To What Extent has E-substitution Impacted the Demand for Letters and Which Factors are Constraining its Advance [1]

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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 Some communication that would have taken place previously through letter mail has been replaced by electronic media, much of this process being associated with the expansion and growing use of the Internet.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 limited published information across countries on the detail and extent to which the cumulative impact of e-substitution has reduced letter volumes. The main exceptions appear to be Finland, the UK and the US. In various papers, Nikali has examined the path of e-substitution in Finland in total and by high level sender-recipient profile (see, for example, Nikali (2014)). Cigno et al. (2014) report estimates of the impact of Internet penetration in the US on postal volumes by mail class/category. For the UK, Rodriguez, Soteri and Tobias (RST) (2016, 2017) explored trends in e-substitution for business or transactional mail up to 2012 and examined longer term prospects for the volume of such mail. Rodriguez and Soteri (2018) extended the analysis of e-substitution trends by another four years to cover the period up to 2016. However, the declines in letter volumes that have occurred in developed economies cannot be explained adequately by the negative effects of e-substitution alone. In the UK, at least other variables that historically have influenced volumes, such as GDP, appear to remain in place (Jarosik et al., 2013, RST (2016)). .

The results reported in RST (2016, 2017) and Rodriguez and Soteri (2018) emphasized that the speed and distribution of the effects of e-substitution on business to consumer (B2C) business mail, which accounts for about three quarters of all business mail in the UK, have not been uniform across different segments of traffic. These papers disaggregated e-substitution trends 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 B2C business mail. This chapter provides further insight to these empirical results by assessing the relative importance of these factors in the advance of e-substitution. Analysis of variance techniques are used which, to the best of our knowledge, breaks new ground in the postal economics literature.

The chapter is structured as follows. Section 2 reports estimates of key trends in the e-substitution of business mail in the UK. Section 3 uses analysis of variance modelling to assess the relative importance of letter content type, sender group and age group of recipient as factors underpinning the advance of e-substitution. Section 4 undertakes a further examination of e-substitution in the light of the analysis of variance results, and Section 5 concludes.

[1] The views expressed in this chapter are those of the authors and do not necessarily reflect those of the organizations to which they are affiliated. We are grateful for comments on an earlier version of this article by Aleksander Rutkowski and the editors.

2. E-Substitution trends in the UK

The extent of e-substitution is measured using an index, E_t , defined as (1– proportionate loss of mail to e-substitution) where ($0 < E_t \leq 1$) and $E_t = 1$ represents a year *t* when there has been no overall net impact on mail volumes from e-substitution, as set out in RST (2017, p.36). For example, a value of $E_t = 0.6$ in year *t* indicates that mail volumes were only 60% of the level they would have reached in that year if there had been no impact on volumes from e-substitution.

Estimates of E_t are based on results from an updated version of the econometric model developed in Veruete-McKay et al. (2011) reported in RST (2016, p.4), which used annual data from 1980 to 2012 for the UK from Royal Mail and includes an equation for the volume of commercial mail which is explained as a function of GDP, demographics, prices and "unexplained" time trends which are included to account for the impact of e-substitution[2]. As outlined in RST (2016, 2017) and Rodriguez and Soteri (2018), information from the two linear time trend terms (and also the relatively small impact from prices) in that equation have been used to derive estimates of E_t for business mail overall[3]. The first, T_1, begins in 2002 and equals -3½ % pa. It is added to by a second time trend, T_2 , commencing in 2010 (-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 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; T_1 and T_2 enter as proportions; 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 as a product calculated over the years to year *t* from *t* = 2002.

The time path of E_t, as reported in Rodriguez and Soteri (2018) and which extended RST (2017) results to 2016, is shown by the "Overall" series in each panel of Figure 1 and accelerates after 2009. By 2016 E_t is estimated to have declined to 0.39, which implies that business mail volumes were only about 39% of the level they would have reached in that year in the absence of e-substitution.[4] Although not equal to unity in many years, over the period 2002 to 2016 as a whole the product of the terms in x_t in (1) is close to 1, signifying that the negative impact of real prices on B2C business mail volumes is estimated to have been relatively small.[5] Note that the overall decline in business mail volumes since 2001 has been

[2] An alternaive approach would have been to have identified variables that can be directly associated with e-substitution. However, as noted by Jarosik et al. (2013, p203), models including time trends tended to contain better properties and diagnostic test statistics than those including internet and broadband penetration rates. This may be because the dynamic impact of technology related letter substitution is unlikely to be reflected within the properties of a single direct variable and time trends may be a better proxy for the net impact of numerous and overlapping technology effects. Further discussion on this issue is contained in RST(2016).

