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# The Impact of the Diffusion of a Financial Innovation on Company Performance: An Analysis of SWIFT Adoption

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**Abstract**
How does a major financial network innovation influence firm performance? Despite much speculation we have little hard quantitative evidence about the impact of technology diffusion in financial services. In this paper we use the entire adoption history for SWIFT (the Society for Worldwide Interbank Financial Telecommunication - standards provider and messaging carrier) matched to bank-level panel data for the US, Canada and 27 European countries. Our dataset covers almost 7,000 banks (including 1,689 SWIFT adopters) between 1998 and 2005. We find that adoption appears to have large effects on profitability, but it takes several years before any positive return is discernible, consistent with the idea of significant complementarities between new technologies and firm organization. The profitability effect operates by both raising sales and decreasing operating costs and is greater for smaller firms than larger firms. Although the long-run effects are similar, US and UK banks appear to reap the benefits from adoption more quickly than their Continental European counterparts. This is consistent with the idea that the impact of information and communication technologies is stronger in the US than Europe due to lower adjustment costs.

Keywords: Diffusion, profitability, banks, SWIFT
JEL Classification: O33, N20

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## 1. Introduction

The effect of information and communication technology (ICT) on performance has been hotly debated for many years. Initially there was doubt over whether ICT had a significant effect on productivity[1], but over the last decade evidence has mounted confirming that ICT does have major effects on economic performance at both the macro and micro levels. A large number of studies now report a positive effect of ICT investment on a range of measures of economic performance[2] (see the surveys in Brynjolfsson and Yang, 1996, or Draca, Sadun and Van Reenen, 2007), however, the magnitude of the ICT effect varies between firms, sectors and nations. In particular, US firms appear to be much better at reaping productivity benefits from ICT than their European counterparts (e.g. Bloom, Sadun and Van Reenen, 2007) which may explain faster productivity growth in the US than Europe after 1995 (Stiroh, 2002).

One of the sectors that has been transformed by significant improvements in ICT is financial services. The implications of ICT for the global financial system have been fundamental. ICT not only transformed transactions processes but also facilitated the creation of new financial products, changed the nature of work (Barrett and Walsham, 1999), helped globalize financial markets (Sassen, 2002) and restructured the character of financial intermediation (BIS, 2002). Financial institutions have long been among the most intensive users of information technologies but there is relatively little research probing the impact of ICT on performance in the financial sector. One line of research employs a case study approach (e.g. Clemons and Weber, 1990; Scott and Barrett, 2005) which is useful for understanding the richness of processes in specific contexts but is hard to generalise. For example, Autor et al (2002) examine the introduction of automatic image processing on one of the top 20 US banks, arguing that the introduction of complementary organizational changes were crucial in understanding the impact on performance. A second approach is to econometrically estimate the impact of ICT, but this has the disadvantage that the measures are necessarily crude, such as the total ICT expenditure[3]. For example, Casolaro and Gobbi (2007) estimate profit and cost functions for a panel of 600 Italian banks 1989-2000 and find that IT capital intensive techniques significantly increase total factor productivity. Jun (2008) reports the findings from several studies showing a positive relationship between IT and banking performance, and also presents results showing that IT investments are associated with higher returns on assets in a sample of 22 South Korean securities firms. Anderson et al (2006) investigate the value implications of investments on information technology on a panel of Fortune 1000 companies, including 62 banks, and find that firm value increased on average with Y2K spending on IT. Finally, Parsons et al (1993) estimate a cost function using data from a single large Canadian bank between 1974 and 1987 and find a weak but significant correlation between productivity growth and the use of computers. While these are all useful, treating ICT as a single analytic category makes it hard to disentangle which aspects of ICT led to performance increases and identify the dynamic effects of ICT adoption.

Our paper is distinct from the previous literature in several respects. First, we propose an in-depth econometric case study of a particular ICT-related innovation in a particular sector (banking), rather than

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[1] This trend was appropriately characterized by Robert Solow's famous quote that '*you can see the computer age everywhere but in the productivity statistics*' (New York Times, 1987), which eventually became known as the *Productivity Paradox*.

[2] Examples would include Aral, Brynjolfsson and Wu (2006), Brynjolfsson and Hitt (2004), Bresnahan et al (2002), Brynjolfsson and Hitt (2006), or Dewan and Kraemer (2000).

[3] See also Banker and Kauffman (1988), or Alpar and Kim (1991).

examining ICT in general. This follows in the tradition of Griliches (1957) who first launched an econometric study of diffusion by looking at the case study of hybrid corn in US agriculture. Second, we track the effects of the adoption of SWIFT in a large sample of banks (almost 7,000) in the US, Canada and 27 European countries. Previous micro-econometric studies have (at best) limited themselves to a single country, even though many industries, such as financial services, are international in scope. Thirdly, we have been granted confidential access to the population of adopters and the exact timing of adoption by SWIFT. We are therefore able to track the long-run effects of adoption (up to 30 years) which is important as the impact of innovation is unlikely to be realised in the short run (as we show)[4]. Finally, as part of our examination into whether SWIFT adds value by influencing organisational as well as technological changes we analysed *qualitative* data prior, during, and after our econometric analysis. The complementary data was gathered in two stages: we began by interviewing more than 20 SWIFT employees, bank executives, and domain experts who described the SWIFT implementation process and the potential benefits. Secondly, we conducted a qualitative case study focusing on a small-medium bank within our sample to hypothesize and compare our findings to the quantitative results.

Both qualitative and quantitative analyses reveal a large effect of the adoption of this financial innovation on firm performance (mainly measured by profitability, but also by costs, revenue and survival). This effect only occurs after a large number of years which suggests the need for complementary organizational changes to take place when adopting new technologies. The effect is also larger for US and UK banks than their continental European counterparts which may find it easier to adjust labor and organizational structures to reap these benefits.

The paper is structured as follows. Section Two provides background information on SWIFT as well as the relevant technologies and standards, and outlines a brief cost-benefit analysis on the adoption of SWIFT alongside the findings of a case study. In sections Three and Four we describe our data and expose the empirical framework, and in section Five we present our main results. Conclusions are provided in section Six.

## 2. Analytical Description of SWIFT

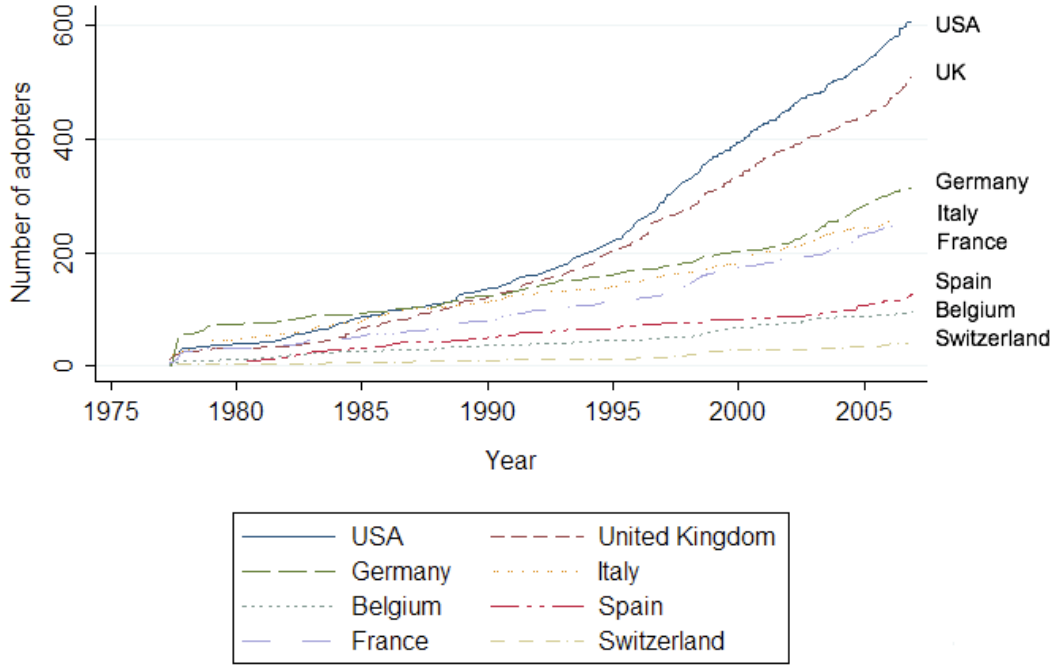
Founded in Brussels in 1973, the Society for Worldwide Interbank Financial Telecommunication (S.W.I.F.T.) is a co-operative organization serving as a shared global communications link and a common language for international financial transactions (SWIFT, 2006). The operation of its network started in 1977 and it was initially supported by 518 Banks in 22 countries. Since then, the use and size of its platform has expanded rapidly and it has evolved from a mere tool for bankers into a broadly based institution serving the financial community. Today, SWIFT is headquartered in Brussels with data centres in Belgium and the United States. It has more than 8,400 live users connecting from 208 countries which may sound relatively small however each "user" is an organization which means that there may be thousands of employees within a single organisation using SWIFT at any one time. In the three decades of its operation, SWIFT has assumed a dominant presence the financial sector and has created an extensive infrastructure of interconnectivity between its members. Significant economies of scale have been created through the spread of its network.

[4] Geroski, Machin and Van Reenen (1993), amongst others, show that there are long lags between innovation and improved firm performance.

Figure 1 shows the number of SWIFT adopters in total for some major countries over the entire history of SWIFT using the population database (see below). As shown below, SWIFT was adopted first mainly by European-based banks in 1978, although by the end of the period, US banks lead the curve, followed by UK banks. The overall diffusion curve does not seem to follow the traditional "S" shape, suggesting that SWIFT adoption is not a completed process, by any means.

One distinctive characteristic of SWIFT is that from its inception it has assumed the status of a jointly owned non-profit making organisation where the member banks own share capital and split their operating costs according to their message volume and the number of terminals (Ambrosia, 1980). The community ethos that arose as a result of this governance structure has particular advantages including knowledge-sharing above and beyond the more easily identifiable benefits of SWIFT membership. The key service offered by SWIFT is the ability for financial institutions listed in the SWIFT membership directory to send funds directly to each other at a greatly reduced cost relative to traditional methods of fund transfers (bank drafts, airmail transfers). By increasing speed and volume as well as improving security, the SWIFT platform introduced considerable efficiencies compared to the previous system of correspondent banking (Winder, 1985).

**Figure 1 – SWIFT Diffusion by selected countries**




*Note*: Figure 1 shows the diffusion curves for eight of the countries in our sample (USA, United Kingdom, Germany, Italy, Belgium, Spain, France, and Switzerland). The lines represent the cumulative number of SWIFT adopters over time from 1977 to 2006. The precise number of adopters for each country in 2006 can be found in Table 1.

SWIFT's growth was not smooth. Shortly after the network started its operation, it was realised that the general legal principles of international business practices were inadequate to deal with the new technology of SWIFT transactions. In the late 1970s, members adopted new SWIFT-specific rules which defined their liabilities and responsibilities in more explicit terms. However, additional problems emerged due to the large and exceptionally diverse membership of banks with different sizes and dissimilar expectations.

These issues were compounded by what was described at the time as a "complicated administrative and political structure" (Winder, 1985).

In 1987, despite resistance to earlier proposals to expand SWIFT membership beyond banks (Banker, 1992), a majority voted to increase the user-base by including other financial service providers: broker-dealers, exchanges, central depositories and clearing institutions (Copon and Gold, 2001). Many corporations had also expressed interest in joining the network but their attempts to become members were rejected. In 2006, SWIFT announced the approval of a new corporate group of users – large non-financial institutions such as Microsoft, Volkswagen, Hewlett-Packard, etc. – that would be able to connect to SwiftNet via a member Bank. Practitioners have described the existence of this model, which is known as MA-CUG model, as "limited but relevant access" to SwiftNet and a lively debate about whether corporations should have direct access to the network or not continues.

Since its launch in 1973, SWIFT has largely maintained its identity within the financial services industry as a "proprietary communications platform" that allows financial institutions to "connect and exchange financial information securely and reliably"[5]. Various attempts to create similar networks prior to the launch of SWIFT failed due to lack of collaboration between banks. The design and governance of SWIFT's potential predecessors were regarded as captive by competitors and the suspicion of proprietary interest eventually led to their demise[6]. The establishment of SWIFT marked a concord which has held for over thirty years and dampened the development of alternatives. There are some business and connectivity "solutions" in the technology market that compete with SWIFT, however they account for a small fraction of business and do not offer such a wide portfolio of services or global coverage.

### *2.1 Technology and Solutions*

SWIFT was initially founded with the objective of automating and potentially replacing the *telex* as a means of communication between banks[7]. Hence, the operations and business requirements of banks still remain its primary focus. SWIFT promotes and develops standardized global interactivity for financial transactions. It operates a focal service for the exchange of financial messages such as payments, confirmations, settlement messages, letters of credit, securities transactions, and other types of standardized messages. Member institutions generate and send individual structured financial messages that are then forwarded through the set infrastructure to the recipient member organization. SWIFT's main role is to deliver these messages rapidly and securely with the "*lowest risk and highest resilience*" (SWIFT London 2008). It functions as the core gateway *"...as an obligatory passage point to other parts of the transactional infrastructure, which gives it effective control of the payment* [or any other] *system*" (Weirdt, Hadji-Ashrafi, Randall, and Scott, 2005). SWIFT's central store-and-forward messaging service is FIN[8]. FIN messaging services are provided via SwiftNet, a reliable and secure IP network (SIPN) that offers a single window to other member organizations. Today, SWIFT provides numerous solutions for an array of organisations such as banks, broker/dealers, corporations, custodians, investment managers, payment and securities market infrastructures.

