = 1, ... 5: 16-34, 35-44, 45-54, 55-64, 65+).

The data used in this analysis were taken from a continuing survey of mail sent and received by households in the UK. Respondents completed a detailed diary each day and recorded information on the number of items of mail sent and received, the content of the mail (by content type) and its origin (by sender group). Information was also recorded on the characteristics of the respondent including their age group. Because the data for our analysis were sourced from a survey, they are subject to sampling error and noise and the results reported in the current paper are best viewed as indicative of main trends. The last full year for which survey data were available at the time of analysis was 2016 and so our sample period extends to that year.

The approach we adopt, following RST, is to use the household survey data to help allocate our overall estimate of the e-substitution of B2C business mail determined by the econometric model as outlined in Section 2 across the various segmentations of traffic. At the level of total traffic we can express the total volume of B2C business mail in year t in a stylised form of the variables in the econometric model as its volume in year t = 0 (2001) multiplied by three factors reflecting the impacts of e-substitution (including price effects), GDP and population[2] on overall volumes since year t = 0 :

$$Q_t = Q_{t=0} \,.\, E_t \,.\, (1 + g.G_t).(1 + p.P_t) \qquad (2)$$

where Q_t is an estimate of the total volume of B2C business mail received by individuals in year t; $Q_{t=0}$ is an estimate of that volume in year t = 0 (2001); E_t is the overall e-substitution index as estimated by (1); g and p are the elasticities of total B2C business mail volume with respect to, respectively, GDP and population; and G_t and P_t are the cumulated proportionate changes in GDP and population by year t from year t = 0.

For any segment of B2C business mail *s* (s = i, j, k or any pairwise or three-way combination of categories), the formulation at (2) can be applied such that:

$$a_{st} \,.\, Q_t = a_{s,t=0} \,.\, Q_{t=0} \,.\, E_{st} \,.\, (1 + g_s.G_{st}).(1 + p_s.P_{st}) \qquad (3)$$

where a_{st} is the share of segment s as a proportion of the total volume of B2C business mail in year t; $\sum_s a_{st}$ = 1 for a particular segmentation across all B2C business mail such as sender groups, j; $a_{s,t=0}$ is the corresponding share in year t = 0; and the subscripts s on other variables in (3) denote their correspondence to segment s. Of particular interest in terms of identifying trends in e-substitution at a disaggregated level is the variable E_{st} which is the index of e-substitution for segment s in year t. Some rearrangement and equating (2) and (3) yields:

$$E_{st} = E_t \,.\, \left(\frac{a_{st}}{a_{s,t=0}}\right).\left(\frac{1 + g.G_t}{1 + g_s.G_{st}}\right).\left(\frac{1 + p.P_t}{1 + p_s.P_{st}}\right) \qquad (4)$$

[2] Consistent with Veruete-McKay et al. (2011), population enters (2) separately in order to reflect the impact of delivery point growth on demand while the impact of population on total economic activity is embodied in the GDP term. The demographic variable in Veruete-McKay et al. to capture delivery point growth is the number of households and population is used in the current paper as a proxy.

The e-substitution index for a particular segment of traffic in year t then is equal to the e-substitution index across all B2C business mail for that year, E_t , as estimated by the ec**o**nometric model multiplied by three factors: the ratio of the volume share of segment s in year t to its share in year t = 0; and the ratios of the impact of GDP (respectively population) on overall B2C business mail in year t to the impact of GDP (respectively population) on segment s in that year. The index E_{st} is lower relative to the overall index E_t (implying more e-substitution of segment s than overall B2C business mail) the less (respectively more) the share of segment s traffic has increased (respectively decreased) since year t = 0 and the greater the impact of GDP (respectively population) on segment s compared with the impact of these variables on B2C business mail overall.

To make (4) operational we need to consider the extent to which segment values for g_s , p_s , G_{st} and P_{st} are likely to differ from values for g , p , G_t and P_t in (2) for total traffic. Where segment values for these variables all equal those at the total level (4) reduces to E_{st} equalling E_t weighted by the ratio of segment s volume share in year t to its volume share in year t = 0. For the elasticities g and p, and lacking disaggregated estimates of these parameters, we follow the method applied in RST and set all segment elasticities to their econometrically estimated values at the total traffic level from Veruete-McKay et al. (2011) such that $g_s = g = 0.9$ and $p_s = p = 1$.