[3] Although the equation estimated was for the volume of commercial mail and the traffic measure included relatively small amounts of publishing material and lightweight packets, it is considered a good proxy for both total and overall B2C business mail volumes.

[4] This value is towards the upper end of the range of the values in the two hypothetical scenarios for the rate of advance of e-substitution presented in RST (2017, p.46) of 0.42 in the "low rate of advance scenario" and 0.33 in the "high rate of advance scenario".

[5] The estimated cumulative impact of price on E_t by 2016 was to reduce it from 0.42 to 0.39. The main reason for this relatively small difference is that the two letter price elasticities used to inform our analysis were low, as

considerably less for, as the econometric model indicates, there have been continuing upward impacts on volumes from GDP and demographics that have contrasted and partially offset the negative effects of e-substitution.[6]

The main focus of interest of this chapter is on analysis of the advance of e-substitution at a disaggregated level. Three disaggregations of B2C business mail traffic are considered. The first is by content type, j ($j = 1, \ldots 6$: Bills, Invoices; Business Letters; Insurance, Legal, Financial Documents; Financial Statements; Other Financial Correspondence; and All Other Content Types). The second is by sender group, k ($k = 1, \ldots 6$: Banks and Loan Companies; Government (including Health and Education); Insurance and Other Finance; Retail; Utilities; and All Other Sender Groups). The third is by age group of recipients of B2C business mail, l ($l = 1, \ldots 5$: 16-34, 35-44, 45-54, 55-64, 65+).

Some of the data used in this analysis were taken from a continuing survey of mail sent and received by households in the UK.[7] These data, along with other information, were used to allocate the overall estimate of the e-substitution of B2C business mail determined by the econometric model across the various segmentations of traffic (Rodriguez and Soteri, 2018). At the level of total traffic, the total volume of B2C business mail in year t can be expressed in a stylized 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[8]),

GDP and population[9] 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; g and p are the elasticities of total B2C business mail volume with respect to,

informed by RST (2016, Table 1 page 4). In particular, the analysis assumed a real letter own-price elasticity of -0.13 and a real telecommunication price elasticity (acting as a substitute price effect) of 0.18. Therefore only a small proportion of the change in real letter and telecommunication prices, which themselves tend to be low, are estimated to impact letter volumes.

[6] For example, in 2016 business mail volumes in the UK were around 60% of their level in 2001.

[7] Respondents in the survey 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. The survey is operated by an outside market research company and was given to a panel sample of about 1500 households, with 1200 reporting each month and weighted to reflect population characteristics. The business mail outputs of the survey are periodically checked against Royal Mail customer and product data information for consistency and are deemed by business experts to be broadly representative. However, as these data are 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.

[8] As the estimated impact of the effect of price changes on letter volumes was estimated to be relatively small (see footnote 3) the analysis was simplified by including this effect within E_t.

[9] 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 chapter as a proxy, given the lack of published disaggregated annual data in the UK on the number of households.

respectively GDP and population; and G_t and P_t are the cumulated proportionate changes in GDP and population by year t from year $t = 0$. [10]

For any segment of B2C business mail s ($s = j, k, l$ or any pairwise or three-way combination of categories of which, for the latter, in total there are (6X6X5= 180), 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 derived from the household survey data; $\sum_s a_{st} = 1$ for a particular segmentation across all B2C business mail such as sender groups, k. The corresponding share in year $t = 0$ is $a_{s,t=0}$. The subscripts s on other variables in (3) denote their correspondence to segment s. Some rearrangement and equating (2) and (3) yields E_{st}, the index of e-substitution for segment s in year t, as:

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

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 econometric 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.[11] The index E_{st} is lower (respectively higher) relative to the overall index E_t (implying more e-substitution of segment s than overall B2C business mail) where the share of segment s traffic has fallen (respectively increased) since year $t = 0$ and where the impact of GDP or population on segment s is greater than the impact of these variables on B2C business mail overall. Further detail on the data used to populate the elements of E_{st} for each segment of traffic is reported in Rodriguez and Soteri (2018). In particular, with regard to the elasticities g and p, and lacking disaggregated estimates of these parameters, the method in RST (2016) is followed which sets all segment elasticities to the values at the total traffic level from the econometric results reported there such that $g_s = g = 0.9$ and $p_s = p = 1$.