[5] Source: http://www.swift.com

[6] For a detailed historical study on the origins and development of SWIFT see also Scott and Zachariadis (2010).

[7] The *telex* was a system that used telephone-like rotary dialling to connect teletypes. Subscribers to a telex service could exchange textual communications and data directly with one another (Britannica Online Encyclopaedia).

[8] For more specific information on SWIFT solutions and products visit: http://www.swift.com/index.cfm?item_id=1008.

In addition to its network, SWIFT uses advanced technologies and its standards expertise to leverage its business. SWIFT provides a vast range of standards products, tools and services. It promotes interoperability via its standards programme. Apart from achieving technical interoperability, SWIFT standards and technologies provide a way for users to automate their transactions throughout their lifecycle. For example, SwiftNet FIN is a "Straight-Through-Processing" product that enables an entire transaction to be conducted electronically without the need for manual intervention. This is important because it minimizes operational costs, reduces systemic and operational risk, and improves the certainty of the transaction process.

### *2.2 Infrastructure deployment and Connectivity*

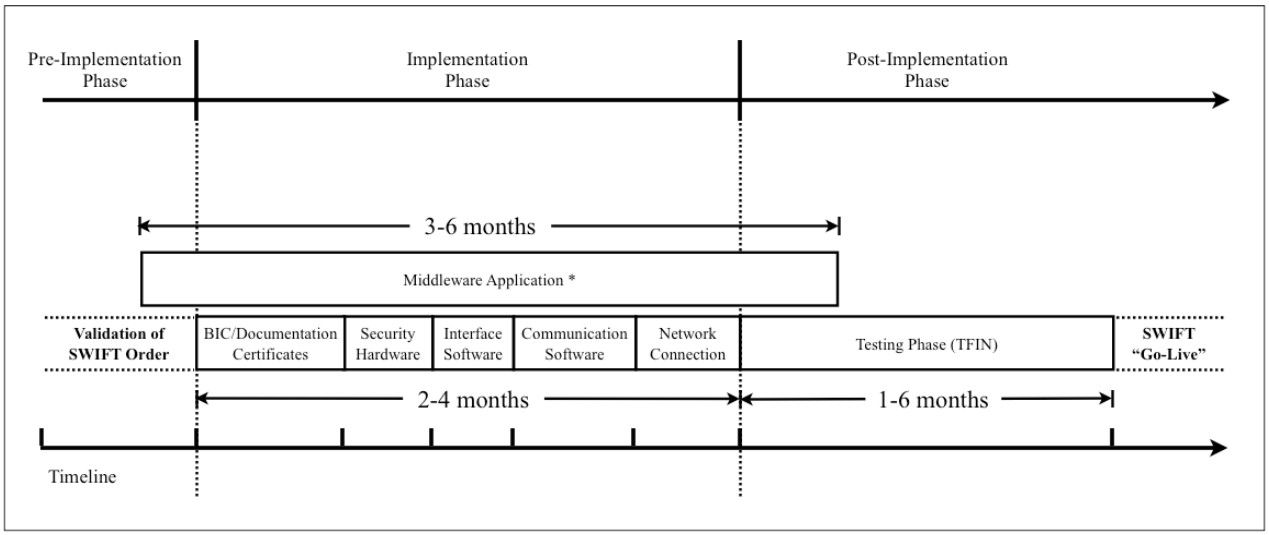
SWIFT groups its clients into three different categories according to the volume of transactions they process per day. Low volume customers have a traffic volume of below 1,000 messages/files per day, middle-volume process between 1,000 and 40,000, and high-volume typically exchange more than 40,000 messages/files per day. Each user, depending on the category he belongs, needs to go through a different implementation process in order to connect to SwiftNet and be able to use the interfaces that SWIFT provides for each of the groups. Within every traffic-volume cluster, the customers need to agree on the SwiftNet infrastructure they will deploy and choose between three basic connectivity options: a Private Infrastructure (direct connectivity), a Shared Connection (indirect connectivity), or a Shared Infrastructure (indirect connectivity). Every connectivity option has different implementation costs. For example, high-volume users with private infrastructures will need to set up and align an entire arrangement of business applications, middleware, messaging software, communication hubs, and network links in contrast to low-volume customers that can outsource all the required applications and use a shared connection to link to SwiftNet. In the case of a private infrastructure the costs can be substantially higher than other options of connectivity. Time is also a crucial element in the adoption process. Private infrastructures can take much longer to install and test than other smaller infrastructures. To complement its intensive connectivity options, SWIFT offers a 'light' solution for customers who plan to exchange less than 200 messages/files per day[9].

In addition to conducting interviews with SWIFT senior managers and SWIFT customers, we studied relevant documentation in order to identify the requirements for successfully establishing a SwiftNet connection (see Figure 2). No matter what connectivity option is chosen, every new customer needs to go through three distinct phases of implementation: the *Pre-implementation, Implementation, and Post-implementation phases*. In the Pre-implementation phase the user needs to define its requirements and identify the project teams. After analysing its current infrastructure a proposal needs to be made on the network configuration that is implemented. When the two previous steps are approved, the client prepares its order by completing all the essential forms. SWIFT then validates the order and if required, requests corrections before moving onto the next phase. The Implementation stage consists of Provisioning and Installation of the full configuration. Hardware (e.g. lines, VPN boxes, routers etc.) and software (e.g. interface and communication packages etc.) are installed and the connection to SwiftNet is established and ready to test. The last Post-Implementation phase starts off by performing end-to-end tests at application and network level. A SwiftNet FIN session is established to check the system's resilience by sending and receiving traffic. When the testing period is over the customer confirms all systems are operational and *live activation* takes place (the SWIFT "Go Live" point). A brief snapshot of the SWIFT implementation process timeline is given in Figure 2.1.

[9] *Alliance Lite* is an Internet-based service that provides a low cost and secure access to the SWIFT network.

The total process from the beginning of the Implementation phase (which starts after the validation of the SWIFT order) until the *Go-Live* stage, lasts on average seven months. The key functions that can postpone the live activation of the system for more than a year from the initiation of the Implementation stage are: the Middleware Application and the Testing phase. The Middleware application is optional (according to the type of connectivity the user will select), but its development and deployment are very crucial especially for large firms that need to connect multiple business (back-office) applications with SWIFT. For example, investment banks and other securities institutions might want to link up all their back-office applications with SWIFT in order to send/receive confirmations of trades, settle their payments with third parties, and communicate with market infrastructures (such as CREST). All these requirements need to be configured in the Middleware Application in order to ensure that all their needs are encountered. Consequently, the testing phase is also demanding because it must ensure that all possible transactions are error free when the system goes live. Middleware applications are also core components enabling Straight-Through-Processing (STP)[10]; they integrate the customer's business applications with the SWIFT gateway and translate financial transactions into SWIFT messages that are then sent to their counterparties through the secure network without human intervention.

**Figure 2.1 – SWIFT Implementation timeline**




*Note:* Figure 2.1 presents an estimate based upon discussions with SWIFT managers and customers as well as an analysis of relevant documentation. Adoption of SWIFT can be categorized into three distinct phases: the Pre-implementation, the Implementation, and the Post-implementation phase.

## *2.3 Costs and Benefits of adoption*

The associated costs and benefits for deployment within a population of this size and range can vary significantly between institutions. Our first task in this paper is to disentangle the various costs and benefits from SWIFT adoption and categorise them according to their timing and significance during the implementation process.

*SWIFT Costs*

[10] Straight-Through-Processing (STP) enables entire transactions to be processed electronically without re-keying or manual intervention.

Once SWIFT is up and running in the post-implementation phase the overt variable costs are the maintenance, upgrade, and improvement expenses. Two additional operating expenses are the fees SWIFT charges its customers (per transaction and fixed annual fees), and any future potential training. These again vary according to the Connectivity package the client operates. There may also be further significant costs that can overrun into the post-implementation period. So while the major sunk costs relate to the original analysis and design process, testing and subsequent software development can be extensive. There is an additional opportunity cost associated with the level of time spent managing change and disruption costs associated with the implementation. These can go on well after the "Go-Live" period as teething problems and re-organizations continue to occur as the system beds down.

Off-the-shelf products such as hardware and essential software can also be regarded as one-off expenses. By contrast, users that decide to implement a private, in-house built infrastructure are likely to have relatively higher capital costs than users with a shared connection or infrastructure. Banks that do not possess the expertise to install the required configuration have the option to outsource the implementation project to a SWIFT "Service Partner". There are initial training costs to ensure the minimum essential knowledge. Finally, there is SWIFT's one-time connection fee that also differs according to the connectivity option the client chooses.

*SWIFT Benefits*

In contrast to expenses, benefits are typically not realized until the infrastructure is properly configured and used. We have already mentioned some of the benefits that SWIFT offers to its customers but will distinguish between them further in terms of *intangible* and *tangible* benefits. Intangible benefits (also known as "soft benefits") are related to the reduction of operational risk and fraud, enhancement of customer satisfaction, security and resilience, easier regulatory compliance, greater visibility, control, reliability and timing. These are difficult to measure, but will be captured in our study because over the longer-run they will be reflected in profitability. Further, we gathered qualitative evidence from domain experts about how these contribute to the bottom line performance of the firm.

The most obvious tangible benefit is the reduction of operating costs. While the implementation of SWIFT can be a costly investment it is regarded as having a long-term cost-saving effect. SWIFT helps reduce user's costs by providing reach, re-usability and standardisation. These three characteristics substitute for a number of business activities that are obligatory for a transaction to take place. Legal, labor and other communication costs can be radically reduced with the use of a technology that can standardise these actions and consolidate them into a single operating platform.

Another desirable property that derives from the design and the technical attributes of SWIFT is *scalability*. It is critical for an organization to have the capability to support the increasing demand in products and services. This is of particular importance in the financial services sector given the intense competition and fast-paced market developments. If a firm lacks the ability to create economies of scale that will counter the increasing volume of transactions it can constrain business growth. SWIFT allows banks and other institutions to communicate independent of their size, location, and volume of transactions. Therefore, adopters can deal with additional clients and handle the growing number of transactions. This offers a distinct advantage as a one-time investment can reduce the marginal operating costs for an extensive period of time as sales increase.

Note that we would also expect the benefits of SWIFT to be increasing with the size of the network

(Economides, 1996; Liebowitz and Margolis, 1994). We expect to detect some supplementary boost in the performance of adopters, as SWIFT increases its popularity and the number of its members grows. Finally, SWIFT supports the creation of new revenue streams; as adopters expand their business network to new territories (not only geographically but also in terms of products) they can explore opportunities to increase their revenues. As the financial markets become global, there is an increasing need for cross-border payment products and services. SWIFT enables the globalization of the supply chain and expands reach to countries around the world. Greater access along with the automation and reliability of trusted communications help users secure new business and boost their revenues.

### *2.4 Case Study*

In order to map the value generating mechanism associated with the adoption of SWIFT in detail, we conducted a qualitative case study at a small, UK-incorporated, commercial bank within our sample. The financial institution studied was established in 1984, and it currently operates five branches in the UK and two additional ones in foreign countries at Europe and South Asia. The average number of employees between 1998 and 2005 was 65, and the mean total assets were approximately $272 million[11]. The organisation adopted SWIFT in 2002. According to the General Manager at the head-office in London who is responsible for the implementation of the project, the idea to adopt SWIFT had been debated since 1997. While it was realized that adopting SWIFT would improve client services, the concern was that it would also drive up operating costs and therefore a decision could not be financially justified. A clear, identifiable return-on-investment (ROI) was prerequisite to approve a business case which ostensibly rested on cost-saving rather than revenue generation.