With respect to G_{st} and the ratio or weight applied to reflect the differential impact of GDP growth on a segment s compared with total B2C business mail, growth in GDP varies across industrial sectors of the economy and we link this specifically to sender groups j which are identified broadly in those terms in the household survey data. For a segment of traffic containing a sender group dimension we set $G_{st} = G_{jt}$ where G_{jt} is the cumulated growth in GDP since year t = 0 for industrial sectors of the economy corresponding to a particular sender group.[3] Where a sector has grown more rapidly than overall GDP then $G_{jt} > G_t$ reducing, other things being equal, the weight applied in (4) to estimate E_{st} for those segments incorporating the dimension of sender group j.[4] A lower resulting value of E_{st} for that segment implies that e-substitution in that segment has been higher than if no allowance were made for the effects of differences in GDP growth rates across sectors. Failure to make such an adjustment would imply an understatement of the extent of e-substitution in that segment of traffic for the higher level of e-substitution would be partially cancelled and hidden by its stronger underlying growth of traffic.

Similarly, with respect to P_{st} and the ratio or weight applied to reflect the differential impact of population growth on a segment s compared with total B2C business mail, growth in population varies across age groups so that for a segment of traffic containing an age group dimension we set $P_{st} = P_{kt}$ where P_{kt} is the cumulated proportionate change in the population of age group k in year t from year t = 0. Where an age group has increased in size more rapidly than overall population then $P_{kt} > P_t$ reducing the value of E_{st} for a segment s containing the dimension age group of recipients and so increasing the estimate of e-substitution for that segment. We apply no additional weight for the dimension of content type i in a segment. In this framework, GDP and population

[3] For example, growth in economic activity in utilities industrial sectors recorded in GDP data is applied in constructing the GDP-based weight for the Utilities sender group j.

[4] The relevant measure of G_t in constructing the GDP weight is a letter demand weighted measure of GDP. This provides consistency between the volume of e-substitution in total implied by the aggregate index E_t and the sum of the volume of e-substitution aggregated across all segments implied by the set of E_{st} calculated for a particular segmentation involving all sender groups j.

growth are considered to impact traffic by content type through sender group and age group of recipients. Any additional second order effects are not considered further.

Table 1 reports the ratios or weights in expression (4) for GDP by sender group and population by age group of recipients using data for the UK published by the Office for National Statistics (ONS 2017a,b). In 2016 the GDP weights were generally close to 1 implying they had limited impact on estimates of E_{st} involving sender groups. However, in 2012 and, particularly, 2009 the weights were in many cases substantially different from 1. For example, in 2009 the rapid growth of the financial services industry in the run up to the financial crisis ($G_{jt} > G_t$ for sender groups Banks and Insurance and Other Financial Companies) and accompanying higher growth in mail volumes to some extent masked a more rapid rate of e-substitution and negative impact on mail volumes from this source. This is corrected, at least in part, by applying the GDP weight of 0.89 which reduces the value of the e-substitution indices for the financial services sender groups to indicate a more rapid rate of e-substitution up 2009 than provided by unweighted indices. The converse is the case for the other sender groups, particularly Retail and the miscellaneous All Other Sender Groups.

Table 1: Weights Used to Compute E-substitution Indices at a Disaggregated Level[1,2]

	2009	2012	2016
GDP Weights by Sender Group, j:			
- Banks	0.89	0.94	1.01
- Government	1.09	1.05	1.02
- Insurance Cos etc	0.89	0.94	1.01
- Retail	1.15	1.10	0.93
- Utilities	1.02	0.99	1.00
- Other	1.18	1.10	0.99
Population Weights by Age Group, k:			
- 16-34	1.03	1.02	1.04
- 35-44	1.04	1.13	1.19
- 45-54	0.99	0.95	0.95
- 55-64	0.91	0.94	0.93
- 65+	0.99	0.95	0.89