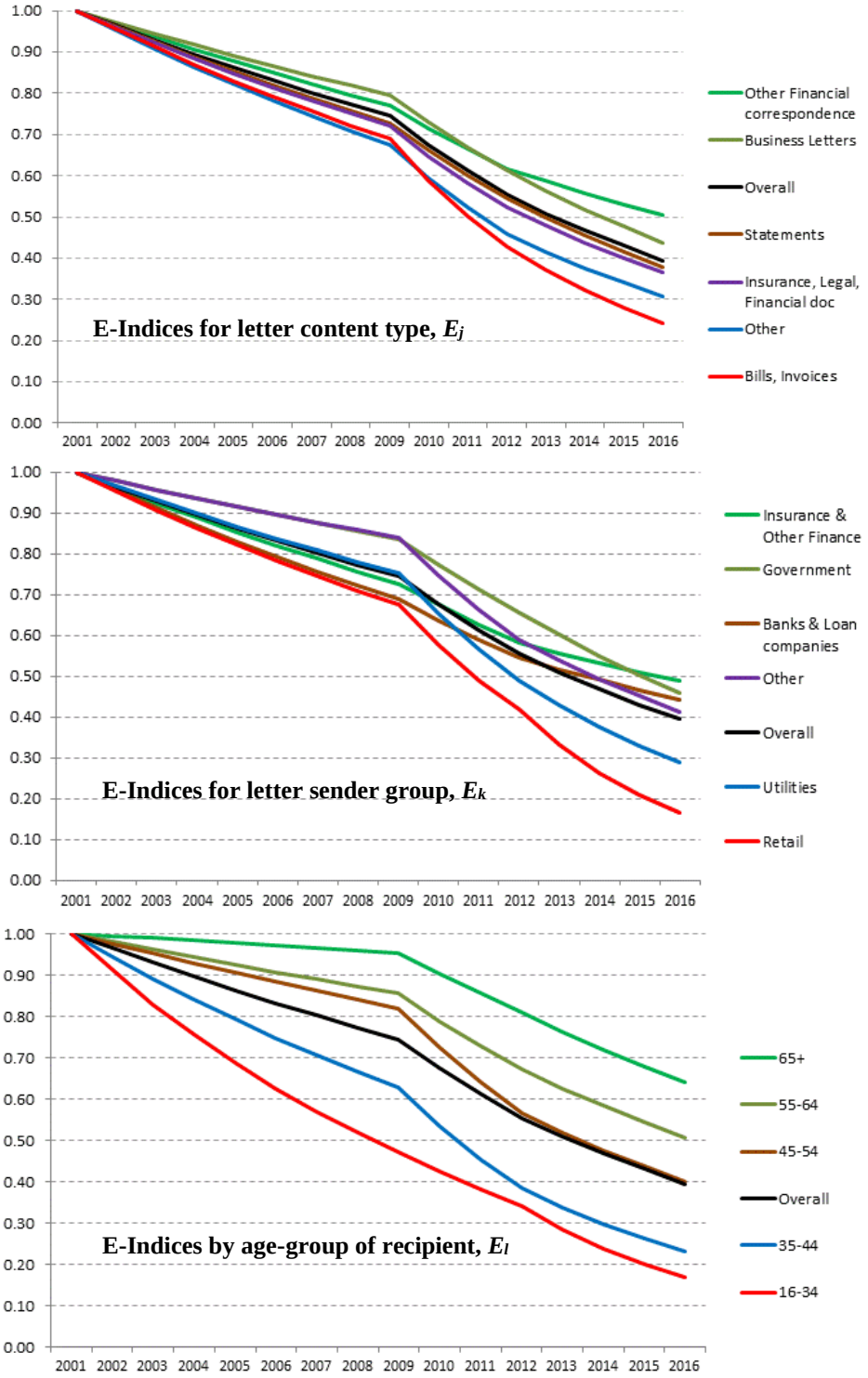
Section 3 analyses the development of e-substitution at the three-way or 180 level of segmentation but it is insightful first to summarize this at a higher level of aggregation. Figure 1 reports the time paths for estimates of e-substitution at the level of the six content types, six sender groups and five age groups of recipients used in the analysis based on detailed analysis of three years: 2009, 2012 and 2016. By content type, e-substitution is estimated to have advanced furthest for Bills, Invoices where communication is more routine in nature, and least for the categories of Other Financial Correspondence and Business Letters where communication is generally *ad hoc* and less suited to standardization. By sender group, Retail and Utilities sectors are those where e-substitution is estimated to have developed most while