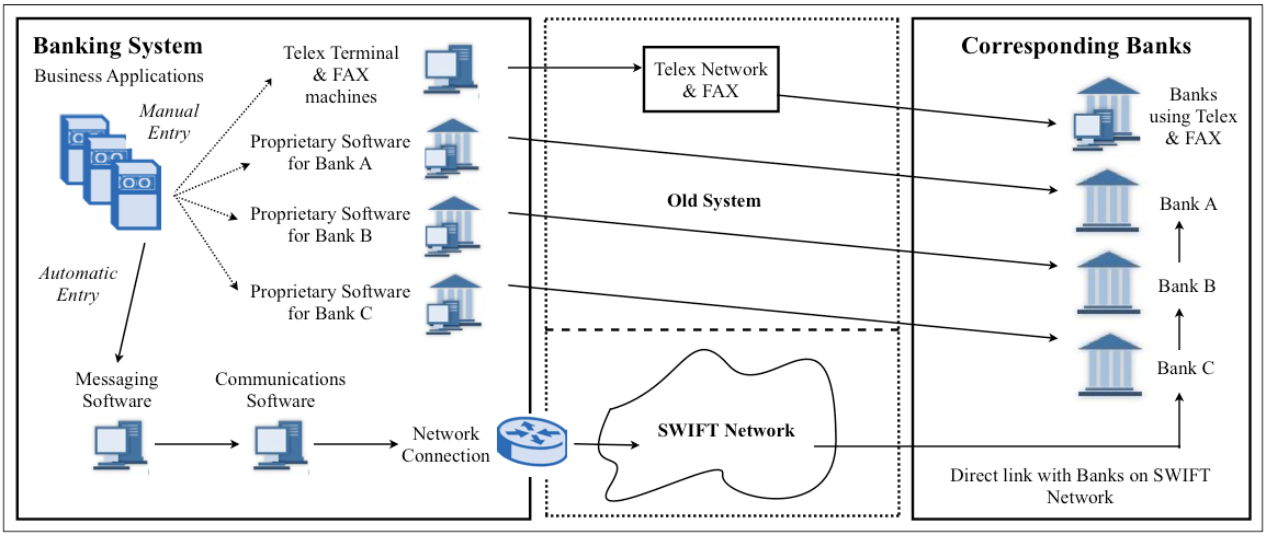
The decision to adopt the network innovation came after consultation with the marketing and sales teams who argued that SWIFT would increase business revenues and attract new clients. According to our interviewee, the bank eventually managed to crystallise a number of relationships with clients once SWIFT was installed and it also meant that they could "reach out" to several new potential clients with the added confidence of new services. In practice, benefits from the adoption of SWIFT could be categorised in three groups: firstly, even though no exact estimations could be made, it was expected that there would be an increase in revenues due to the increasing volume of transactions from existing and new clients. The old systems could not process the number of transactions that SWIFT could perform, thus making the new technology more efficient. This is in line with the economies of scale that we discussed in our previous cost-benefit analysis. Secondly, the telex system was becoming obsolete and the service had many disruptions that cost the bank dearly both in terms of business transactions and trustworthiness. SWIFT adoption helped the bank to offer a better quality of service to its clients through its fast and reliable network. According to our interviewee, this was a significant advantage for the bank. Thirdly, SWIFT was directly connected to the bank's in-house business applications which reduced the amount of manual work that the proprietary systems and telex connections required. Figure 2.2 outlines in more detail the contributions of SWIFT and the value added generated from its implementation and use.

According to our interviewee, the costs went up as expected after the initial investment in SWIFT but in the long-term operating costs decreased as they were automating paper transactions and migrating manual work onto SWIFT. In addition, they took advantage of the system's flexibility and linked their business

[11] We chose to conduct our case study with a small bank as the impact of SWIFT adoption would be more prevalent and easier to identify. In addition, smaller firms in our sample seem to benefit more from SWIFT adoption rather than larger organisations as it is described in our results section.

applications to SWIFT software which allowed for more automation and a reduction in working hours on manual tasks[12]. The whole SWIFT implementation lasted around 6 months but was extended to two years with all the enhancements and relevant applications that were built during the post-implementation phase. Additional gains were realised later at an enterprise level when the system eventually functioned as a whole. Different banks may use SWIFT in a different way and take advantage of a broader set of alternative functions. In the following sections, we try to estimate the average effect of SWIFT on the population of its adopters in North America and Europe.

**Figure 2.2 – Detailed outline and value added from SWIFT adoption**




*Note:* Figure 2.2 presents a detailed illustration of the SWIFT function and clearly depicts the value added from its usage compared to the old system of communication between banks (Telex, FAX, and Proprietary systems). This figure was constructed after discussions with domain experts and studying relevant documentation.

## 3. Data

Our main dataset is a collection of detailed raw data on SWIFT adoption of 35,249 firms worldwide from 1977 to 2006. This dataset is the complete global list of live SWIFT customers, operating 424 services and products in 208 countries. Following interviews with domain experts and technical staff from SWIFT, we decided to narrow the focus of our study about SWIFT technology adoption to "SwiftNet FIN" (or "SNFIN"), the most popular service and core SWIFT product. Considering the complexity of the financial systems around the world and the constraints that are placed from national financial regulatory bodies, we also limited our initial analysis in Europe and North America. Since 1977, SNFIN has been adopted by 3,380 firms in the 29 countries of our sample.

To this panel we matched information from Bankscope, a global database containing information on more than 28,000 public and private banks around the world. This is compiled by Bureau van Dijk (BVD), a European electronic publisher of business information. The database combines data from seven sources including Fitch Ratings, Capital Intelligence, the Economist Intelligence Unit, Moody's, Standard and Poor's etc. It includes all the information in the banks' published accounts and is reasonably comprehensive in coverage for all but a number of smaller banks. The product of this merge is a unique dataset containing a large sample of firm-level longitudinal information on ICT adoption and financial

[12] Even though no employees were laid off due to the adoption of SWIFT, working hours were allocated to different functions in the bank.

performance. Our financial data run from 1997 (the first year that Bankscope was produced) through 2006, but due to the small number of observations in years 1997 and 2006, we exclude them from our estimations and exploit the years from 1998 to 2005. After cleaning[13] we are left with an unbalanced panel of 6,848 firms and up to eight years of financial data.

Our main indicator of diffusion is simply an adoption dummy equal to unity in the year that the bank adopts SwiftNet Fin marked by the end of the post-implementation and the start of the "Live" phase (recall figure 2). It is unclear when the pre-implementation phase begins so we are careful to test for the exact timing (see below). In particular, it is likely that the benefits of SWIFT will not be observed in the first year, but instead there will be a longer term dynamic at work between the introduction of SWIFT and its eventual effect on the bottom line. The fact that we have the entire history of all adoptions of SWIFT is helpful here because we are able to construct long lags back to 1977 for each firm. In other words we are able (in 1998) to include up to a twenty year distributed lag for SWIFT adoption to examine the dynamic effects on firm performance.

In Table 1, we present some statistics of our data by country. From BVD's Bankscope we have 6,848 firms in our sampled countries as shows in column (1). Looking down the column, almost a quarter of firms are in Germany and almost one fifth in the US. Other countries which have many banks in the sample are the UK (6.6%), France (6.8%), Switzerland (7.9%) and Italy (11.4%). This reflects the size of the country, the relative importance of finance and the degree of fragmentation in the banking sector. Column (3) contains the population of 3,380 SWIFT adopters in our 29 countries from SWIFT's records. Our coverage rate of 41% of all SWIFT adopters (in 2006) rather than 100% is mainly because of two reasons. First, we exclude all organisations outside of Europe and North America (e.g. Japan). Second, many SWIFT adopters are organisations such as stock exchanges, large corporations and other non-financial institutions that are not in Bankscope. Thus the matched data from the SWIFT-Bankscope merge in column (5) is only a sub-sample of the data in column (3)[14]. The final column shows the proportion of SWIFT adopters in the Bankscope data of column (1). On average 25% of Bankscope's firms use SWIFT, but this ranges from 9.35% (Sweden) to 100% (Latvia and Lithuania). The econometric analysis includes all the firms in column (1), both adopters and non-adopters.

In order to avoid any duplication in our data we excluded the unconsolidated accounts if we had their consolidated companions and used unconsolidated accounts of a subsidiary when there were no consolidated companions (results were robust when using only consolidated or only unconsolidated accounts).

Measuring productivity is extremely challenging in the financial sector, mainly due the difficulties involved in developing an adequate price index for value added. In this paper we focus on the profit margin defined as gross pre-tax operating profits divided by revenue ("return on sales") as our key performance measure (we also compare the results to alternative normalizations such as assets or equity). Accounting profits can

[13] We clean our dataset from extreme negative and positive values that appear in our factor inputs. We also avoid dropping the data by winsorising our performance variables on the top and bottom percentiles. Results are similar if we simply trim the outliers.

[14] Bankscope also excludes some of the very smallest banks, which is another reason for the fall in numbers, but this is very minor.

diverge from economic profits, but the two are likely to be correlated at the firm level and there is a tradition in industrial organisation scholarship which supports using profitability as a key measure of firm performance[15].

A drawback of the data is that the SWIFT organization only keeps track of banks that currently use SWIFT. Thus our data is conditioned on firms who were alive in 2006 (whether or not they used SWIFT). Bankscope has data on firms who were dissolved prior to 2006, but because we were unsure of their SWIFT adoption history we dropped them from the baseline estimating sample. In the robustness section we show that our findings are robust to any suspected survivor bias by examining the dissolved firms and survivor equations.

Table 2 presents some of the descriptive statistics. The median bank in the sample is not large: it has 164 employees, sales of $50 million and $5.9m in profit. The profit margin is 13.8%. Note, however, that the data is quite skewed as mean sales are $638m with a standard deviation of $3,702m. The other parts of the table break down the descriptive statistics by firm size and country. Anglo-American banks are larger and more profitable than other banks.

Profits are the difference of revenues and costs, so we also present econometric results that disaggregates profitability into the revenue and cost components. We examine the change in employment following SWIFT adoption as a further outcome.

We do not have data on the intensity of usage of SWIFT for the whole period (some proxies exist in one or two years but these are not consistent across countries. Consequently we focus on the simple adoption dummy as is standard in the diffusion literature.

## 4. Modelling Strategy

The main equation of interest is:

$$\left(\frac{\Pi}{S}\right)_{it} = \sum_{j=0}^{L} \alpha_j SWIFT_{it-j} + \beta_1 X_{it} + \eta_i + T_t + \varepsilon_{it} \quad (1)$$

Where $(\Pi/S)_{it}$ is the profit margin, the ratio of pre-tax profits to sales of firm $i$ at time $t$. $X_{it}$ denotes a vector of control variables such as the log of total assets to employees as proxy for the fact that firms of different capital intensity have different profit sales margins (e.g. if there are high fixed costs gross margins will be higher). The time dummies to control for macro-economic shocks, $T_t$. The $\eta_i$ are a full set of firm fixed effects, to control for permanent unobserved heterogeneity (the country dummies are absorbed into this) and $\varepsilon_{it}$ is an idiosyncratic error term. We discuss the properties of $\eta_i$ and $\varepsilon_{it}$ below. $SWIFT_{it}$ is an adoption variable that is a binary dummy variable taking the value of one in the year of the "go-live" phase of adoption and all years after (and zero in the years before the go-live year). We example several lag lengths, but our basic results allow a distributed lag up to $L$ years on SWIFT where we estimate that $L$ is approximately 9, in other words it takes about a decade for the full effect of SWIFT to play out on bank performance. This was also generally confirmed by the people we interviewed in banks.

[15] For a discussion of the pros and cons see *inter alia* Slade (2004).

An econometric problem that arises while trying to estimate the effects of technology adoption on firm performance, is unobserved heterogeneity. This occurs when there are many factors correlated with firm performance that we do not measure. In our case, this may create an upwards bias for the coefficient of SWIFT if better managed firms are both more profitable and more likely to adopt SWIFT. We assume that these unobserved factors stay roughly constant over time and we treat them as fixed effects. Then we proceed with our estimation by including a full set of firm-level dummy variables (the *within-groups* estimator). A problem with the fixed effects estimator is that it will exacerbate classical measurement error causing the SWIFT coefficient to be attenuated towards zero. But since this is data from SWIFT's electronic customer database there is probably little measurement error. A second concern, however, is that there may still be unobserved shocks, so that SWIFT adoption is correlated with the error term, $\varepsilon_{it}$ .In the absence of an instrumental variable it is difficult to do much abut this, but the fact that the main effects come not from the current variables but the long-lagged variables gives some reassurance that the positive effects we identify are not due to endogeneity bias.

Finally, note that all standard errors are clustered by firm to allow for arbitrary patterns of autocorrelation over time (serial correlation is typical in firm panels even after removing fixed effects).

## 5. Results and Interpretation

### *5.1 Basic Results*

Table 3 reports our basic regression results using the specification in equation (1). Column (1) simply regresses profitability on a nine-year distributed lag of SWIFT adoption (all columns include year and firm dummies). SWIFT appears to have a significant impact on firm profitability for up to 9 years. Lags at ten years and beyond were insignificant. As shown at the base of the column the sum of the SWIFT coefficients are significantly different from zero (p-value = 0.0018) and the coefficients are jointly significant (p-value = 0.0006). The dynamics are interesting: there is little effect, even a negative coefficient in some of the early years of SWIFT on profits. The larger effects do not materialise for several years. We illustrate these dynamic effects in Figure 3 which presents the cumulative effect of SWIFT over time. The figure illustrates that positive returns are not clearly visible until two years after SWIFT adoption and only gradually build up the long-run effect of 0.0823, which is sizeable. This finding of very long lags before adoption and firm performance has often been suggested by case studies, but there are few econometric studies with a long enough time dimension to show this convincingly. Interestingly, Geroski, 1991, also found that a lag length of about a decade was necessary to trace out the effects of innovation on productivity.