Source: Royal Mail

[1] Weights above 1 act to lower estimates of e-substitution for a segment

[2] GDP weights calculated as: $((1 + g.G_t)/ (1 + g.G_{jt}))$ where g is the estimated elasticity of total B2C business mail volume with respect to GDP (0.9); G_t is the cumulated proportionate change in letter demand weighted UK GDP by year t from t =0 (2001); and G_{jt} is the cumulated growth in GDP since year t = 0 in the industrial sectors of the economy corresponding to sender group j. Population weights calculated as $((1 + p.P_t)/ (1 + p.P_{kt}))$ where p is the estimated elasticity of total B2C business mail volume with respect to population (1, using elasticity for household numbers); P_t is the cumulated proportionate change in UK population since t = 0; and P_{kt} is the cumulated proportionate change in the population of age group k since t = 0. Data from Office for National Statistics (ONS 2017a, b).

The values of the population weights have been moving in the other direction and becoming more unequal across different age groups. Comparing 2009 and 2016, the 35-44 age group contracted in size as the declining numbers in Generation X replaced post-war Baby Boomers and a large weight of 1.19 is applied to correct for this in estimating the corresponding 2016 value of the e-substitution index for this age group. The total of B2C business mail received by this group has declined in part

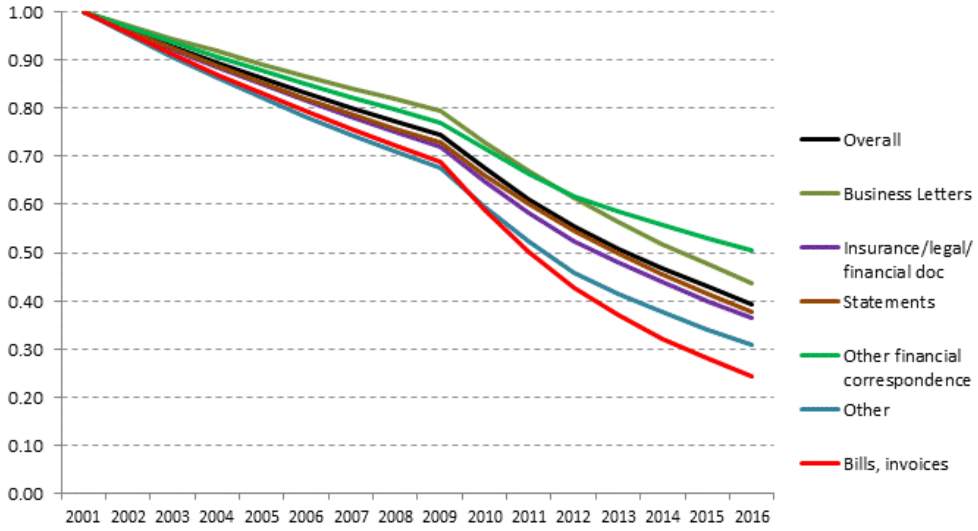
due to e-substitution but also because of a decrease in the population of recipients in that age group. The converse applies in 2016 among older age groups, particularly 65+.

4. Recent Trends in E-substitution at a Disaggregated Level

In this section we report estimates of the extent of e-substitution between 2001 and 2016 by each of three segmentations (content type i, sender group j and age group of recipient k) using the methodology outlined in Section 3. We do not consider e-substitution at a more disaggregated level in the current paper (for example, sender group by age group of recipient) where in some cases differences across segments of traffic are estimated to have been even greater.

i) Content type. Trends in e-substitution by content type i, measured through estimates of indices E_{it}, are shown in Figure 2. This segmentation reflects the purpose for which mail is being sent and so is of importance in understanding the development of e-substitution. Based on these estimates of E_{it} Table 2 then reports the implied percentage change in B2C business mail volumes as a result of e-substitution. As in the case of the overall index E_t , Figure 2 and Table 2 relate only to the estimated impact of e-substitution on volumes. The decline in B2C business mail by content type was less than that arising from e-substitution alone because of the positive impact on volumes of factors such as GDP and demographics.

