# The Diffusion of Payment Innovations: Insights from the Stellar Rise of Swish[1]

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## Abstract

Swish, a payments system based on mobile phones supported by banks, diffused rapidly and was adopted by the majority of the Swedish population only a few years after its launch. This paper examines the drivers and determinants of the rise of Swish. First, we present novel stylized facts about Swish and the related transformation of Sweden's payments market. Second, we identify critical factors in Sweden's institutional environment, and in the design and roll-out of Swish, that facilitated its rapid diffusion. Third, using rich individual-level data, we examine econometrically the role of personal characteristics as well as network effects in the adoption of Swish. Among other purposes, this analysis of Swish aims to help inform current public policy debates on the digitalization of payment systems around the world.

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[2] Sveriges Riksbank.

## I. INTRODUCTION

Only a few years after its launch, Swish -a payments system based on mobile phones supported by banks-, has been adopted by the vast majority of Sweden's adult population to make payments via their mobile phones. This stellar rise is all the more impressive because payment instruments are subject to strong network externalities, where their utility to each potential user depends greatly on how widely they are already used (see, for instance, Segendorf and Wretman, 2015). Such externalities make it unclear if, and to what extent, novel payment instruments will actually be used and widely adopted.[3] This paper seeks to examine the drivers and determinants of the adoption of Swish.

Better understanding the factors that underpin user participation in payments is useful for country authorities seeking to improve domestic payment systems. For example, the ECB has led the establishment of the TARGET Instant Payment Settlement (TIPS) to provide the infrastructure for banks to facilitate real time payments between customers. Central bank digital currencies (CBDCs) are also being discussed as an alternative to cash and to facilitate retail payments. Achieving widespread use of such payments innovations is a critical design goal for their implementation to be considered effective.

The diffusion of Swish has been much faster than that of many past payments innovations. For instance, the payment card business has its origins in the 1950s, so it took several decades until there was widespread use (Evans and Schmalensee, 2010).[4] In the early 2000s, Gowrisankaran and Stavin (2003) observed that 'in an age when computers and technology have become prevalent, only a tiny fraction of payments are completed using electronic payment.' Until recently, the conventional wisdom was that the payments industry had comparatively low rates of technological adoption and diffusion (Milne, 2006). Indeed, since the late 1990s, there have been a range failures of mobile payment services. [5] In the Appendix, alongside a more detailed account of the history of Swish, we discuss failed mobile payment services in Sweden. Hence, Swish's success cannot be taken for granted and could even be seen as an exception to the rule.

To help guide the subsequent analysis, this paper first documents patterns in the rise of Swish within the Swedish payments market. Swish transaction volumes are negatively correlated with the stock of cash in circulation that has fallen significantly since 2012. Yet, the extent to

[3] Network effects worked initially against the adoption of Swish when its market share was very low, but more recently, they may have reinforced the increase in its use.

[4] Diners Club launched the first successful network for consumers and merchants in 1950. In the first year, it added less than 50,000 customers, less than Swish in the first month after its launch. See Evans and Schmalensee, 2010, for additional details on the origins of card payments.

[5] Leibbrandt (2004) and Gannamaneni et al. (2015) discuss examples of early mobile phone payment schemes that failed in several European countries. By contrast, in countries outside of Europe, mobile payments have also quickly spread and reached high levels of market penetration in several segments. However, in many cases, they are imperfect comparisons to Swish as they are closed non-bank platforms that are sometimes linked to other types of e-commerce and some of their success can be attributed to leapfrogging traditional digital payment methods. This also implies that it is unclear whether they provide policy lessons for other advanced economies in Europe and elsewhere. See Korella and Wenwei (2018) for a discussion of examples of mobile payment systems and payment patterns outside Europe.