Column (2) includes the capital assets to labor ratio as an additional control, whose coefficient is positive and highly significant. The dynamics are illustrated in Figure 4 and show an even slower build up of profit margins than the previous column – the long-run effect falls to 0.07[16]. Column (3) and Figure 5 includes a lead in SWIFT to pick up whether there were costs in the year prior to the "go-live" year of SWIFT. The coefficient is insignificant and actually positive rather than negative. This suggests either that the costs

[16] It is not obvious that we want to condition on the capital-intensity measure as part of the effect of adoption is through changing the input requirements. We use this as our baseline, however, to be conservative. Including the lagged assets to labor ratio reduces the long-run coefficient to 0.047, but this is because we are reducing the sample size (we obtain a similar long-run effect on this smaller sample using the specification of column (2) Table 3.

before the go-live point are insubstantial or that most of these are captured in the year when the go live period occurs (given that the implementation period may just be months).

The first three columns of Table 3 all suggest a positive long-run impact of SWIFT on profit margins of between 0.06 and 0.08 a decade after the adoption of SWIFT - a large effect[17].

***5.2 Firm size***

In columns (4) and (5) we repeat the analysis by splitting the sample into larger and smaller firms based on median assets[18]. The specifications are identical to column (2) and the dynamic responses are plotted in Figures 6 and 7. The coefficients are much larger for smaller firms than bigger ones: smaller firms have a long-run SWIFT effect of 0.12 whereas this is only 0.02 for larger firms. Since the margins are larger for bigger firms (see Table 1) the implied proportionate effect is even greater for the small firms than the large firms. A possible explanation for this is that the larger firms have to bear a lot more re-organisation costs because of their legacy proprietary systems and greater difficulty in managing organizational upheavals.

In summary, and taking all columns together, we have three key results. First, there seems to be a positive and statistically significant effect of SWIFT adoption on firm performance (measured in terms of the profit to sales ratio), and this effect appears to be substantial in magnitude. Second, this effect takes many years to play out - around a decade. This is consistent with other recent findings on ICT and firm performance. Thirdly, this effect is much higher on smaller firms rather than big firms.

***5.3 Other Outcomes: Sales, Expenses and Labor***

Table 4 presents the estimates of three other outcome variables: ln(Sales), ln(costs) and ln(labor-capital ratio). As in the previous tables, in all columns, we control for firm fixed effects and we include a full set of country and year dummies. The dynamic responses are graphically presented in Figures 8-10)

Column (1) of Table 4 presents the sales equation. Sales are positively and significantly associated with SWIFT adoption: the long-run effect of SWIFT on Sales is 40 log points, implying the firm sales increase about 50% (exp(0.4) - 1) over the decade since SWIFT was adopted. These results are consistent with our hypothesis that SWIFT creates new revenue streams and with our case study findings in which SWIFT resulted an increase in sales.

The second column uses costs - operating expenses – as a dependent variable. Controlling for assets, we find that the first two years expenses actually increase and start to decrease only from the third year after adoption. The long-run effect is negatively correlated with SWIFT adoption and is statistically significant. The initial increase the long-term decrease of the costs is consistent with our story of how SWIFT affects firm operating expenses. While SWIFT in various cases demands a considerable initial amount of investment to implement and use, it substitutes different inputs that account for a large piece of the

[17] The results are robust even when we put in country dummy and year dummy interactions (year*country) for all years and countries (long-run effect of SWIFT is 0.055 with a p-value of 0.016).

[18] Descriptive statistics on small and large firms are reported in Table 2. The results largely stay the same if we split our sample based on the number of employees instead of using total assets as a size indicator.

operating costs. From the results we can presume that operating costs fall by approximately 20% in the 10-year period following SWIFT adoption. This is smaller than the proportionate increase in revenues, suggesting that SWIFT increases profits both by reducing costs and increasing demand, but the effect is stronger on revenues.

In column (3) we use the ratio of employees over assets as a dependent variable. There appears to be a substantial shakeout of workers relative to capital following SWIFT adoption, presumably because SWIFT enables reductions in manpower. The results here are also statistically significant.

### *5.4 Cross Country Differences: US/ UK versus Rest of Europe*

We examined differences in response parameters by country block and found that a key difference appeared to be between two sub-samples: "Anglo-American" countries (US and UK) and "Continental Europe"[19]. Columns (1) and (2) of Table 5 report the SWIFT coefficients on profits margins from the two samples, controlling again for assets and employees, firm fixed effects, year dummies and country dummies. Contrary to what one might think, the long-term effect of SWIFT is quite similar in the two sub-samples. If anything Continental European firms have a slightly higher return (0.08) than the Anglo-American firms (0.06). Considering the difference in the size of the firms in the two samples we construct two further sub-samples and compare US and UK with EU firms in the same size category. The results are reported in columns (3) and (4) of Table 5. Here, we can see more clearly that the returns from SWIFT, investigating the same size category of firms, are very much alike in (0.12 in both sub-samples). Due to the large number of observations, the statistical significance of the European estimates is higher compared to the US and UK estimates.

Overall we could not find any suggestive evidence that US/UK firms enjoy superior returns from SWIFT adoption in comparison to European firms in the long-run. However, by observing the dynamics of the effect of SWIFT over time (Figures 11-14), we observe something quite interesting. US/UK firms respond faster to change and harvest the benefits of ICT investment earlier than European firms. For example, in Figure 11, US and UK firms reach the long-term return 4 years after SWIFT adoption, while in Figure 12 EU firms accomplish only 30% of their long-run returns in the same period. The results look similar in Figures 13 and 14. One explanation for this difference in the dynamics of SWIFT adoption and firm performance is that flexibility of labor and other regulations in the UK and US allow for a more rapid reorganisation to better leverage SWIFT.

### *5.5 SWIFT Network Effects*

In Table 6, we augment equation (1) to include a network variable defined as the cumulated aggregate number of SWIFT adopters in a country in a year from the entire SWIFT population.

Column (1) and (2) report the coefficients for network effects and lagged network effects respectively. In both columns we find a significant and positively correlated result on firm performance. Even though the coefficients seem small they suggest a considerable effect if the number of the adopters increases rapidly

[19] It is unclear where Canada sits in this division as it has a much smaller financial sector that the US or UK. Consequently we drop it from this split.

every year in each country. The literal interpretation of the current results is that for every additional firm that adopts SWIFT in a specific country, other adopters will increase their average profit margin ratio by approximately 0.0002. If the number of adopters for example grows by 10 in a country in a year, firms are going to benefit from another 0.002 increase on their profit margin (1.3%).

The full network effects are hard to credibly estimate as many are international rather than national. Unfortunately the aggregate number of adopters is collinear with the time dummies so cannot be separately identified. Still, the finding of intra-country network effects is consistent with what we would expect from a network technology like SWIFT.

### *5.6 Are we over-estimating the SWIFT effect because of survivor bias?*

As noted in the data section we dropped the Bankscope firms who dissolved prior to 2006 because we were unsure of their adoption history (SWIFT does not keep track of users who have died). Could this generate an upward bias to the results because SWIFT adopters may be more likely to exit due to possible organizational disruption?

It is very likely that banks that dissolved prior to 2006 were non-adopters of SWIFT because a Bank Identifier Code (BIC) code is a necessary condition for SWIFT adoption and, according to Bankscope, only five of the 2,516 banks which exited over the 1997-2006 period had BIC codes. If we assume that the dissolved banks without a BIC code did not adopt SWIFT and the other five did adopt SWIFT our results are very robust[20]. Re-running the specification of Table 3 column 2 on the 7,208 firms (of living and dead firms) generated a long-run effect of SWIFT on profit margins of 0.071 (p-value = 0.0029) compared to 0.070 in the baseline. Replacing the dependent variable with survival (instead of profitability) led to an implied long-run positive effect of SWIFT of 5 percentage points (significant at the 1% level). This is consistent with the idea that SWIFT raises firm performance and suggests that our baseline results may actually be *underestimating* the effect of this financial innovation.

### *5.7 Robustness Tests*

We examined a wide range of further tests to make sure that the results were robust. First, we included a specification with a full set of year dummies interacted with country dummies in column (1) of Table A1. The results are very similar to the baseline specification of column (2) Table 3, suggesting the linear time dummies are adequate. We re-estimated the basic model including total assets as a size measure. The second column shows similar effects to using whether asset per worker as in the baseline results. Third, we examined whether the results are driven simply by the difference between adopters and those who never adopted SWIFT. We are concerned that the latter are not a valid comparison group. Consequently columns (3) and (4) of Table A1 drop the firms who never adopted SWIFT. It is reassuring that the results are stable: the long-run effect is significant and positive (0.060).

Fourth, we examined heterogeneity by type of bank. Table A2 shows that we have a range of banking types in the data with commercial banks being the most prevalent (28% of the sample). Table A3 estimates the

[20] Note that how we deal with these five banks is immaterial. Dropping them from the sample or assuming they were non-adopters leads to near identical results.

models of Table A1 on the commercial banking sample alone. Reassuringly, the results are robust, with a significant long-run effect of 0.09 in column (9). By contrast, there is no significant effect on the non-commercial banks (the long-run effect is actually negative). Further investigation reveals that the SWIFT effects are weak or negative for some of the financial institutions including (see Table A2) - Central Banks, Islamic Banks, Credit banks, multi-lateral government banks, non-banking credit institutions, mortgage banks, savings banks and government credit institutions. Dropping these from the sample (as we do in the last two columns of Table A3), shows that we have a positive and significant long-run effect with the same properties as the basic model. This is unsurprising as the measurement of firm performance is particularly difficult in some of these organizations. It may also be related to the fact that many of these organizations are in the public sector where the ability to manage IT is notoriously poor.

Finally, we also examined normalizing profits on assets or equity instead of sales, which led to similarly positive results[21]. Finally, we examined whether there was a premium to being an "earlier adopter". We could find no evidence of this. For example, if we split the sample into two periods (after 2001 and before 2001, the long-run effect of SWIFT was 0.122 in the early period and 0.137 in the later period with both effects remaining significant.

## 6. Summary and Conclusions

This paper has examined the impact of ICT on the performance of firms in the financial services sector through looking at data on the adoption of a particular financial innovation - SWIFT, one of the first and probably the most ubiquitous network technology in the banking world. We exploit a unique and uncommonly rich data of a panel of banks in 29 countries in Europe and North America that allows us to control for a number of confounding influences. In addition, the breadth of our data enables us to construct long lags and investigate the dynamics of the effect of SWIFT on bank performance.

Overall, we recover robust evidence that SWIFT adoption has a positive and significant correlation with firm performance even after controlling for many factors, including firm fixed effects. Our main results show that the returns from SWIFT can take up to ten years to be fully realised. As expected for most technology investments, we observe an extremely weak or negative result within the first few years of the adoption of SWIFT. This is consistent with previous findings that demonstrate that technological and organisational changes take time to implement and realise the benefits (e.g. Bresnahan et al, 2002). Additionally, the profitability effects of SWIFT derive mainly from an increase in sales, not just a fall in long-term operating expenses (due to fewer employees per unit of capital). Two additional results that emerge from our analysis are that smaller firms seem to benefit from relatively higher returns than the larger ones, and that US and UK firms reach long-run results earlier than the European firms. Finally, there is also some indication of the existence of network effects between the members of SWIFT within the same country.

There are many outstanding issues and research questions. First, the long lags of the effects of SWIFT adoption on performance make it unlikely that our results are driven by endogeneity. Nevertheless, it would be desirable to have a better model of why some firms adopted SWIFT earlier than others. Second, understanding why smaller firms benefit more than larger firms from SWIFT adoption is important. For

[21] For example, if we replace the dependent variable by the return on assets in column (1) of Table 3 the long-run effect is 0.226 over the mean of 0.775.

example, is this because, they find it easier to change internal organization? Finally, the crisis in the banking sector which occurred just after our sample period ends offers an opportunity to examine how early and later adopters responded differentially to the challenge of the crisis.

## References


Alpar, P., and Kim, M. 1990. A microeconomic approach to the measurement of information technology value. *Journal of Management Information Systems, 7*: 55-69.

Ambrosia, D. W. 1980. New SWIFT rules on the liability of financial institutions for interest losses caused by delay in International fund transfers. *Cornell International Law Journal, Vol. 13*: pp. 311-327.

Anderson, M. C., Banker, R. D., & Ravindran, S. 2006. Value Implications of Investments in Information Technology. *Management Science, 52*(9), 1359-1376.

Aral, S., Brynjolfsson, E., and Wu, D. J. 2006. Which Came First, IT or Productivity? The Virtuous Cycle of Investment and Use in Enterprise Systems. *Twenty Seventh International Conference on Information Systems*. Milwaukee.

Autor, D., Lavy, F. and Murnane, R. 2002. Upstairs, Downstairs: Computers and skills on two floors of a large bank *Industrial and Labor Relations Review*, 55, 432-47

Banker. 1992. SWIFT Busters Strike Out. *The Banker, May 1992(issue 795)*: pp. 44.

Banker, R. D., and Kauffman, R. J. 1988. Strategic contributions of Information technology: An empirical study of ATM networks. *Proc. of the 9th Int. Conf. on Information Systems*: 141-150.

Barrett, M., and Walsham, G. 1999. Electronic Trading and Work Transformation in the London Insurance Market. *Information Systems Research, 10(1)*: 1 - 22.

BIS. 2002. IT innovations and financing patterns: implications for the financial system. 1-37: Bank for International Settlements (BIS) - Committee on the Global Financial System.