Figure 2: Estimates of E-substitution Index by Content Type, E_{it} , to 2016 (2001 = 1)[1]



Source: Royal Mail

[1] E_t equals (1 – proportionate loss of mail to e-substitution) where E_t = 1 implies no e-substitution (last such year estimated as 2001) and E_t = 0 implies complete loss of all mail.

In each of the sub-periods in Table 2 the content types for which the extent of e-substitution is estimated to have been greatest are Bills, Invoices and the residual category All Other Content Types which includes items such as acknowledgements, cheque books, credit and bank cards and payments. Bills, Invoices in particular has continued to decline most rapidly of all content types such that by 2016 the change in Bills, Invoices mail volumes due to e-substitution is estimated to have been -76% although the actual level of volumes was higher due to the positive impact of GDP and other factors. The volume of this content type then was barely a quarter of the level it is estimated it would have reached in the absence of e-substitution. The content types for which e-substitution

seems to have been the least rapid are Other Financial Correspondence and Business Letters and this slower pace of advance has continued in the most recent sub-period, 2012-16. By 2016 the implied change in volume arising from e-substitution in both of these types of traffic was around a half.

Table 2: Implied Change in B2C Business Mail Volume due to E-substitution, 2001-16[1,2]

		% per annum		Change 2012-16 on	Total change
	2001-09	2009-12	2012-16	2009-12, %	2001-16, %
Total Business Mail	-4	-9	-8	1	-61
Content Type:					
-Bills, invoices	-5	-15	-13	2	-76
- Business Letters	-3	-8	-8	0	-56
- Insurance etc	-4	-10	-9	2	-63
- Statements	-4	-9	-9	1	-62
- Other Fin Corr	-3	-7	-5	2	-50
- Other	-5	-12	-9	3	-69
Sender Group:					
- Banks	-5	-7	-5	2	-56
- Government	-2	-8	-9	-1	-54
- Insurance Cos etc	-4	-7	-4	3	-51
- Retail	-5	-15	-21	-6	-83
- Utilities	-4	-13	-12	1	-71
- Other	-2	-11	-9	3	-59
Age Group of Recipients:					
- 16-34	-9	-10	-16	-6	-83
- 35-44	-6	-15	-12	3	-77
- 45-54	-2	-12	-8	3	-60
- 55-64	-2	-8	-7	1	-49
- 65+	-1	-5	-6	0	-36

Source: Royal Mail

[1] These estimates include a small element of decline due to price increases, estimated to have averaged close to 0% pa over the period 2001-16. Note that the actual levels of B2C business mail volumes during this period were higher for each of these segments due to the positive impact of factors such as GDP and demographics which are estimated jointly to have added about 3% pa to volumes over the period as a whole.

[2] Column "% per annum, 2001-09" calculated as: $(((E_{it=2009} / E_{it=2001})^{(1/(2009-2001))}) - 1) \times 100\%$. Columns 2009-12 and 2012-16 calculated applying the same method. Column "Total change 2001-16, %" calculated as $(1 - E_{it=2016}) \times 100\%$.

Results from Ofcom's Residential Postal Tracker survey accord broadly with these differences in recent years in e-substitution by content type (Ofcom, 2017). Comparing mail received in 2017 with that in 2015, 27% of respondents in Ofcom's survey received fewer "Letters from organisations that you have had a relationship with" (corresponding in our categorisation principally to Business Letters and Other Financial Correspondence) and 13% more, a net balance of respondents of -14%. The equivalent figures for the other category of traffic by content type in Ofcom's survey "Bills/Invoices/Statements" were 34%, 12% and so a net balance of respondents of -22% suggesting a considerably higher rate of e-substitution in the latter grouping in the recent past in line with the results reported in Table 2 and depicted in Figure 2.

As discussed in RST, the content type Bills, Invoices represents mail that contains clear standardised instructions and requests for action. For much of this type of mail there is a regular interaction between the sender and recipient of a communication which, if both parties wish, in many cases can be engaged electronically so obviating the use of physical mail. The sender can make a request electronically for payment and the recipient can pay electronically by means of direct debit or some other method of electronic transfer. In some cases also services may be offered by firms only where payment by customers is electronic in form. By contrast, Other Financial Correspondence and Business Letters are content types where mailings are likely to be less standardised and more irregular in their frequency and where the mailer may have less information about the recipient (for example, only a postal but not an email address). From the sender's perspective there may be a reduced incentive to try to substitute out of physical mail as the frequency of the mailings are likely to be lower and more varied in content than in the case of Bills, Invoices.