[10] In order to ease the analysis and simplify the expressions used later in the article we adopted expression (2) which is an approximation to the expression $Q_t = \; Q_{t=0} \,.\, E_t \; (1 + G_t)^g \; (1 + P_t)^p$ that is consistent with the econometric model reported in RST (2016).

[11] If we had adopted the expression referred to in footnote 10, expression (4) would have taken the form $E_{st} = \; E_t \,.\, \left(\frac{a_{st}}{a_{s,t=0}}\right) . \left(\frac{(1+G_t)^g}{(1+G_{st})^{g_s}}\right) . \left(\frac{(1+P_t)^p}{(1+P_{st})^{p_s}}\right)$ and estimates for E_{st} would be marginally different. A range of estimates found the differences to E_{st} to move the 3rd decimal point or in most cases the fourth or fifth.

the differences between the other sender groups were relatively small and had narrowed substantially by 2016 compared with divergence between them in earlier years.

Figure 1. Estimates of E-substitution indices, E_t, for UK business mail to 2016 (2001 = 1)*



Source: Royal Mail Group and Author calculations

*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 largest differences in the development of e-substitution are estimated to be those by age group of recipient highlighting the importance of considering this process from not only the perspective of senders but also that of recipients (Nikali, 2008)[12]. Differences in trends in mail received by age of recipient are evident also in the US over the period 2001 to 2016. Declines in both US First Class correspondence (for example, business letters) and, particularly, transactional mail (for example, bills and statements) received by younger individuals have been larger than for older recipients (Office of Inspector General (OIG), United States Postal Service 2018a, 2018b).[13]

RST (2017) showed that the very high rates of e-substitution of mail received by younger age groups compared with older groups are due only partially to differences in access to the Internet. The differences in e-substitution between age groups are substantially greater than in such access. This point was reaffirmed in Rodriguez and Soteri (2018) using data up to 2016. It is likely then that, where recipients have choice, older age groups have a lower willingness to accept an e-communication in place of letter mail than younger groups.

3. ANOVA methodology and results

Analysis of variance (ANOVA) is a robust and widely used statistical method that decomposes the variance of a particular variable into components attributable to different sources of variation. This method is appropriately suited to assessing the relative extent to which e-substitution can be accounted for by letter content type, sender group, and recipient age group. An ANOVA analysis is undertaken at the three dimensional E-Index level E_{jkl} consisting of 180 segments. This method is equivalent to a regression setting in which dummies for all segments are covariates.

3.1 ANOVA methodology

ANOVA models consider the variation of a quantitative dependent variable to be a function of some categorical variables (or factors) and provide a framework to evaluate the relative importance and significance of the effects of each factor and their interactions. For example, if the dependent variable y_i is considered to be a function of three factors (j, k, l) , the standard ANOVA model denotes y_{ijkl} to be the value of the dependent variable defined by the combination of the three factors, with $i = 1, \ldots, n_{jkl}$ and j = 1, …,J, k=1, …,K and l=1,…L (where J, K and L are the numbers of categories for each factor, and n_{jkl} is the number of observations for the cell (j, k, l)). In the specific empirical application of this chapter, the number of observations n_{jkl} is equal to 1 and thus index i is dropped henceforth.

To test the significance of the effects of each factor and their interactions on the quantitative variable, the variance for y_{jkl} can be decomposed using the standard ANOVA

[12] As noted, these estimates of e-substitution by age group of recipient were derived using population data. Broadly similar results were obtained using instead more limited household data as the demographic measure in expression (3). In particular, estimates using household data from the decennial censuses of 2001 and 2011 (the only source of data in the UK on the number of households at the level of disaggregation required for these estimates) were within +/- 0.03 of those contained in Figure 1 for each age group in 2011.