Bloom, N., Sadun, R., and Van Reenen, J. 2006. Americans Do I.T Better: US multinationals and the productivity miracle NBER Working Paper No. 13085.

Bresnahan, T., Brynjolfsson, E. and Hitt, L. 2002. Information technology, workplace organization and the demand for skilled labor, *Quarterly Journal of Economics*, 117(1), 339-376.

Brownlow, D. 2007. Bank Efficiency: Measure for measure. *International Banking Systems Journal(16.5)*.

Brynjolfsson, E., and Hitt, L. M. 1996. Paradox Lost? Firm-Level Evidence on the Returns to Information Systems. *Management Science, 42*(4, April), 541-558.

Brynjolfsson, Erik and Hitt, Lorin. 2003. Computing productivity: Firm level evidence, *Review of Economics and Statistics,* 85 (4), 793-808.

Brynjolfsson, E., and Yang, S. 1996. Information Technology and Productivity: A Review of the Literature. *Advances in Computers, 43*: 179-214.

Caroli, E. and Van Reenen, J. 2001. Skill biased organizational change? Evidence from British and French establishments, *Quarterly Journal of Economics* CXVI (4), 1449-1492.

Casolaro, L. and Gobbi, G. Information Technology and Productivity Changes in the Banking Industry *Economic Notes*, 36(1), 43-76

Clemons, E. K., and Weber, B. W. 1990. London's Big Bang: A case study of Information Technology, Competitive Impact, and Organisational Change. *Journal of Management Information Systems, 6(4)*: 41 - 60.

Copon, A., and Gold, J. S. 2001. Accelerating Swift. *Institutional Investor, 35(9)*: pp. 141-144.

Dewan, S., and Kraemer, K. L. 2000.. Information Technology and Productivity: Evidence from Country-Level Data. *Management Science, 46*(4), 548-562.

Draca, M., Sadun, R. and Van Reenen, J. 2007. Productivity and ICT: A review of the evidence. Handbook of Information of Information and Communication Technologies" R. Mansell, C. Avgerou, D. Quah and R. Silverstone (eds) *Oxford Handbook on ICT*, Oxford University Press,

Economides, N. 1996. The Economics of Networks. *International Journal of Industrial Organization, 14(2)*.

Geroski, P., Machin, S. and Van Reenen, J. (1993) The Profitability of Innovating firms *Rand Journal of Economics* 24 (2), 198-21

Geroski, P. (1991) Innovation and the Sectoral Sources of UK productivity Growth. *Economic Journal* 101 (409), 1438-1451

Griliches, Z. 1957. Hybrid Corn: An Exploration in the Economics of Technological Change. *Econometrica,* 25: 501-522.

Hall, B. H., and Khan, B. 2003. Adoption of New Technology. *NBER Working Paper* No. 9730

Jorgenson, D. 2001. Information technology and the U.S. economy, *American Economic Review*, 91(1), 1-32.

Jorgenson, D., Ho, M. and Stiroh, K. (2008) A retrospective look at the US productivity growth resurgence, *Journal of Economic Perspectives*, 22(1), 3-24.

Jun, S. (2008) The link between IT investment and securities firms' returns in Korea *Journal of Economic Research* 13 1-43

Liebowitz, S. J., and Margolis, S. E. 1990. The Fable of Keys. *Journal of Law and Economics, 33(1)*: 1-26.

O'Leary, D. 2000. *Enterprise Resource Planning Systems: Life Cycle, Electronic Commerce, and Risk*. New York: Cambridge University Press.

Queree, A., and Ball, M. 1997. Swift ends dream of direct access. *Corporate Finance, Aug. 1997(153)*: pp. 22-26.

Parsons, Gotlieb and Denny (1993) Productivity and Computers in Canadian Banking *Journal of Productivity Analysis,* 95-114

Sassen, S. 2002. *Global Networks, Linked Cities*. London: Routledge.

Scott, S. V., and Barrett, M. 2005. Strategic Risk Positioning as Sensemaking in Crisis: The adoption of electronic trading at the London International Financial Futures and Options Exchange. *Journal of Strategic Information Systems, 14(1)*: 45-68.

Scott, S. V., and Zachariadis, M. 2010. A historical development of core financial services infrastructure: The Society for Worldwide Interbank Financial Telecommunication (S.W.I.F.T.). *Working paper Series, ISIG, Department of Management - LSE*.

Slade, M. (2004) Models of Firm-Level Profitability, *International Journal of Industrial Organization*, 22, 289-308.

Stiroh, K. (2002) Information technology and the US productivity revival: What do the industry data say?, *American Economic Review*, 92(5), 1559-1576.

SWIFT. 2006. SWIFT History. Brussels: Society for Worldwide Interbank Financial Telecommunication (SWIFT).

Weirdt, D. M., Hadji-Ashrafi, S., Randall, P., and Scott, S. V. 2005. Standards: Building a generic template. *Dialogue – The SWIFT Community*.

Winder, R. 1985. Too SWIFT for comfort. *Euromoney (January)* 55-56.

TABLE 1 – COUNTRY STATISTICS

| Country name | (1) Sample firms | (2) Percent | (3) Number of SWIFT adopters | (4) Percentage of SWIFT population | (5) Matched adopters in sample | (6) Proportion (%) of adopters in sample |
|---|---|---|---|---|---|---|
| Austria | 230 | 3.36 | 100 | 1.22 | 69 | 30.00 |
| Belgium | 98 | 1.43 | 88 | 1.08 | 43 | 43.39 |
| Canada | 83 | 1.21 | 62 | 0.76 | 31 | 37.35 |
| Cyprus | 29 | 0.42 | 38 | 0.46 | 15 | 51.72 |
| Czech Republic | 32 | 0.47 | 28 | 0.34 | 16 | 50.00 |
| Denmark | 121 | 1.77 | 59 | 0.72 | 41 | 33.88 |
| Estonia | 10 | 0.15 | 13 | 0.16 | 7 | 70.00 |
| Finland | 19 | 0.28 | 22 | 0.27 | 7 | 36.84 |
| France | 468 | 6.83 | 250 | 3.06 | 118 | 25.21 |
| Germany | 1710 | 24.97 | 298 | 3.65 | 178 | 10.40 |
| Greece | 23 | 0.34 | 41 | 0.50 | 19 | 82.60 |
| Hungary | 40 | 0.58 | 43 | 0.53 | 25 | 62.50 |
| Ireland | 70 | 1.02 | 81 | 0.99 | 37 | 52.85 |
| Italy | 782 | 11.42 | 258 | 3.16 | 167 | 21.35 |
| Latvia | 23 | 0.34 | 27 | 0.33 | 23 | 100.00 |
| Lithuania | 10 | 0.15 | 12 | 0.15 | 10 | 100.00 |
| Luxembourg | 115 | 1.68 | 148 | 1.81 | 83 | 72.17 |
| Malta | 14 | 0.20 | 15 | 0.18 | 9 | 64.28 |
| Netherlands | 101 | 1.47 | 98 | 1.20 | 45 | 44.55 |
| Norway | 88 | 1.29 | 34 | 0.42 | 17 | 19.31 |
| Poland | 52 | 0.76 | 47 | 0.57 | 39 | 75.00 |
| Portugal | 47 | 0.69 | 45 | 0.55 | 31 | 65.95 |
| Slovakia | 21 | 0.31 | 20 | 0.24 | 14 | 66.67 |
| Slovenia | 20 | 0.29 | 23 | 0.28 | 17 | 85.00 |
| Spain | 166 | 2.42 | 120 | 1.47 | 71 | 42.77 |
| Sweden | 139 | 2.03 | 35 | 0.43 | 14 | 9.35 |
| Switzerland | 539 | 7.87 | 270 | 3.30 | 162 | 30.00 |
| United Kingdom | 455 | 6.64 | 538 | 6.58 | 177 | 38.90 |
| USA | 1343 | 19.61 | 567 | 6.94 | 204 | 15.19 |
| Total | 6848 | 100.00 | 3380 | 41.34 | 1689 | 24.66 |

*Notes*: Column (1) includes 6,848 firms from 29 countries in BVD's Bankscope. Column (3) shows the number of adopters of SWIFT from these 29 countries in SWIFT's database of customers (adoption information is from 1977 to 2006). This is given as a % of all SWIFT's data (that includes non-banks). Column (5) reports the number matches between the Bankscope data of column (1) and SWIFT customers in column (3) - i.e. the number of adopters in Bankscope. Column 6 reports the proportion of Bankscope firms that (at some point) adopted SWIFT.

TABLE 2 – DESCRIPTIVE STATISTICS

| | Obs. | Median | Mean | Standard deviation |
|---|---|---|---|---|
| Variables | | | | |
| Total assets (m$) | 29970 | 729.43 | 10300 | 62000 |
| Total sales (m$) | 29970 | 49.705 | 637.6793 | 3701.933 |
| Pretax profits (m$) | 29970 | 5.936 | 104.894 | 759.944 |
| Employees | 29970 | 164 | 1460.54 | 8479.635 |
| Operating expenses (m$) | 29901 | 20.1 | 259.637 | 1674.894 |
| Ratios | | | | |
| Profit margin (pre-tax profits/sales) | 29970 | 0.1384 | 0.1522 | 0.1524 |
| Return on assets | 29970 | 0.61 | 0.7822 | 0.9919 |
| Return on equity | 29946 | 7.43 | 8.5566 | 8.1563 |
| Cost to income | 29789 | 67.13 | 68.337 | 29.8822 |
| | | | US&UK | |
| Total assets (m$) | 8768 | 1371.213 | 17100 | 82800 |
| Total sales (m$) | 8768 | 98.9 | 1190.498 | 5388.061 |
| Pre-tax profits (m$) | 8768 | 18.842 | 253.4578 | 1268.289 |
| Profit margin | 8768 | 0.2124 | 0.2067 | 0.1533 |
| | | | Rest of Europe | |
| Total assets (m$) | 21100 | 557.761 | 7068.323 | 50000 |
| Total sales (m$) | 21100 | 37.381 | 383.7651 | 2626.956 |
| Pre-tax profits (m$) | 21100 | 3.541 | 39.709 | 361.452 |
| Profit margin | 21100 | 0.112 | 0.1296 | 0.1464 |
| | | | Small Firms | |
| Total assets (m$) | 14300 | 255.992 | 294.235 | 211.316 |
| Total sales (m$) | 14300 | 17.273 | 22.053 | 27.465 |
| Pre-tax profits (m$) | 14300 | 1.808 | 3.396 | 9.0938 |
| Profit margin | 14300 | 0.1308 | 0.1418 | 0.156 |
| | | | Big Firms | |
| Total assets (m$) | 15670 | 2429.1 | 19400 | 84700 |
| Total sales (m$) | 15670 | 162.521 | 1199.482 | 5054.607 |
| Pre-tax profits (m$) | 15670 | 22.23 | 197.518 | 1042.361 |
| Profit margin | 15670 | 0.1459 | 0.1618 | 0.1483 |

*Notes*: Sample includes 6,848 firms in 29 countries, from 1998 to 2005; m$ = Millions of US Dollars. "US & UK" are firms located in the United States of America and the United Kingdom, and "Rest of Europe" includes the European countries outside the UK (see Table 1). "Small" and "Big" firms are defined according to the overall median of the firm's assets.