which Swish contributed to the decrease in cash usage remains unclear after comparing the small size of typical Swish transaction amounts with the cash usage decrease focused mostly on large denomination bills. While overall adoption levels of Swish are high, it is notable that growth in the number of users among some parts of the population has been very slow, especially among the elderly. Finally, a minority of users make payments to many payees, suggesting that some users were "super spreaders" who played a key role in promoting the adoption of Swish. Second, drawing on narrative accounts of the development of Swish, the paper examines the institutional and other factors that were likely critical in promoting the spread of Swish. We identify three broad factors at work (i) dedicated strategies in the design of Swish by the banks to incentivize user adoption, (ii) broad cooperation among banks supported by their common interest to reduce costs associated with cash usage, and (iii) the availability of complementary services such as a system for online ID verification and signing, and facilitation of instant settlement by the central bank , which each have public good features. Notably, the first two set of factors were all be predicted to be critical for mobile and other new forms of electronic payments to succeed by an earlier strand of the business administration literature, which we discuss in detail below. This makes Swish a "textbook case" of a successful innovation in the mobile payments market.

Finally, the paper examines the factors that are empirically associated with the use of Swish. Our data comes from the bi-annual payment surveys conducted by the Riksbank which contains rich information on a range of user demographics together with their usage of different payment instruments. We find that age, education, size of the city of residence and income are all important predictors of the use of Swish. The old, poor and less educated individuals and residents of smaller towns and cities are less likely to use Swish. The diffusion of Swish did not exhibit clear geographical patterns, but, network effects, namely average usage in the same geographical area or among people with similar demographic characteristics, also played an important role.

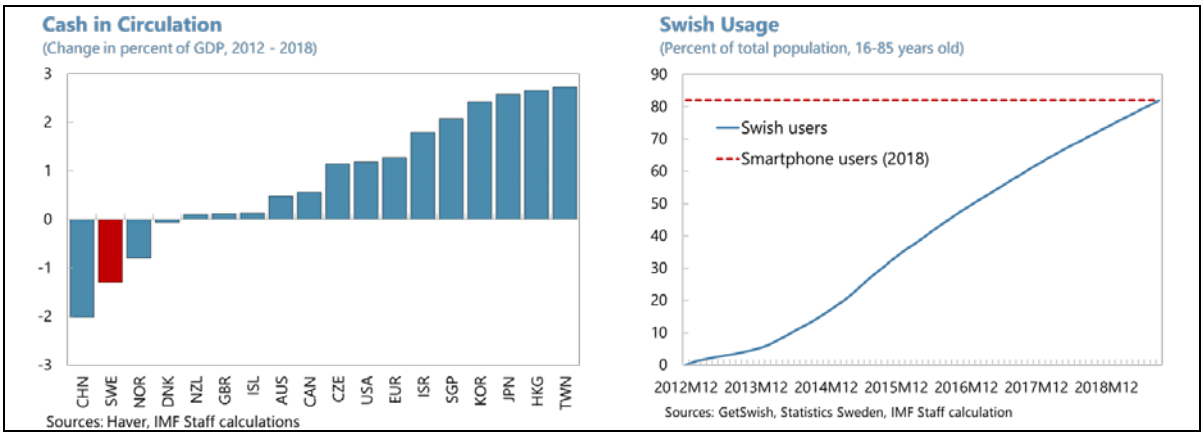
Our paper is related and contributes to several strands of the existing literature. First, there is a growing literature on the decline in cash use and the rise in instant retail payments; see Engert et al. (2019), Shirai and Sugandi (2019), Shy (2019) , Bech et al. (2018), Khiaonarong and Humphrey (2019) and Hartmann et al. (2017). Second, there is a large literature on financial, payments, and other innovations that overcame network externalities; see Saloner and Shepard (1995) on the spread of ATMs, Gowrisankaran and Stavins (2005) on the adoption of automated clearing house services by U.S. banks. There is a small but emerging literature that utilizes proprietary Fintech data (mostly related to credit provision); see Berg et al. (2019) and Hau et al. (2019) as examples.

The remainder of the paper is organized as follows. Section 2 describes the transformation of the Swedish payments market and presents stylized facts related to the adoption and use of Swish. Section 3 provides narrative evidence on key factors that facilitated the spread of Swish. Using individual-level data, Section 4 empirically analyzes factors correlated with Swish use. Section 5 concludes and discusses policy implications.