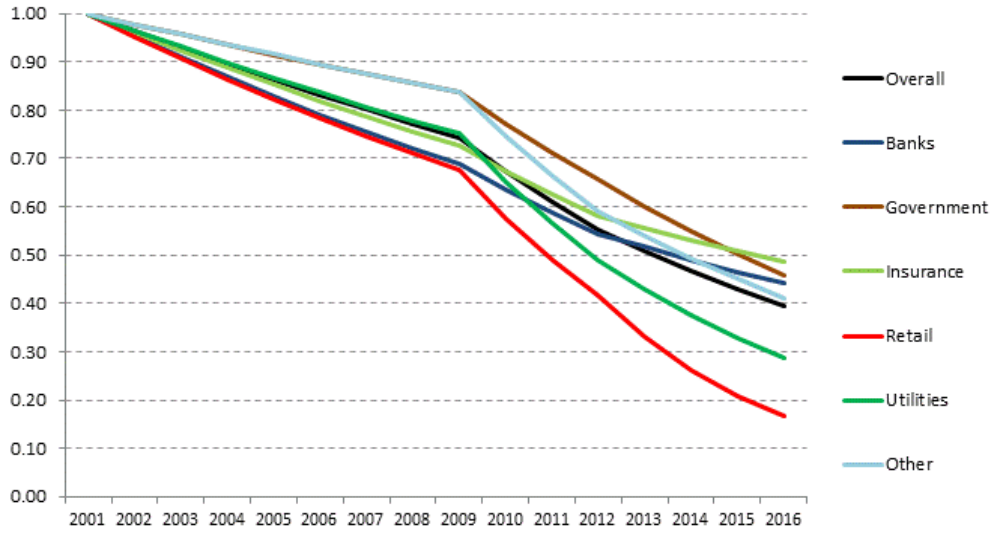
The differences in the underlying factors driving the e-substitution of different content types of B2C business mail appear to have continued and, indeed, resulted in a further widening of the rates of e-substitution across content types in the period 2012 to 2016. As less of more easily substitutable mail remains the rate of advance of e-substitution by content type is likely to depend increasingly on whether senders and recipients of business mail/correspondence type mail are able and willing to substitute e-communication for letter mail.

ii) **Sender Group**. Trends in e-substitution of B2C business mail by sender group j, measured through the indices E_{jt} , are shown in Figure 3 and the resulting implied percentage changes in mail volumes arising from e-substitution reported in Table 2.The sender groups are defined by industrial sector in order to help identify the extent to which the impact of e-substitution on postings of B2C business mail have differed across industries in the UK.

The sender groups for which the process of e-substitution is estimated to be most advanced are Retail and Utilities. There has been a very rapid rate of e-substitution for these sender groups since 2009 and in the case of Retail a further acceleration in the process since 2012. By 2016, it is estimated that B2C business mail volumes sent by Retail were barely a sixth of the level it is estimated they would have reached in the absence of e-substitution and for Utilities less than a third. By contrast, while in the earlier period to 2009 the extent of e-substitution for the two financial services industry groupings in the segmentation (Banks and Insurance and Other Financial Companies) is estimated to have been as large as the Retail and Utilities sectors, since 2009 (and particularly 2012) the financial services sender groups are estimated to have become ones where e-substitution has been developing least rapidly.

This divergence between Retail and Utilities sender groups on one side and Banks and Insurance and Other Financial Companies in the development of e-substitution is associated in part with the differences identified above by content type. The former sender groups send or sent (by mail or electronically) disproportionately higher percentages of Bills, Invoices while the latter send or sent above average volumes of Other Financial Correspondence. The apparent relative easing of the pace of e-substitution in the financial services sender groups is of importance given the high proportion of B2C business mail originating from these sectors.