[13] Definitions of mail as reported by OIG. For example, between 2001 and 2016 the percentage change in transactional mail received by households with a head aged 25-34 was -58%; -49%, aged 35-44; -41%, aged 45-54; -36%, aged 55-64; and only -25% for those aged 65+ (OIG 2018b, p.8).

equation and assessed using the Fisher statistics relative to each factor and their interaction terms. This analysis commences with the following identity:

$$y_{jkl} - \bar{y}_{...} = (\bar{y}_{j..} - \bar{y}_{...}) + (\bar{y}_{.k.} - \bar{y}_{...}) + (\bar{y}_{..l} - \bar{y}_{...}) + (\bar{y}_{jk.} - \bar{y}_{j..} - \bar{y}_{.k.} + \bar{y}_{...}) + (\bar{y}_{j.l} - \bar{y}_{j..} - \bar{y}_{..l} + \bar{y}_{...}) + (\bar{y}_{.kl} - \bar{y}_{.k.} - \bar{y}_{..l} + \bar{y}_{...}) + (y_{jkl} - \bar{y}_{.kl} - \bar{y}_{j.l} - \bar{y}_{jk.} + \bar{y}_{..l} + \bar{y}_{.k.} + \bar{y}_{j..} - \bar{y}_{...}) \quad (5)$$

(where $\bar{y}_{...} = \frac{1}{JKL}\sum_{j=1}^{J}\sum_{k=1}^{K}\sum_{l=1}^{L} y_{jkl}$; $\bar{y}_{j..} = \frac{1}{KL}\sum_{k=1}^{K}\sum_{l=1}^{L} y_{jkl}$; … and the other means being defined in a similar way. The ANOVA equation is obtained by decomposing the total sum of squares (TSS) of the dependent variable as a sum of the sum of squares (SS) associated to each of the three factors (SS1, SS2 and SS3), their interactions of order 2 (SS12, SS13, SS23) and of order 3 (SS123), which can be written as:

$$TSS = SS1 + SS2 + SS3 + SS12 + SS13 + SS23 + SS123 \quad (6)$$

In this study for e-substitution, as there is just one observation for the e-substitution index y_{jkl} for each cell (*j, k, l*), then the interaction of order 3 (SS123) should be replaced in (5) by the residual component (Sum of Squared Residuals, denoted SSR)[14].

The significance of each effect (principal effects and interactions) can then be tested by using Fisher statistics. For example, to test the significance of the principal effect of factor 2 (with *K* categories), this statistic is defined as the ratio:

$$F_2 = \frac{SS2/df_2}{SSR/df_R} \quad (7)$$

where $df_2 = K - 1$ and $df_R = (J-1)(K-1)(L-1)$, are the corresponding degrees of freedom.

The precision of the e-substitution index estimates may vary across cells. To account for this, the ANOVA estimation for decomposing the variance is weighted by the inverse of the variance of e-substitution indices, as in weighted least squares or more exactly Asymptotic Least Squares (Gouriéroux et al., 1987). This amounts to minimizing the sum of weighted squares of residuals. The mail volume shares are used as weights that are highly likely to be related to the precision of the E-indices. This modifies the ANOVA equation for the decomposition of variance (5 and 6), since the factors and their interactions are no longer orthogonal in the usual least squares sense. However it does not change the interpretation of the estimated F-statistics and their relative importance as measured by their corresponding p-values.

3.2 ANOVA results

Table 1 contains the ANOVA results applied to the 180 E-indices, E_{jkl}, pertaining to 2009, 2012 and 2016. In this table, the value of "partial sum of squares" for a particular term represents the contribution of this term to a model including all the other terms. More precisely, the effect of each term is equivalent to it being evaluated after all other terms have been accounted for (that is, equal to the sum of squares as if each term were entered last into the model). The ANOVA results applied to the 180 E-indices pertaining to the three years

[14] For details about ANOVA models see for example Cameron and Trivedi (2010)

examined show that all the models have a high degree of explanatory power with the adjusted R^2 values lying in the range 0.87 to 0.98.