TABLE 3 – SWIFT ADOPTION & FIRM PERFORMANCE

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Estimation method | OLS | OLS | OLS | OLS | OLS |
| Sample | | All firms | | Small firms | Big firms |
| Dependent variable | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ |
| $\log\left(\frac{Assets}{Employees}\right)_{it}$ | – | 0.0358*** | 0.0358*** | 0.0543*** | 0.0268*** |
| | | (0.0076) | (0.0076) | (0.013) | (0.0093) |
| $SWIFT_{it+1}$ | – | – | 0.0155 | – | – |
| | | | (0.0138) | | |
| $SWIFT_{it}$ | 0.0011 | 0.0006 | –0.0087 | 0.0012 | 0.0023 |
| | (0.0177) | (0.0171) | (0.0162) | (0.0273) | (0.0216) |
| $SWIFT_{it-1}$ | –0.0087 | –0.0106 | –0.0102 | –0.0001 | –0.0187 |
| | (0.0205) | (0.0201) | (0.0201) | (0.0309) | (0.0261) |
| $SWIFT_{it-2}$ | 0.0269* | 0.0243 | 0.0246 | 0.0376 | 0.0114 |
| | (0.016) | (0.0159) | (0.0158) | (0.0288) | (0.0155) |
| $SWIFT_{it-3}$ | –0.0051 | –0.0057 | –0.0056 | 0.0059 | –0.0162 |
| | (0.0133) | (0.0132) | (0.0132) | (0.023) | (0.014) |
| $SWIFT_{it-4}$ | 0.0263** | 0.026** | 0.0262** | 0.0411** | 0.0105 |
| | (0.0113) | (0.0112) | (0.0112) | (0.0173) | (0.0141) |
| $SWIFT_{it-5}$ | 0.038 | 0.002 | 0.002 | –0.0002 | 0.0028 |
| | (0.0108) | (0.0108) | (0.0108) | (0.0161) | (0.0145) |
| $SWIFT_{it-6}$ | 0.0057 | 0.0055 | 0.0055 | 0.0027 | 0.0074 |
| | (0.011) | (0.011) | (0.011) | (0.0172) | (0.0141) |
| $SWIFT_{it-7}$ | 0.0105 | 0.0098 | 0.0098 | 0.0147 | 0.0062 |
| | (0.0104) | (0.0104) | (0.0104) | (0.0171) | (0.0132) |
| $SWIFT_{it-8}$ | 0.0034 | 0.0026 | 0.0026 | –0.0015 | 0.0042 |
| | (0.0089) | (0.0089) | (0.0089) | (0.016) | (0.0105) |
| $SWIFT_{it-9}$ | 0.0184** | 0.0154** | 0.0155** | 0.0167 | 0.0138 |
| | (0.0077) | (0.0076) | (0.0076) | (0.0135) | (0.009) |
| Sum of coefficients | 0.0823 | 0.07 | 0.0618 | 0.1181 | 0.0238 |
| Significance of the sum of SWIFT coef. (Prob>F) | 0.0006 | 0.003 | 0.01 | 0.0024 | 0.4053 |
| Joint significance of SWIFT coef. (Prob>F) | 0.0018 | 0.0093 | 0.0096 | 0.0215 | 0.6004 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes |
| Number of firms | 5615 | 5615 | 5615 | 2832 | 2783 |
| Number of obs. | 29970 | 29970 | 29970 | 14300 | 15670 |
| $R^2$ | 0.6694 | 0.6726 | 0.6727 | 0.6622 | 0.6852 |

*Notes*: *significant at 10%, **significant at 5%, ***significant at 1%. Standard errors in brackets are robust to heteroskedacity and autocorrelation of unknown form and are clustered by firm. All equations include a full set of country and year dummies. The dependent variable in all columns ($\Pi/S_{it}$) is the Profit Margin denoting Pre-tax Profits over Total Revenues (Sales). In all columns we include a 9-year lag structure to test the long-term effect of SWIFT on firm performance. In column 3 we have also constructed a lead to investigate the causal direction of SWIFT adoption and firm performance. In columns 4 & 5, we split our data between "Small" and "Big" firms we use a mean of the Total Assets of each firm as size indicator to make the categorisation. The time period of our sample is 1998-2005 (eight years).

TABLE 4 – SWIFT ADOPTION AND SALES, EXPENSES AND LABOUR

| | (1) | (2) | (3) |
|---|---|---|---|
| Estimation method | OLS | OLS | OLS |
| Dependent variable | $\log(\text{Sales})_{it}$ | $\log(\text{Opex})_{it}$ | $\log\left(\frac{Employees}{Assets}\right)_{it}$ |
| $\log(\text{Assets})_{it}$ | – | 0.633*** | – |
| | | (0.031) | |
| $SWIFT_{it}$ | 0.0386 | 0.0174 | –0.0162 |
| | (0.0646) | (0.0473) | (0.0468) |
| $SWIFT_{it-1}$ | 0.1569** | 0.0219 | –0.0527 |
| | (0.0714) | (0.0395) | (0.0385) |
| $SWIFT_{it-2}$ | 0.0813** | –0.0217 | –0.0708** |
| | (0.0373) | (0.0249) | (0.0278) |
| $SWIFT_{it-3}$ | 0.0449 | –0.0473 | –0.0165 |
| | (0.0308) | (0.0303) | (0.0312) |
| $SWIFT_{it-4}$ | 0.0605** | –0.0146 | –0.0067 |
| | (0.0247) | (0.0249) | (0.0239) |
| $SWIFT_{it-5}$ | 0.0064 | –0.0217 | –0.0504* |
| | (0.0247) | (0.024) | (0.0293) |
| $SWIFT_{it-6}$ | –0.0078 | –0.0131 | –0.0043 |
| | (0.0271) | (0.0258) | (0.0298) |
| $SWIFT_{it-7}$ | –0.0095 | –0.0385* | –0.0196 |
| | (0.0239) | (0.0221) | (0.0239) |
| $SWIFT_{it-8}$ | 0.003 | –0.0102 | –0.0232 |
| | (0.0252) | (0.0202) | (0.0236) |
| $SWIFT_{it-9}$ | 0.0327 | –0.0662*** | –0.0846*** |
| | (0.0338) | (0.025) | (0.0275) |
| Sum of coefficients | 0.4072 | –0.1939 | –0.345 |
| Significance of the sum of SWIFT coef. (Prob>F) | 0.0000 | 0.0023 | 0.0000 |
| Joint significance of SWIFT coef. (Prob>F) | 0.0022 | 0.0036 | 0.0007 |
| Firm fixed effects | Yes | Yes | Yes |
| Number of firms | 6727 | 6720 | 5620 |
| Number of obs. | 39395 | 39259 | 30039 |
| $R^2$ | 0.9722 | 0.9822 | 0.9429 |

*Notes*: *significant at 10%, **significant at 5%, ***significant at 1%. Standard errors in brackets are robust to heteroskedacity and autocorrelation of unknown form and are clustered by firm. All equations include a full set of country and year dummies. The dependent variable in column 1 is the log of total revenues, in column 2 the log of operating expenses, and in column 3 the log of employees over assets. The time period is 1998-2005.

TABLE 5 – SWIFT ADOPTION & FIRM PERFORMANCE – USA/UK & EU FIRMS

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Estimation method | OLS | OLS | OLS | OLS | OLS | OLS |
| Countries | All firms | | Small firms | | Big firms | |
| Sample | US&UK | Rest of Europe | US&UK | Rest of Europe | US&UK | Rest of Europe |
| Dependent variable | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ |
| $\log\left(\frac{Assets}{Employees}\right)_{it}$ | 0.0595*** | 0.0327*** | 0.0757** | 0.0566*** | 0.0551*** | 0.0153 |
| | (0.0103) | (0.0105) | (0.0365) | (0.0145) | (0.0102) | (0.0134) |
| $SWIFT_{it}$ | –0.0322 | 0.0121 | –0.0457 | 0.0154 | –0.0211 | 0.0132 |
| | (0.0304) | (0.0203) | (0.0515) | (0.0313) | (0.0354) | (0.0267) |
| $SWIFT_{it-1}$ | 0.0279 | –0.0247 | 0.0434 | –0.0119 | 0.0157 | –0.035 |
| | (0.0387) | (0.0234) | (0.0788) | (0.0322) | (0.0411) | (0.0329) |
| $SWIFT_{it-2}$ | 0.0316 | 0.021 | 0.0628 | 0.0346 | 0.0209 | –0.0014 |
| | (0.0261) | (0.0194) | (0.0696) | (0.0315) | (0.0264) | (0.0183) |
| $SWIFT_{it-3}$ | 0.0005 | –0.0086 | 0.0111 | 0.0047 | –0.0021 | –0.0297 |
| | (0.0185) | (0.0171) | (0.0519) | (0.0254) | (0.0178) | (0.0201) |
| $SWIFT_{it-4}$ | 0.0282** | 0.0253* | 0.0651* | 0.0355* | 0.0149 | 0.0088 |
| | (0.0135) | (0.0148) | (0.0356) | (0.0193) | (0.0131) | (0.0225) |
| $SWIFT_{it-5}$ | 0.0008 | 0.002 | –0.0337 | 0.0051 | 0.0112 | –0.005 |
| | (0.0115) | (0.0145) | (0.027) | (0.0186) | (0.0126) | (0.0222) |
| $SWIFT_{it-6}$ | –0.0081 | 0.0113 | –0.0368 | 0.0124 | 0.033 | 0.0112 |
| | (0.0148) | (0.0142) | (0.0304) | (0.0197) | (0.0163) | (0.0205) |
| $SWIFT_{it-7}$ | –0.0131 | 0.0191 | 0.0231 | 0.0137 | –0.0282 | 0.024 |
| | (0.0179) | (0.0126) | (0.0262) | (0.0204) | (0.0227) | (0.0162) |
| $SWIFT_{it-8}$ | 0.0288** | –0.0052 | 0.0586** | –0.0167 | 0.0181 | 0.003 |
| | (0.0136) | (0.011) | (0.0252) | (0.0185) | (0.0163) | (0.0132) |
| $SWIFT_{it-9}$ | –0.0165 | 0.024*** | –0.0275 | 0.0261* | 0.0009 | 0.0238** |
| | (0.0155) | (0.0085) | (0.0284) | (0.015) | (0.0184) | (0.01) |
| Sum of coefficients | 0.0578 | 0.0764 | 0.1204 | 0.1189 | 0.0335 | 0.0127 |
| Significance of the sum of SWIFT coef. (Prob>F) | 0.089 | 0.0117 | 0.1023 | 0.0076 | 0.3820 | 0.7412 |
| Joint significance of SWIFT coef. (Prob>F) | 0.1519 | 0.0079 | 0.2176 | 0.0543 | 0.5738 | 0.1444 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of firms | 1405 | 4193 | 476 | 2356 | 929 | 1837 |
| Number of obs. | 8768 | 21100 | 2768 | 11532 | 6000 | 9568 |
| $R^2$ | 0.6572 | 0.6643 | 0.6454 | 0.6672 | 0.6604 | 0.6664 |

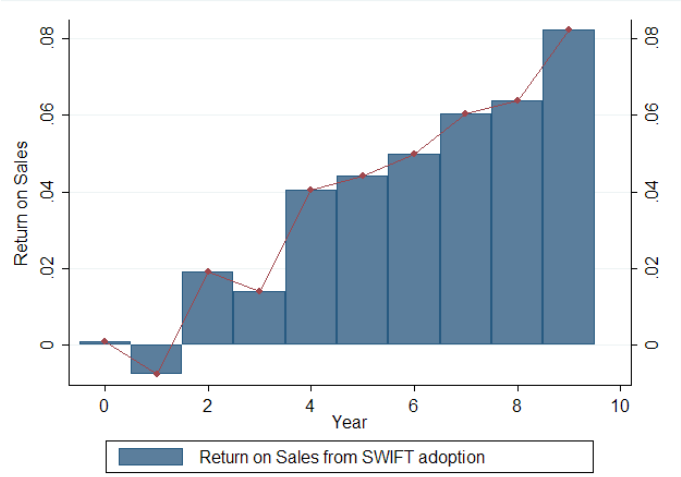
*Notes*: *significant at 10%, **significant at 5%, ***significant at 1%. In this table we investigate the SWIFT-effects in two separate Country sub-samples: US&UK with all the rest of the European countries. Standard errors in brackets are robust to heteroskedacity and autocorrelation of unknown form and are clustered by firm. All equations include a full set of country and year dummies. In all columns we include a 9-year lag structure to test the long-run effect of SWIFT on firm performance. In columns 3 and 4, we report the coefficients for all the "Small" firms in the US&UK and the Rest of Europe, and in columns 5 and 6 for all the "Large". As in all our "Small" and "Big" splits, we use the same median of the average Total Assets of each firm as size indicator to make the categorisation. The time period of our sample is again from 1998 to 2005 (eight years).

TABLE 6 – SWIFT NETWORK EFFECTS

| | (1) | (2) |
|---|---|---|
| Estimation method | OLS | OLS |
| Sample | All firms | |
| Dependent variable | $\Pi/S_{it}$ | $\Pi/S_{it}$ |
| $\log\left(\frac{Assets}{Employees}\right)_{it}$ | 0.0362*** | 0.0362*** |
| | (0.0076) | (0.0076) |
| Network Effect$_{jt}$/1000 | 0.1808*** | – |
| | (0.0575) | |
| Network Effect$_{jt-1}$/1000 | – | 0.2741*** |
| | | (0.0547) |
| SWIFT$_{it}$ | 0.001 | 0.0013 |
| | (0.017) | (0.017) |
| SWIFT$_{it-1}$ | –0.0102 | –0.0107 |
| | (0.02) | (0.02) |
| SWIFT$_{it-2}$ | 0.025 | 0.025 |
| | (0.0158) | (0.0158) |
| SWIFT$_{it-3}$ | –0.0053 | –0.0054 |
| | (0.0132) | (0.0132) |
| SWIFT$_{it-4}$ | 0.0264** | 0.0264** |
| | (0.0112) | (0.0112) |
| SWIFT$_{it-5}$ | 0.0023 | 0.0023 |
| | (0.0108) | (0.0109) |
| SWIFT$_{it-6}$ | 0.006 | 0.0061 |
| | (0.011) | (0.011) |
| SWIFT$_{it-7}$ | 0.0106 | 0.0108 |
| | (0.0103) | (0.0104) |
| SWIFT$_{it-8}$ | 0.0033 | 0.0034 |
| | (0.0089) | (0.0089) |
| SWIFT$_{it-9}$ | 0.0176** | 0.0183** |
| | (0.0076) | (0.0076) |
| Sum of coefficients | 0.0765 | 0.0776 |
| Significance of the sum of SWIFT coef. (Prob>F) | 0.0011 | 0.0009 |
| Joint significance of SWIFT coef. (Prob>F) | 0.0027 | 0.0020 |
| Firm fixed effects | Yes | Yes |
| Number of firms | 5615 | 5615 |
| Number of obs. | 29970 | 29970 |
| $R^2$ | 0.6730 | 0.6735 |

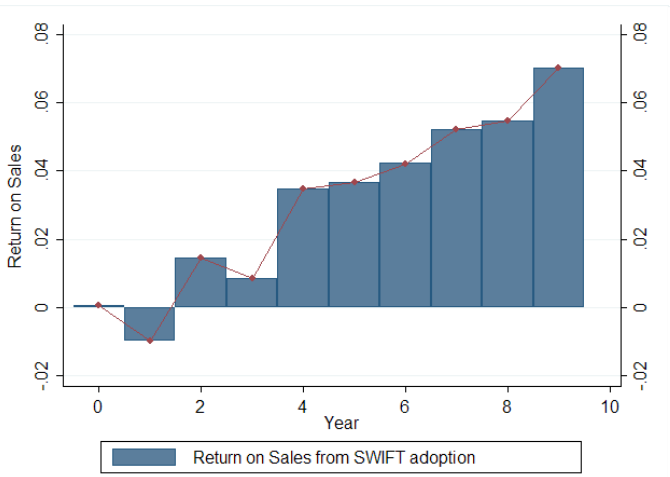
*Notes*: *significant at 10%, **significant at 5%, ***significant at 1%. Standard errors in brackets are robust and are clustered by firm. All equations include a full set of country and year dummies. The time period is 1998-2005. The Network Effect variable is the cumulative number of SWIFT adopters in country *j* since 1977 (and year *t*).