Figure 3: Estimates of E-substitution Index by Sender Group, E_{jt} , to 2016 (2001 = 1)[1]



Source: Royal Mail

[1] E_t equals (1 – proportionate loss of mail to e-substitution) where E_t = 1 implies no e-substitution (last such year estimated as 2001) and E_t = 0 implies complete loss of all mail.

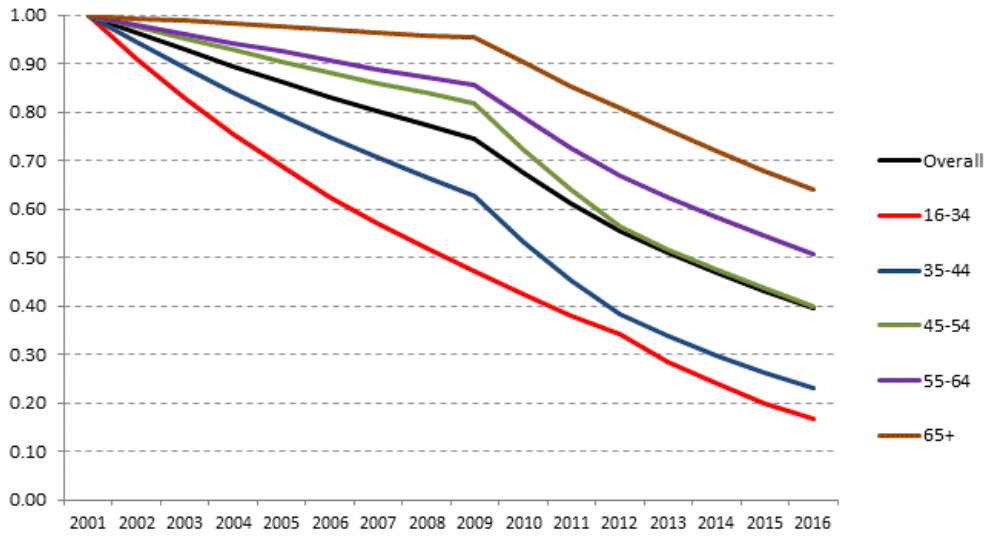
The two other sender groups in the segmentation are Government and All Other Sender Groups. Both are very heterogeneous with Government including Health and Education services as well as a wide range of government agencies and departments such as tax collection, pensions and licensing authorities and local government. All Other Sender Groups includes industries accounting for over a half of UK GDP and variation across sectors where many have mail volumes that are low such as manufacturing, construction and leisure and entertainment industries and some where volumes are relatively high including charities and clubs and societies. The impact of e-substitution on both of these sender groups in the period to 2009 is estimated to have been clearly below the overall average rate but has advanced much more in line with the higher overall average since then.

It is probably the case that there have been quite substantial differences in the extent of e-substitution across the various sub-sectors in both of these sender groups and this may be associated both with the content type sent by the two sender groups and also the age groups of the recipients of their mail. As indicated by Figure 3, this more rapid rate of e-substitution since 2009 than that estimated to have occurred in the financial services sender groups implies that by 2016 the cumulative impact of e-substitution in the All Other Sender Group had caught up with the UK Overall level and the Government sector is catching up to private sector levels but still has some way to go. Across all four (Banks, Insurance, Government and Other) the implied change in B2C business mail volumes due to e-substitution is estimated to have been between -50% and -60% by 2016 although actual traffic decreased by less than this due to the positive impact on volumes of other factors such as GDP.

A further point to note, as highlighted by Table 2, is that the sender group e-substitution estimates over the two time periods, 2009 to 2012 and 2012 to 2016, indicate that those sectors with relatively faster (respectively slower) rates of e-substitution in the earlier period also experienced faster (respectively slower) rates over the most recent period.

iii) Age Group. Figure 4 reports the estimated trends in e-substitution of B2C business mail by age group of recipient, E_{kt} , and Table 2 implied percentage changes in mail volumes due to e-substitution. The differences across age groups are very marked and consistent throughout the period since 2001. E-substitution is estimated to have developed fastest for mail volumes received by the youngest group identified (16-34 year olds) in all three sub-periods except between 2009-12 when it is estimated that e-substitution advanced more rapidly in mail sent to the 35-44 and 45-54 age groups. E-substitution is estimated to have been slower in developing for mail sent to older age groups but there appears to be no evidence of catch-up in the rates of e-substitution since 2009. Indeed, quite the reverse is estimated to have occurred at least up to 2016 with a very pronounced further widening across age groups of the extent of e-substitution in mail received. Whereas the volume of B2C business mail received by 16-34 year olds in 2016 is estimated to have been less than a fifth of the level it would have reached in 2016 in the absence of e-substitution, among the 65+ age group the corresponding estimate is over 60%.