To evaluate the relative significance of factors or the interactions between factors, the p-values associated with the hypotheses of the absence of an effect of a factor or an interaction term on e-substitution can be examined. The value of these p-values is the probability of rejecting incorrectly the hypothesis that a factor or an interaction term has no influence on e-substitution. The p-values reported in Table 1 indicate that all factors (principal and interactions) are significant at a 5% level of significance in explaining the variation in the E-indices for the three years examined and most are significant at the 1% level for all years except for the interaction between Age and Content. .

The factor Age is estimated to be the most important factor that explains the variation in E-indices because its p-value is by far the smallest of all factors or interaction terms in all the years examined. The second most important term, moving ahead of the individual factor Sender after 2009, is the interaction of Content and Sender groups followed, some way behind, by the remaining Age interaction terms which, while statistically significant, have consistently been the relatively less important.

. It is also worth mentioning that the explanatory power of the model was lower in 2009, with a value for the adjusted R^2 equal to 0.87 and the variance of the E-indices have increased over time (as denoted by the increasing sum of squares in Table 2), indicating that the three factors and their interactions are accounting for a somewhat higher proportion of the total variance in 2012 and 2016 compared to 2009.

Table 1. ANOVA results for business mail letter e-substitution by content-type , sender group and recipient age-group, E_{jkl} in 2009, 2012 and 2016

	Partial Sum of Squares	Degrees of freedom	Mean Square (SS/df)	F-statistic	P-value (prob>F stat)
2016 model	7.0498	79	0.0892	46.29	1.16E-54
Age, *l*	1.8008	4	0.4502	233.53	8.62E-50
Sender, *k*	0.2180	5	0.0436	22.61	4.11E-15
Content, *j*	0.1993	5	0.0399	20.67	3.97E-14
Age & Sender, *lk*	0.0919	20	0.0046	2.38	2.51E-03
Age & Content, *lj*	0.0669	20	0.0033	1.74	3.96E-02
Content & Sender, *jk*	1.1707	25	0.0468	24.29	5.71E-32
Residual	0.1928	100	0.0019		
Total variance	7.2426	179	0.0405	Adjusted R^2:	0.9524
2012 model	6.4616	79	0.0818	121.69	5.10E-75
Age, *l*	2.9096	4	0.7274	1082.25	2.41E-81
Sender, *k*	0.1177	5	0.0235	35.02	1.51E-20
Content, *j*	0.3162	5	0.0632	94.08	3.22E-36
Age & Sender, *lk*	0.0508	20	0.0025	3.78	4.94E-06
Age & Content, *lj*	0.0488	20	0.0024	3.63	9.55E-06
Content & Sender, *jk*	0.8898	25	0.0356	52.96	8.92E-47
Residual	0.0672	100	0.0007		
Total variance	6.5289	179	0.0365	Adjusted R^2:	0.9816
2009 model	5.3570	79	0.0678	16.27	8.85E-34

Age, *l*	2.6830	4	0.6707	160.9	1.20E-42
Sender, *k*	0.3663	5	0.0733	17.57	1.86E-12
Content, *j*	0.0786	5	0.0157	3.77	3.61E-03
Age & Sender, *lk*	0.1591	20	0.0080	1.91	1.95E-02
Age & Content, *lj*	0.1215	20	0.0061	1.46	1.14E-01
Content & Sender, *jk*	0.5676	25	0.0227	5.45	4.44E-10
Residual	0.4169	100	0.0042		
Total variance	5.7738	179	0.0323	Adjusted R^2: 0.8708	

4. A further examination of e-substitution by content type, sender group and age group of recipient

The ANOVA models show that amongst the factors examined to account for differences in B2C business mail e-substitution, the age of recipients is by far the most important factor and the interaction of content-sender factors has become more important over time. This section examines E-index estimates for these categories in more detail.

Figure 2 reports estimates of sender-age group E-indices. The individual curves all slope upwards and indicate that the E-indices tend to increase (that is, e-substitution declines) by age group of recipients for all sender groups. It is noticeable that Retail business senders tend to have the lowest and shallowest curve, which indicates that in addition to possessing the highest rate of e-substitution, this sender group also exhibits the least variation by age groups. In contrast, the Utilities sender group, which is estimated to have the second highest overall level of e-substitution (see Figure 1), exhibits a steeply rising curve in Figure 2, similar to all the other sender groups. This pattern suggests that characteristics related to recipients' age are more important than sender specific factors for all of these sectors.[15] These results may also suggest that factors driving e-substitution in the retail sector may be more independent of the demand for letter mail by recipients than in other sectors, especially those in more regulated areas such as finance and utilities. .