FIGURE 3 – LONG-TERM RETURNS FROM SWIFT



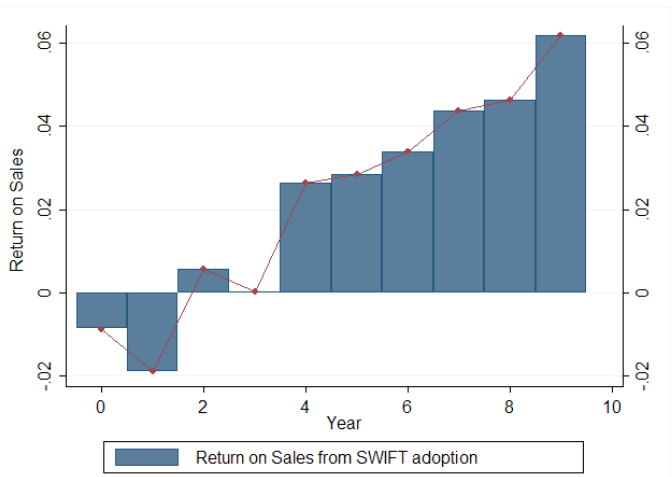

*Notes*: Figure 3 is a graphical representation of column (1) in Table 3. It presents the long run effect of SWIFT adoption on Profit Margin in the whole sample. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Adoption data run from 1977 - 2006 and financial data from 1998 – 2005.

FIGURE 4 – LONG-TERM RETURNS FROM SWIFT



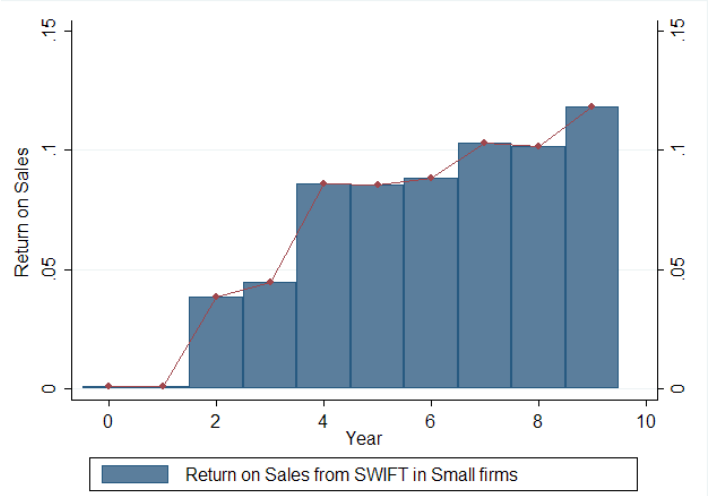

*Notes*: Figure 4 is a graphical representation of column (2) in Table 3. It presents the long run effect of SWIFT adoption on Profit Margin in the whole sample. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Adoption data run from 1977 - 2006 and financial data from 1998 – 2005.

FIGURE 5 – LONG-TERM RETURNS FROM SWIFT



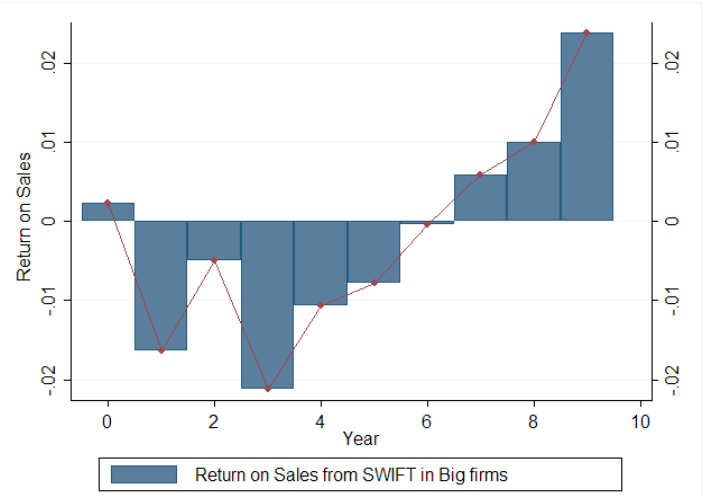

*Notes*: Figure 5 is a graphical representation of column (3) in Table 3. It presents the long run effect of SWIFT adoption on Profit Margin in the whole sample. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Adoption data run from 1977 - 2006 and financial data from 1998 – 2005.

FIGURE 6 – LONG-TERM RETURNS IN SMALL FIRMS



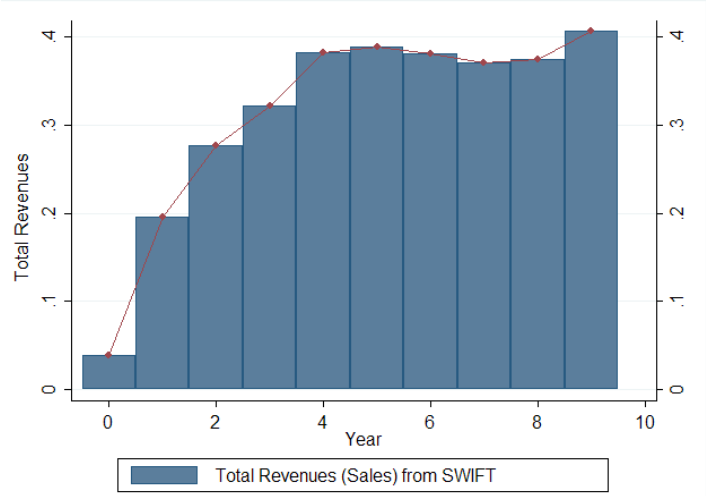

*Notes*: Figure 6 is a graphical representation of column (4) in Table 3. It presents the long run effect of SWIFT adoption on Profit Margin in the sub-sample of Small firms. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Adoption data run from 1977 - 2006 and financial data from 1998 – 2005.

FIGURE 7 – LONG-TERM RETURNS IN BIG FIRMS



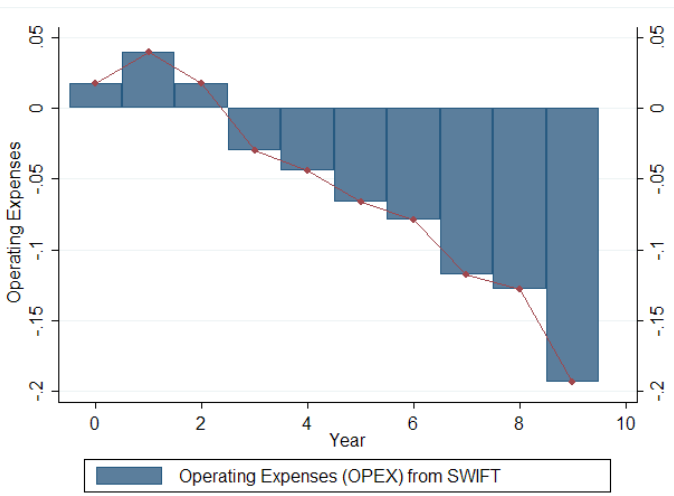

*Notes*: Figure 7 is a graphical representation of column (5) in Table 3. It presents the long run effect of SWIFT adoption on Profit Margin in the sub-sample of Big firms. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Adoption data run from 1977 - 2006 and financial data from 1998 – 2005.

FIGURE 8 – SWIFT EFFECT ON TOTAL SALES



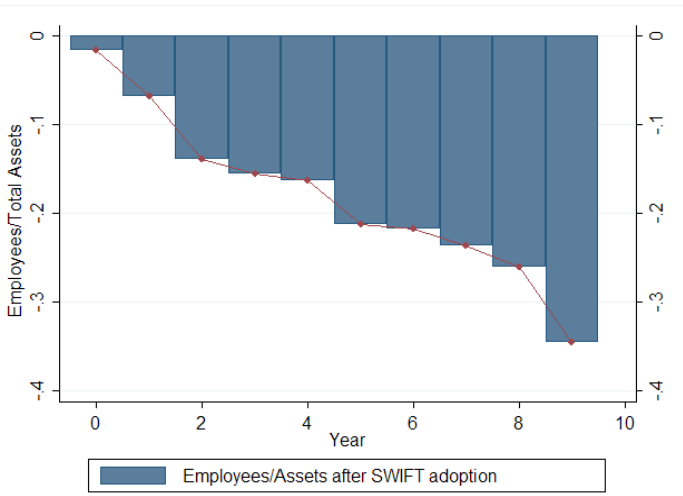

*Notes*: Figure 8 is a graphical representation of column (1) in Table 4. It presents the long run effect of SWIFT adoption on the Total Revenues (Sales) of the firms of the whole sample. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Descriptive Statistics of our variables are reported in Table 2. Adoption information is from 1977 to 2006, and financial performance data are from 1998 to 2005.

FIGURE 9 – SWIFT EFFECT ON OPERATING EXPENSES




*Notes*: Figure 9 is a graphical representation of column (2) in Table 4. It presents the long run effect of SWIFT adoption on the Operating Expenses of the firms in the whole sample. Again we can observe the dynamic effect of SWIFT. According to our analyses on SWIFT, expenses are expected to increase the first two years of the technology implementation. After that, operating expenses experience a drop since automates a list of processes in the organisations. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Descriptive Statistics of our variables are reported in Table 2. Adoption information is from 1977 to 2006, and financial performance data are from 1998 to 2005.

FIGURE 10 – SWIFT EFFECT ON LABOUR/ASSETS




*Notes*: Figure 10 is a graphical representation of column (3) in Table 4. Here we observe a fall in the numbers of employees relatively to the assets of the firm sample. Our full sample includes 6848 firms in 29 countries (adopters & non-adopters). Descriptive Statistics of our variables are reported in Table 2. Adoption information is from 1977 to 2006, and financial performance data are from 1998 to 2005.

FIGURE 11 – US&UK FIRMS

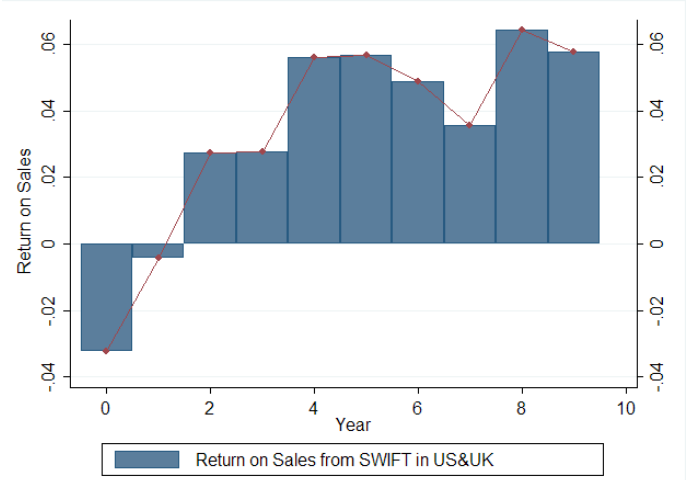
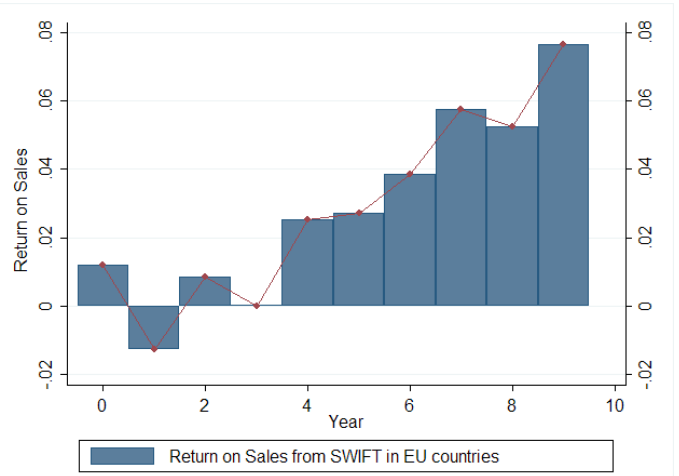



FIGURE 12 – EUROPEAN FIRMS




*Notes*: Figures 11 and 12 illustrate the results from US&UK and European (EU) firms from columns (1) and (2) respectively in Table 5. Descriptive Statistics for the two sub-samples are reported in Table 2. The country statistics are reported in Table 1. Adoption information is from 1977 to 2006, and financial performance data are from 1998 to 2005. Returns to SWIFT are defined by the Profit Margin ratio as described in the Table 2.