Figure 4: Estimates of E-substitution Index by Age Group of Recipients, E_{kt} , to 2016 (2001 = 1)[1]



Source: Royal Mail

[1] E_t equals (1 – proportionate loss of mail to e-substitution) where E_t = 1 implies no e-substitution (last such year estimated as 2001) and E_t = 0 implies complete loss of all mail.

In explaining these very large differences across age groups it is unlikely that they could be accounted for, more than in part, by either the content type of mail received by different age groups or the sender group of this mail. Instead, the ability and willingness of recipients to accept an e-communication in place of letter mail is likely to matter too, for example as captured by the perspective of a sender-recipient framework for B2C business mail sent and received discussed in RST and Nikali (2008). A proxy for the ability of individuals to receive e-communication is provided by information on the percentage that have access to the Internet. Recent figures for the UK are reported in Table 3. While age groups up to 35-44 had, by 2016, Internet access at close to 100% and there are high rates recorded for age groups between 45 and 64, this is not the case for those aged 65+. At the same time it is clear that willingness to accept an e-communication in place of physical mail is also likely to be of importance. The 45-54 and, particularly, 55-64 age groups are estimated to have much lower rates of e-substitution than those aged under 45 even though their access to the

Internet and hence ability to receive e-communications is only slightly lower. Older age groups appear then, where they have an option, to have a lower willingness to accept an e-communication in place of letter mail.

A given cohort of the population born during a given period of time may be willing, where it has the option, to increase the amount of communication it will accept electronically rather than by physical mail. But the large divergence in the rates of e-substitution estimated across age groups suggests that the scale of this "acceptance effect" or propensity on the rate of e-substitution differs across age groups, at least up to 2016, and has resulted in below average rates of e-substitution among older age groups because these acceptance effects are lower. It is likely that as the cohorts of currently younger groups age into the next oldest age group, the lower volumes of mail received by that cohort and implied higher rates of e-substitution will carry through so that over time this "ageing effect" will result in higher rates of e-substitution in older groups. The estimates reported here suggest that there have been substantial and persistent differences in acceptance effects across age groups. The marked differences in these effects together with the less than complete ability of the oldest age group to receive e-communication and the relatively slow progress over time of the ageing effect jointly imply that these differences in the estimated extent of e-substitution by age group may continue, albeit in reduced form, well into the future.

Table 3: Estimates of Access by Individuals in the UK to the Internet by Age Group, %[1]

	Age Group					
	16-34	**35-44**	**45-54**	**55-64**	**65+**	**All**
2012	97	94	88	78	41	81
2016	99	98	95	88	58	88

Source: Office for National Statistics (2017c)

[1] Percentage of individuals using the Internet by any device in the preceding three months. Data refers to January to March.

5. Conclusions

This paper provides estimates of the degree to which e-substitution has reduced the demand for mail in the UK up to and including 2016. We adopt the framework developed in Rodriguez et al. (2016, 2017) and extend it to account more fully for the impacts of differential rates of economic growth by industrial sector and of population growth by age group. Our analysis focuses on B2C business mail and segments this traffic by content type, sender group and age group.

We estimate that B2C business mail in 2016 was only about 40% of the level it would have reached if there had been no e-substitution of such letter mail and the extent to which this has taken place has been highly uneven across different segments of business mail. Since our disaggregated e-substitution analysis is based on consumer survey data it is recommended that these results be interpreted as approximate estimates of the relative magnitude of B2C business mail e-substitution by content type, sender group and age of recipient.

On content type we find evidence that since 2012 e-substitution has continued to advance furthest for bills and invoices and least for business letters and elements of financial correspondence. The

large category of statements has moved approximately in line with the trend for e-substitution of B2C business mail overall.