[15] A similar conclusion can be drawn when examining the age-content equivalent of Figure 2.

Figure 2. Business mail 2016 age-sender E-indices, E_{lk2016}

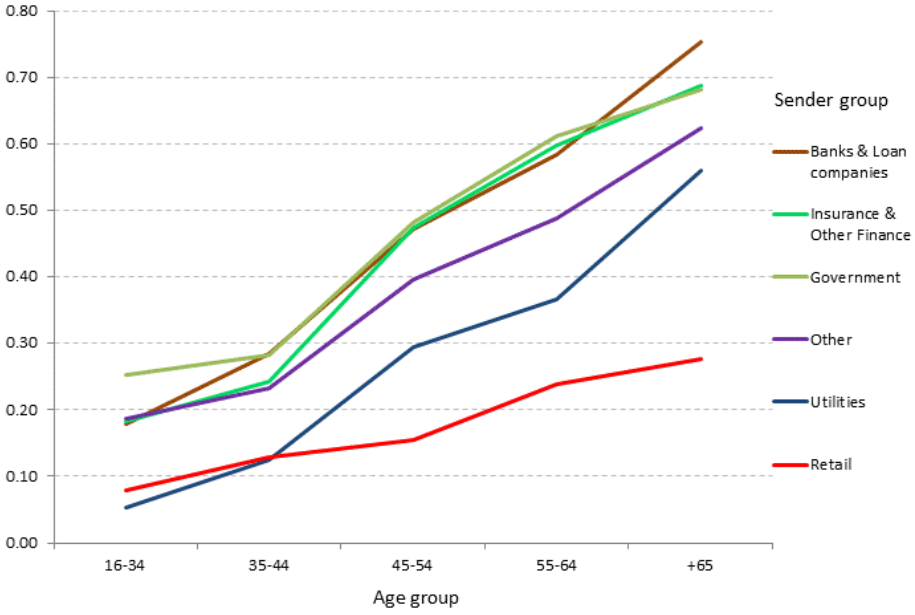
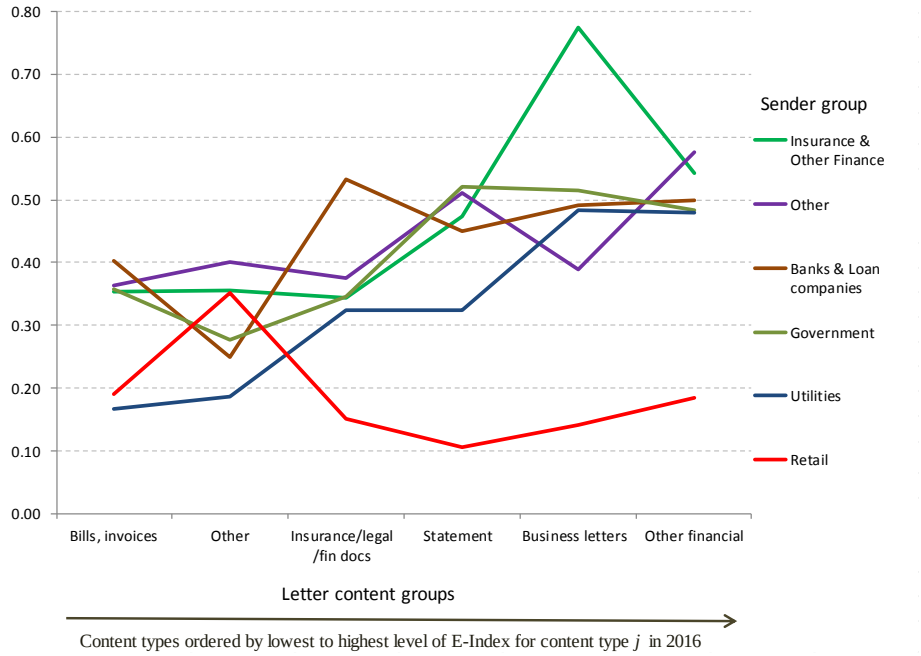


Figure 3 plots E-indices for letter content types by sender group, where the x-axis is ordered by the content type with the lowest to highest E-index value in 2016 as shown in Figure 1 (that is, for content types from most to least e-substitution). This shows no clear upward sloping relationship between the magnitude of the Retail sender E-indices and those for letter content types and suggests that factors related to the latter are unlikely to be a major driver of e-substitution in the retail sector.