## II. THE TRANSFORMATION OF SWEDEN'S PAYMENTS MARKETSTYLIZED FACTS

In 2010, a new real-time settlement system was established by Sweden's commercial banks and the Riksbank, prompting the six largest banks to start cooperating through the Bankers Association to create a leading mobile payment service. A key step was the establishment of a specialized company, Getswish AB, to develop and maintain the new mobile payment infrastructure. The payment service Swish was introduced to the Swedish retail payments market in December 2012, with Swish services initially focused on peer-to-peer (P2P) payments. In 2014. the service was extended to small businesses, charities, and sports associations etc. An e-commerce service was effectively introduced in 2017 and in 2018 Getswish added services for point-of-sale (POS) payments, integrated into store cashier systems. In this section, we analyze confidential data on Swish accounts (around 9 million observations) which contain the age and enrollment date and aggregate data on P2P payments made with Swish since its launch.[6]

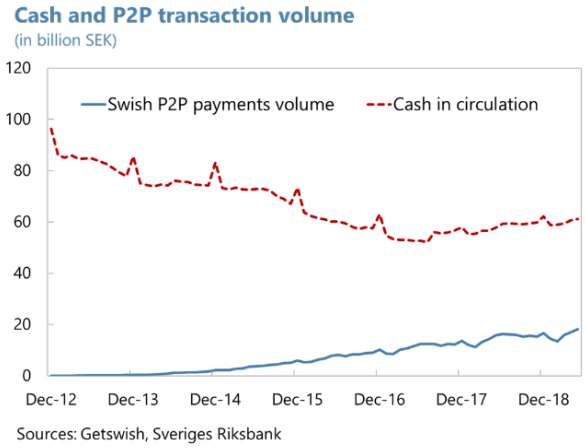
Sweden is among the countries where cash use has declined most in recent years. At the same time, the number of Swish users reached around 80 percent of the adult population between 16 and 85. As this corresponds to available estimate of the share of smartphone ownership, Swish has essentially reached full market penetration in this age group.[7] An obvious question is whether the decline in cash use was driven by the rise in the use of Swish?



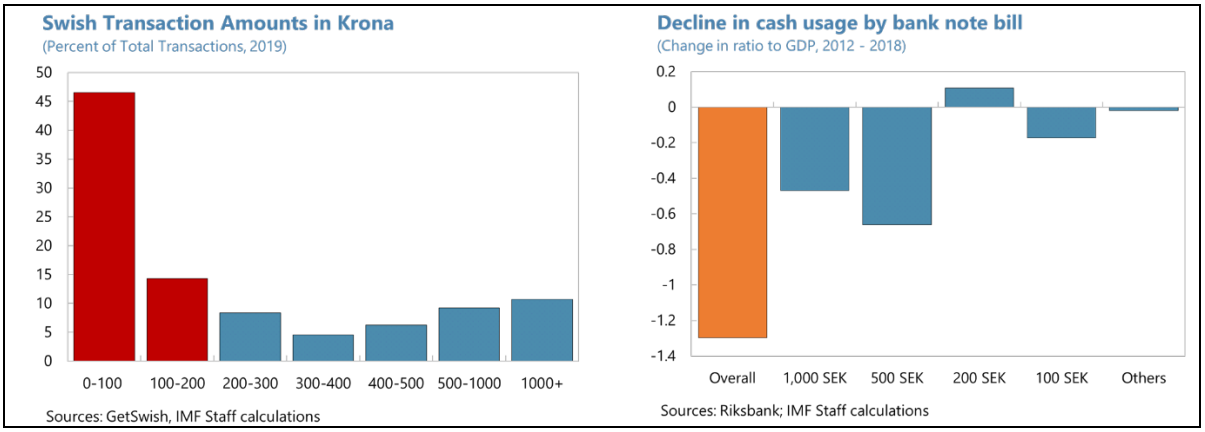

[6] The authors did not have direct access to individual level data, rather, GetSwish kindly shared aggregated analysis of these data.

[7] Data on smartphone use is not available for other age groups.