FIGURE 13 – US&UK SMALL FIRMS

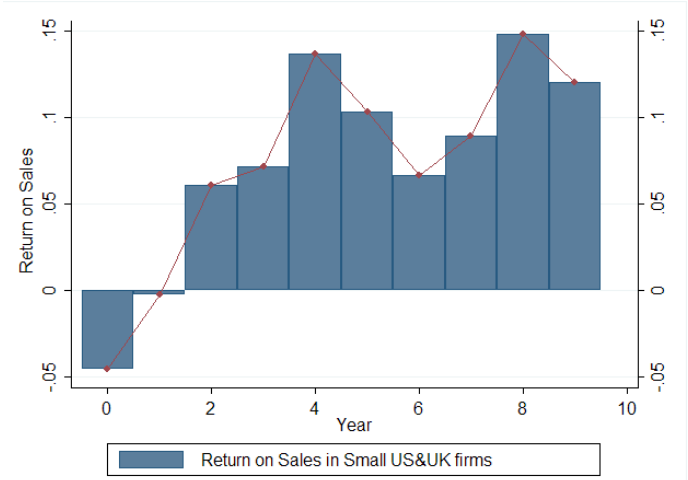
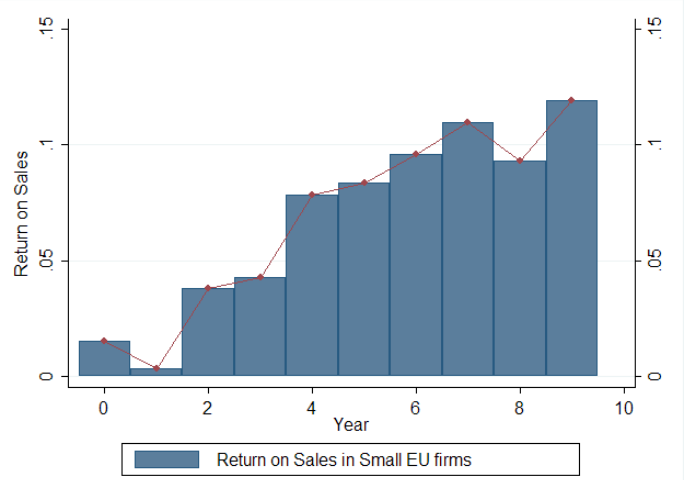



FIGURE 14 – EUROPEAN SMALL FIRMS




*Notes*: Figures 13 and 14 illustrate the results for US&UK and European (EU) Small firms from columns (3) and (4) respectively in Table 5. Descriptive Statistics for the two country sub-samples are reported in Table 2. The country statistics are reported in Table 1. Additional statistics on the Small country sub-samples are reported in Table A2 of the Appendix. Small and Big firms are split according to the overall median of the sample. Adoption information is from 1977 to 2006, and financial performance data are from 1998 to 2005. Returns to SWIFT are defined by the Profit Margin ratio as described in the Table 2.

**APPENDIX TABLES - NOTE THAT THESE ARE NOT INTENDED FOR PUBLICATION UNLESS REQUESTED BY EDITOR OR REFEREES**

TABLE A1 – USING TOTAL ASSETS INSTEAD OF ASSETS/EMPLOYEES

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Estimation method | OLS | OLS | OLS | OLS |
| Sample | All firms | | SWIFT adopters | |
| Dependent variable | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ |
| $\log\left(\frac{Assets}{Employees}\right)_{it}$ | 0.0404*** | – | 0.0509*** | – |
| | (0.0084) | | (0.0098) | |
| $\log(\text{Assets})_{it}$ | – | 0.0119* | – | 0.0133 |
| | | (0.0066) | | (0.0098) |
| $SWIFT_{it}$ | 0.0014 | –0.0023 | –0.0012 | –0.0052 |
| | (0.0168) | (0.0153) | (0.017) | (0.0155) |
| $SWIFT_{it-1}$ | –0.0015 | –0.0054 | –0.0106 | –0.0052 |
| | (0.0191) | (0.0178) | (0.02) | (0.0177) |
| $SWIFT_{it-2}$ | 0.0172 | 0.0133 | 0.0227 | 0.0120 |
| | (0.0157) | (0.0141) | (0.0158) | (0.0141) |
| $SWIFT_{it-3}$ | –0.0073 | 0.0072 | –0.0069 | 0.0055 |
| | (0.0125) | (0.0121) | (0.0133) | (0.0122) |
| $SWIFT_{it-4}$ | 0.0206* | 0.0184* | 0.025** | 0.0170 |
| | (0.0112) | (0.0104) | (0.0112) | (0.0105) |
| $SWIFT_{it-5}$ | 0.0015 | 0.001 | 0.0015 | 0.0009 |
| | (0.0100) | (0.0106) | (0.0109) | (0.0106) |
| $SWIFT_{it-6}$ | 0.0032 | 0.0028 | 0.0056 | 0.0021 |
| | (0.0095) | (0.0103) | (0.011) | (0.0104) |
| $SWIFT_{it-7}$ | 0.0027 | 0.0096 | 0.0086 | 0.0081 |
| | (0.0098) | (0.0096) | (0.0104) | (0.0097) |
| $SWIFT_{it-8}$ | 0.0009 | 0.0098 | 0.0028 | 0.0093 |
| | (0.009) | (0.0093) | (0.0091) | (0.0093) |
| $SWIFT_{it-9}$ | 0.0167** | 0.013 | 0.0128 | 0.0107 |
| | (0.0077) | (0.0083) | (0.0079) | (0.0086) |
| Sum of coefficients | 0.0555 | 0.0672 | 0.0604 | 0.0554 |
| Significance of the sum of SWIFT coef. (Prob>F) | 0.0155 | 0.0020 | 0.0274 | 0.0296 |
| Joint significance of SWIFT coef. (Prob>F) | 0.2009 | 0.0299 | 0.1387 | 0.3271 |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Number of firms | 5615 | 6727 | 1371 | 1642 |
| Number of obs. | 29970 | 39393 | 7320 | 9357 |
| $R^2$ | 0.6919 | 0.6778 | 0.6337 | 0.6271 |

*Notes*: *significant at 10%, **significant at 5%, ***significant at 1%. In this table we perform some robustness check on the relationship between SWIFT adoption and firm performance. Standard errors in brackets are robust to heteroskedacity and autocorrelation of unknown form and are clustered by firm. All equations include a full set of country and year dummies and in column (1) their interaction (the same column without the interactions can be found in Table 3, column (2)). In all columns we include a 9-year lag structure to test the long-run effect of SWIFT on firm performance. We test our data using the whole sample (col. 1 and 2), and SWIFT adopters sample (col. 3 and 4).

TABLE A2 – TYPES OF BANK IN THE SAMPLE

| Bank Specialisations | Number of Firms | SWIFT Adopters (firms) | SWIFT Non-adopters (firms) |
|---|---|---|---|
| Bank Holding & Holding Companies[a] | 717 | 38 | 679 |
| Central Banks | 28 | 27 | 1 |
| Commercial Banks[a] | 1927 | 1034 | 893 |
| Cooperative Banks[a] | 1620 | 87 | 1533 |
| Investment Banks /Securities Houses[a] | 498 | 226 | 272 |
| Islamic Banks | 1 | 1 | 0 |
| Medium & Long Term Credit Banks | 48 | 18 | 30 |
| Multi-lateral Governmental Banks | 2 | 1 | 1 |
| Non-banking Credit Institutions | 463 | 52 | 411 |
| Real Estate /Mortgage Banks | 189 | 31 | 158 |
| Savings Banks | 1280 | 138 | 1142 |
| Specialised Governmental Credit Institutions | 75 | 36 | 39 |
| | **6848** | **1689** | **5159** |

*Notes*: Sample includes 6848 firms (205,440 observations) in 29 countries, from 1977 to 2006.
[a]These banks are included in the sample for columns (5) and (6) in Table A3.

TABLE A3 –HETEROGENEITY OF THE SWIFT EFFECT ACROSS TYPES OF BANK

| Estimation method | (1) OLS | (2) OLS | (3) OLS | (4) OLS | (5) OLS | (6) OLS |
|---|---|---|---|---|---|---|
| Sample | Commercial Banks | | Non-Commercial Banks | | Selection of Banks | |
| Dependent variable | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ | $\Pi/S_{it}$ |
| $\log\left(\frac{Assets}{Employees}\right)_{it}$ | 0.0395*** | – | 0.0319*** | – | 0.0391*** | – |
| | (0.013) | | (0.0088) | | (0.009) | |
| $\log(Assets)_{it}$ | – | 0.0137 | – | 0.0098 | – | 0.016** |
| | | (0.01) | | (0.0089) | | (0.0076) |
| $SWIFT_{it}$ | 0.0005 | –0.0076 | –0.001 | –0.0004 | –0.0086 | –0.0103 |
| | (0.0261) | (0.0235) | (0.0207) | (0.0179) | (0.0209) | (0.0184) |
| $SWIFT_{it-1}$ | –0.0052 | –0.0041 | –0.0194 | –0.0085 | –0.0205 | –0.0166 |
| | (0.0255) | (0.0234) | (0.0332) | (0.0277) | (0.0241) | (0.0209) |
| $SWIFT_{it-2}$ | 0.0209 | 0.0116 | 0.0273 | 0.0108 | 0.0287 | 0.0163 |
| | (0.0175) | (0.0166) | (0.0308) | (0.0255) | (0.0181) | (0.016) |
| $SWIFT_{it-3}$ | –0.0043 | 0.012 | –0.0141 | –0.0089 | –0.0096 | 0.0072 |
| | (0.0165) | (0.0158) | (0.0208) | (0.0172) | (0.0146) | (0.0136) |
| $SWIFT_{it-4}$ | 0.0319** | 0.0235** | 0.0055 | 0.0005 | 0.0327*** | 0.0241** |
| | (0.0137) | (0.0128) | (0.0181) | (0.018) | (0.0117) | (0.0112) |
| $SWIFT_{it-5}$ | 0.0000 | –0.0018 | 0.0018 | 0.0017 | –0.0013 | –0.0005 |
| | (0.0137) | (0.0134) | (0.0156) | (0.0169) | (0.0117) | (0.0114) |
| $SWIFT_{it-6}$ | 0.0116 | 0.0112 | –0.014 | –0.0193 | 0.0063 | 0.0057 |
| | (0.0127) | (0.0131) | (0.0211) | (0.0164) | (0.0111) | (0.0108) |
| $SWIFT_{it-7}$ | 0.0191 | 0.0122 | –0.0171 | –0.0037 | 0.0087 | 0.0053 |
| | (0.0117) | (0.0113) | (0.0213) | (0.0181) | (0.0105) | (0.0099) |
| $SWIFT_{it-8}$ | –0.0014 | 0.005 | 0.0044 | 0.0125 | –0.0004 | 0.006 |
| | (0.0107) | (0.0109) | (0.0161) | (0.0176) | (0.0094) | (0.0093) |
| $SWIFT_{it-9}$ | 0.0171* | 0.0175* | 0.0041 | –0.0059 | 0.0153* | 0.0195** |
| | (0.0092) | (0.0098) | (0.0139) | (0.0155) | (0.0082) | (0.0086) |
| Sum of coefficients | 0.0902 | 0.0796 | –0.0225 | –0.0211 | 0.0513 | 0.0567 |
| Significance of the sum of SWIFT coef. (Prob>F) | 0.0045 | 0.0085 | 0.5608 | 0.5222 | 0.0507 | 0.0193 |
| Joint significance of SWIFT coef. (Prob>F) | 0.0059 | 0.0460 | 0.9422 | 0.9811 | 0.0110 | 0.0170 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of firms | 1565 | 1910 | 4050 | 4817 | 3903 | 4659 |
| Number of obs. | 8516 | 10840 | 21454 | 28553 | 21272 | 27516 |
| $R^2$ | 0.6552 | 0.6452 | 0.6829 | 0.6165 | 0.6625 | 0.6575 |

*Notes*: *significant at 10%, **significant at 5%, ***significant at 1%. In this table we perform some robustness check on the relationship between SWIFT adoption and firm performance. Standard errors in brackets are robust to heteroskedacity and autocorrelation of unknown form and are clustered by firm. All equations include a full set of country and year dummies. In all columns we include a 9-year lag structure to test the long-run effect of SWIFT on firm performance. We test our data using Commercial Banks sample (columns (1) and (2)), Non-Commercial Banks and other financial institutions sample (columns (3) and (4)). The final sample columns include only commercial, holding, cooperative and investment banks (see Table A2).

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