In contrast, the profile for the Utilities sender group slopes upwards which indicates that sender group-content type E-indices tend to increase together. In addition to age, therefore, the interaction of both content and sender factors are also likely to be contributing materially to the relatively high level of overall e-substitution for Utilities. With respect to the remaining sender groups there tends to be some, although less strong evidence, of an upward sloping relationship with regard to content types in Figure 3. This implies that the interaction of sender-content factors is likely to be relatively weaker for these segments.

The high E-index (low level of e-substitution rate) for Business Letters sent by the Insurance and Other Finance is somewhat of an outlier with respect to other points in Figure 3 and suggests that sender-recipient aspects for this segment of traffic are relatively more important than for others.

Figure 3. Business mail 2016 content type-sender group E-indices, E_{jk2016}



5. Conclusions

This chapter provides estimates of the degree to which e-substitution has reduced the demand for B2C business letter mail in the UK overall and by content type, sender group and age group of recipient. As highlighted in Section 2, volumes for B2C business mail overall in 2016 are estimated to have been only about 40% of the level they would have reached if there had been no e-substitution of such letter mail. The overall decline has been considerably less as the negative effects of e-substitution have been partially offset by continuing upward impacts on volumes from GDP and demographics.

Further, the extent to which e-substitution has taken place has been highly uneven across different segments of business mail. With regard to letter content type it is estimated that, up to 2016, e-substitution has advanced 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 appears to have reduced mail traffic most extensively in the retail and utilities sectors and least for senders from government and insurance sectors.

The most pronounced differences seem to be by age of recipient, a result that also that appears to hold in the US (Office of Inspector General, United States Postal Service, 2018a, 2018b). 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 much less. By 2016, the volume of B2C business mail in the UK received by those aged 16 to 34 is estimated to have been less than a fifth of the level it would have reached in the absence of e-substitution while among those aged 65+ the corresponding estimate is over 60%.

The rather distant second most important factor in 2016 was estimated to be the interaction of content type and sender group factors, which has also tended to increase in importance over time. The individual sender and content factors, although highly statistically significant, were estimated to be relatively less important in explaining the variation in e-substitution across different segments, while the interaction terms with age group of recipient were estimated to be the least important.

The very significant extent to which the importance of recipient age far outweighs that of any other factor or interaction of factors suggests that the ability and willingness of senders to replace letter mail by electronic communication are constrained by recipient behavior. With very high accessibility to Internet related technology for nearly all age groups in recent years, it appears that the unwillingness of recipients to accept, where they have a choice, the substitution of e-communications for letter mail is likely to be a key element in limiting the advance of e-substitution; the age group of the recipient of mail captures this effect most strongly. Consumer preferences and choices with respect to the form of the recipient of business communications appear then to be playing a powerful role in determining the rate of decline in B2C business mail letter volumes and the level that these could reach over the medium to long term.

These developments are consistent with a framework first developed by Nikali (2008) for examining trends and prospects for business mail which emphasizes the ability and willingness of recipients to accept communication by electronic means as well as the ability and willingness of senders in wishing to reduce their use of letter mail. To the extent that willingness is likely to change over time as individuals become more familiar with different types of electronic devices and as internet enabled applications become easier to use, it would be very useful to extend the ANOVA estimates to try and capture such effects, possibly by simultaneously estimating all years together and including a fourth factor such as a time trend or other variable.

It is important that postal operators, consumer bodies and policy makers actively support the range of choices available with respect to how recipients of business communications themselves wish to be contacted by companies and other organizations such as government agencies. Evidence from a comparison of the rates and reasons for the decline in mail volumes in Denmark and Sweden (Andersson et al., 2018) has reinforced the significance of this point. In terms of targeting possible activities, the analysis undertaken in Sections 3 and 4 suggests these could focus on all sender groups, with the possible exception of the retail sector, and try to support letter volumes for low e-substitution (high E-index) content types, such as business letters, other financial mail and possibly statements.

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