



# e-Business usage across and within firms in the UK: profitability, externalities and policy

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## ARTICLE INFO

### Article history:

Received 12 October 2006

Received in revised form 13 October 2008

Accepted 31 October 2008

Available online 9 December 2008

### Keywords:

Technological diffusion

e-Business

Technology policy

## ABSTRACT

Using data from the third UK Community Innovation Survey we model the usage of e-business across and within firms in the UK in the year 2000 as a single observation upon an integrated process of inter- and intra-firm diffusion. The intra-firm dimension is a significant extension to standard analysis. The model estimates indicate that the pattern of e-business usage reflects the heterogeneity of firms in terms of size, other innovative activity and labour force skills (generating differences in the payoffs to use) as well as market and non-market intermediated externalities. The policy implications of the findings are discussed.

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## 1. Introduction

The impact of the Internet upon the cost and speed of information access will probably prove in time to make it one of the most important innovations of the last hundred years. One aim of this paper is to understand the process by which this new technology has been adopted by firms and in particular to explore not only usage per se but the extent or sophistication with which the technology has been or is being used. The main theoretical tools for this exercise derive from prior studies of the diffusion of new technologies. The data available comes from the third UK Community Innovation Survey (CIS3) and is a single cross-section rather than a panel, thus we cannot estimate a full dynamic diffusion model; however the model gives clear predictions as to what differences might be expected between firms and industries at a single point in time, which may be tested. The diffusion literature mainly concentrates upon the extensive margin (use across firms) with a growing literature on inter-firm diffusion (see, for example, the recent survey by Hall, 2004). There is a much smaller literature on the intensive margin (use within firms) or intra-firm diffusion (see, Battisti and Stoneman, 2005), although the relative impor-

tance of both in the overall diffusion process has been shown by Battisti and Stoneman (2003). Usually however the two margins are discussed and analysed separately. A second contribution of this paper is to offer an integrated approach that combines analysis of both the intensive and extensive margin. This also allows us to consider the impact upon the extent of use of e-business across and within firms of market intermediated and non-market intermediated externalities after controlling for a number of firm characteristics and environmental factors, which then enables policy discussion.

The data source is discussed in Section 2 and used to provide an overview of e-business use in the UK. In Section 3 a simple integrated inter- and intra-firm diffusion model is presented. In Section 4 this is applied to the data and the drivers of e-business use isolated. The policy implications of the results are discussed in Section 5. Section 6 contains conclusions.

## 2. The Community Innovation Survey

Ideal data for the exercise performed here would be a long and thick panel. There are in fact now considerable data on the use of e-commerce in Europe collected as part of the EC e-Business Market W@tch observatory initiative. In the UK this involves the e-commerce survey that has been conducted by the Office of National Statistics, from which data on ICT usage are available annually for the period 2001–2005 (although the 2001 data are poor) and for which we have been allowed access to the individual returns. There

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are two main problems with these data. First, there are no data on firm characteristics and these have to be observed by cross-reference to the ABI/ARD2 data sets.<sup>1</sup> We found however that there are only 157 firms for which one can obtain full data on e-business usage and other relevant characteristics for the period 2001–2004, which is too small to be useful here. Secondly, even the supplemented data do not contain measures of other innovation indicators to be found in the CIS data and that we use below as important control variables.

We have thus used responses to the third<sup>2</sup> UK Community Innovation Survey (CIS3) which employed a pan-European survey instrument designed to gather information on the extent of innovation in European firms. This was carried out in the UK in 2001 by the Office of National Statistics on behalf of the Department of Trade and Industry (now BERR—the department of Business Enterprise and Regulatory Reform) and anonymised individual returns data has been made available to us.<sup>3</sup> The advantage for current purposes of the CIS3 data is that it contains data upon both the extensive and intensive margin of e-business usage in addition to data upon other indicators of innovativeness and firm characteristics. The CIS3 survey was addressed to enterprises (which we here call firms, although this is misleading for multi-plant firms) with more than 10 employees, in both manufacturing and service industries and related to innovative activities between 1998 and 2000. From an original sample of 126,775 records on the Inter Departmental Business Register, the questionnaire was sent to a stratified (by industry and firm size) sample of 19,602 enterprises and 8173 responses were eventually registered, which represent the sample for the work reported here. We have no reason to believe that there are any particular biases in this final sample.