Among sender groups, the impact of e-substitution up to 2016 appears to have reduced mail traffic most extensively in the retail and utilities sectors and least for senders from government and insurance sectors. Furthermore, estimates over the two time periods 2009 to 2012 and 2012 to 2016 indicate that those sectors with relatively faster (respectively slower) rates of e-substitution in the earlier period also experienced faster (respectively slower) rates over the most recent period.

The most pronounced differences in our estimates of the extent of B2C business mail e-substitution seem to be by age of recipient. Unsurprisingly, e-substitution appears to have advanced most among younger age groups (aged under 45) while for older groups (65 and over) e-substitution is estimated to have commenced later and developed by much less. However, the extent to which our e-substitution estimates differ by age group is considerably greater than could be accounted for by differences in access to the Internet. This result is consistent with the perspective that the extent to which business mail is being replaced by electronic communication depends not only on the ability of senders and recipients to substitute an e-communication for letter mail but also depends on their willingness to do so. It is therefore the case that for e-substitution of B2C business mail to continue to advance at a rapid rate it will need to advance significantly amongst older recipients. The extent to which this will be the case will depend on the speed of two key processes: a slow moving demographic "ageing effect" (that is, today's younger age groups will age into older age groups and so account for an increasingly larger proportion of the older population over time); and an "acceptance effect" as the population of a given cohort ages (today's 55-64 year olds in ten years will be 65-74) and exhibits prospectively a higher level of acceptance of electronic communications in place of physical mail as well as higher levels of access to the Internet.

We are not aware of any other published evidence from elsewhere on the recent path of e-substitution at the disaggregated level reported in this paper. While our results indicate that trends in e-substitution in the UK differ by content type, sender group and recipient age group, it is unclear which of these three categories has the most important impact on the overall rate of UK e-substitution and this is a question worthy of further exploration. Analysis of the respective role of these factors should aid participants in the UK mail market that wish to better understand the extent to which business mail could decline over the long term due to e-substitution and to avoid making invalid comparisons with trends to date in countries that offer mail services to customers that differ considerably in terms of quality, price and service specification. Although not examined in detail in the current paper, the total volume of business mail will be impacted also by variables other than e-substitution, in particular GDP and demographics, which in general will tend to lessen and partially offset the negative impact of e-substitution on traffic levels.

References

Jarosik, M., J. Nankervis, J. Pope, S. Soteri and L. Veruete-McKay (2013), 'Letter Traffic Demand in the UK: Some New Evidence and Review of Econometric Analysis over the Past Decade', M. A. Crew and P. R. Kleindorfer (eds), *Reforming the Postal Sector in the face of Electronic Competition*, Edward Elgar

Nikali, H. (2008), 'Substitution of letter mail for different sender-receiver segments', M. A. Crew and P. R. Kleindorfer (eds), *Competition and Regulation in the Postal and Delivery Sector*, Edward Elgar

Ofcom (2017) Annual Monitoring Update on the Postal Sector, Financial Year 2016-17, 23 November 2017

ONS(2017a)www.ons.uk/economy/grossdomesticproductgdp/compendium/unitedkingdomnationalaccountsthebluebook/2016edition

ONS (2017b) Population Estimates for the UK, England and Wales, Scotland and NI Data Sets, 22 June 2017

ONS(2017c) Internet Users in the UK: 2017, 19 May 2017

Rodriguez, F. , S. Soteri and S. Tobias (2016), 'Some Results from the UK on the Impact of E-substitution on the Demand for Mail', IDEI, Toulouse conference 2016

Rodriguez, F. , S. Soteri and S. Tobias (2017), 'E-Substitution and the Demand for Business Mail in the UK: Trends and Prospects', P.L. Parcu, M. A. Crew and T. J. Brennan (eds), *The Changing Postal and Delivery Sector,* Springer

Veruete-McKay, L., S. Soteri, J. Nankervis, F. Rodriguez (2011), 'Letter Traffic Demand in the UK: An Analysis by Product and Envelope Content Type', *Review of Network Economics, 10(3).*