In CIS3, Question 17.2 is:

17.2 Can you indicate the extent of your enterprise's use of e-business activities over the period 1998–2000 (please tick all that apply):

- a. **Basic Internet presence.**
- b. **Internet used for information.**
- c. **Customers can place orders through the Internet site.**
- d. **Commerce with other businesses through the Internet site.**

The list of offered responses to Q 17.2 does not include a 'no use' choice. Although there may be non-respondents to this question for other reasons, we measure non-users (and thus the extensive margin) by the number in the sample of non-respondents to this question. In order to check upon the validity of this we explored the proportion of firms who claimed in CIS2 to be using the Internet (34% of the sample), who also replied to CIS3 (243) but did not respond to Q17.2. Of the 243 firms only 13 (mostly small firms with little other innovative activity) did not respond to Q17.2, which leads us to believe that any error introduced by our assumption that non-response means non-use will be small. Of the total sample of 8173 enterprises there are 1376 non-respondents/non-users. Thus we estimate that 83.2% of all enterprises in 2000 were engaged in

e-business to some degree. As a check, the e-commerce survey for 2005 estimates that 78.8% of businesses were using the Internet to some degree in 2002 and 88.8% in 2005.<sup>4</sup>

Intra-firm diffusion (or the intensive margin) is often measured by indicators such as the proportion of the firm's capital stock that embodies the new technology, or the proportion of output produced using the new technology, or, in the current situation, the proportion of employees connected to the Internet. Our data source does not provide information on such measures but does enable one to consider the intensive margin via a different metric. As e-business spreads, one might not only expect the number of users in the firm to increase but also the range of tasks that they perform using the technology (additionally or alternatively) to increase, and/or the tasks that they perform using the technology to increase in sophistication (see Forman et al., 2002, 2003 and later Crespi et al., 2004 for a similar approach). It is the latter definition that we adopt to define the metric for intra-firm diffusion.

There is some dispute in the literature as to whether one can devise a simple index of sophistication of use (see for example Bridgewater and Arnott, 2004). In this paper we are restricted by the data available and cannot proceed other than by interpreting the responses already made to Q17.2. These responses cover four different uses to which responses are requested. Response (a) may just mean that the firm has an ISP whereas (b) may just mean that the firm has done a Google search, and we do not consider one can judge either as more sophisticated than the other. Response (d) essentially means that the firm has purchased via the web whereas response (c) essentially means that the firm has sold through the web. Although we may infer that these latter two activities are more 'enhanced' than the first two one cannot necessarily order (c) and (d) in terms of sophistication. It was suggested to us that one may consider sophistication by considering some activities as natural precursors to others, e.g. (a) and (b) would be natural precursors to (c) and (d). However we do not see (a) as a natural precursor to (b) nor (c) as a precursor to (d), nor vice versa. It has also been suggested to us that we consider responses to (a), (b) (c) and (d) separately and allow the empirical method to order patterns of sophistication. Unfortunately respondents did not necessarily take on board the instruction to tick all that apply, and thus we were unable to proceed in this way either. In fact of the sample of 8173 firms, in response to Q17.2, 63.4% ticked (a), 64.8% ticked (b), 16.5% ticked (c), 17.3% ticked (d) and 8.2% ticked both (c) and (d).

In these circumstances we define for empirical purposes just two categories of e-business usage upon the reasoning that we can be sure that (c) and/or (d) are more sophisticated than (a) and/or (b) but little else. The two categories (Category 0 being non-use) are:

Category 1: Basic usage, shown by indicating (a) and/or (b) but not (c) nor (d).

Category 2: Enhanced usage, shown by indicating (c) and/or (d).

We have assumed that all firms in Category 2 also have a basic Internet presence that would seem to be nested in the former. Thus users in Categories 1 and 2 represent the extensive margin whereas the proportion of users in Category 2 indicates the intensive margin.

Table 1 presents some of the detailed information upon the pattern of inter- and intra-firm usage of e-business in 2000. The data are presented as proportions of the sample of enterprises that fall into Categories 0, 1 or 2. The data indicate that in 2000, 83.2% of the sample use the Internet to some degree with 57.5% being basic users and 25.6% being enhanced users (which may be compared to the

<sup>1</sup> See [www.statistics.gov.uk/about/data/guides/productivity/downloads/ProductivityHandbook.Chapter10.pdf](http://www.statistics.gov.uk/about/data/guides/productivity/downloads/ProductivityHandbook.Chapter10.pdf) on such procedures.

<sup>2</sup> An earlier CIS2 survey did initially hold out the prospect of a panel data set, however the relevant question asked in that survey did not identify the intensive margin and the extent of overlap between the two samples is small. Although we make some use of the CIS2 data it is therefore in a supportive rather than central way. We also explored the possibility of constructing a panel using CIS4. Unfortunately the relevant questions on Internet use were dropped from CIS4 (because they were included in the e-commerce survey).

<sup>3</sup> For which we are most grateful to the DTI (as was).

<sup>4</sup> Source: [www.statistics.gov.uk/downloads/theme\\_economy/ecommerce\\_report\\_2005.pdf](http://www.statistics.gov.uk/downloads/theme_economy/ecommerce_report_2005.pdf), Table 12.

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