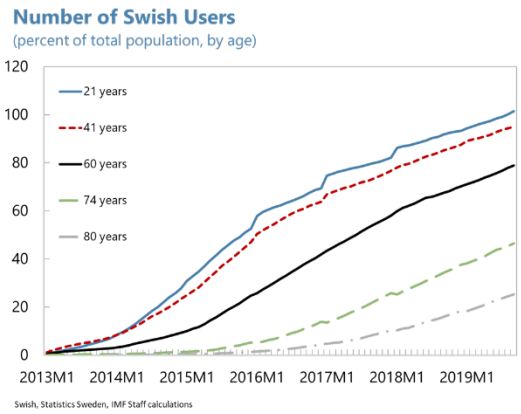
At first glance, the answer is yes: the monthly stock of cash in circulation and the monthly transaction volume for P2P transfers of Swish move together in opposite directions, with a correlation coefficient of [x]. This also appears to be plausible, given that Swish was deliberately targeting P2P transactions often conducted in cash (see below).




Nonetheless, a closer examination finds that the overall observed decline in cash was mainly driven by the decrease in large denomination bills (broadly equivalent to $50 and $100), whereas Swish transaction are mostly of lower value (almost half being for less that about $10). This finding could be interpreted to imply that the extent to which Swish has replaced cash was limited and that cash in circulation decreased because use of cash as a store of value decreased (Engert et al., 2019) or because the Riksbank stopped subsidizing cash (see below). But the wide usage of Swish in small transactions, and the significant value of Swish payments in larger amounts, could also give confidence to users. In this way, Swish could promote a change in payment habits, including less reliance on holding cash for contingencies. In addition, measures of the stock of cash in circulation may be a poor measure of actual cash usage, not least because of uncertainty about the level and changes in the velocity of money.



Finally, we examine the share of the population that adopted Swish over time and across different age groups. The median age of the Swedish population which is around 41. Figure [x] shows that people of this age have rapidly embraced Swish, with younger persons, such as the 21 year olds, showing a similar adoption profile at a modestly higher level after the initial years. Adoption by the 60 year olds was initially slow, but then accelerated in later years to achieve a high share of users more recently. However, older people have been less enthusiastic adopters, with people of 80 years of age still having low adoption of Swish. This suggests that despite the user friendliness and versatility of Swish, some groups of the population are left behind. This could become problematic if cash is not accepted, but, at least in retail transactions, alternatives such as payment by debit cards are still widely available in Sweden.




## III. Determinants of Swish Adoption—Narrative Evidence

There is a large literature examining the factors that help or hinder the diffusion of innovations in payment markets, including of mobile payments. Overall, Swish appears to be a textbook example of how network externalities in the payments market can be overcome, thereby disrupting the payments market in record time. Based on a narrative account of the launch and evolution of Swish (see Appendix), we identify three broad factors that helped promote the diffusion of Swish, two of which are consistent with the hypotheses and evidence of earlier research about what would be needed for mobile payment systems to become widely used (see below).

### A. Strategies to Incentivize User Adoption

Swish initially concentrated on low-value P2P payments, a market segment where there was no easy and convenient digital alternative to cash, as bank transfers usually require knowledge of account and routing numbers of the payee.[8] Mallat (2007) identifies the lack of other payment methods as a critical factor in the user acceptance of mobile payments. When there is unmet demand in the payment sector opportunity costs of using a novel payment instrument are also lower, thereby facilitating the diffusion of innovations (Au and Kauffman, 2007). In addition, Arango et al. (2016) develop a model that suggests that even for low-value payments when consumers have cash at hand, digital payment instruments can be preferred despite the ease of cash usage. The focus on P2P payments also implied that network externalities in a one-sided market (i.e., one where only individuals participated) had to be overcome. This is significantly easier compared to innovations in P2B (peer to business) payments which is a two-sided market and where interdependence between

[8] Checks are not used on the Swedish market making. In 2017, more than 50 percent of P2P Swish payment amounts were below SEK 150 (around USD 15) implying that Swish was mainly used for low-value payments.

customer and merchant acceptance can prevent the diffusion of innovations (van der Heijden, 2002, BIS, 2012).

In addition, Swish P2P payments, which continue to be the dominant type of Swish payments, have been offered for free since Swish's launch. This is in line with Gowrisankaran and Stavin (2003) who hypothesize that pricing below marginal costs is necessary to overcome network externalities. Finally, the Swish app was designed in an intuitive way, making its use convenient and easy. Based on survey evidence, Pousttchi and Wiedemann (XXXX) argue that convenience, in particular 'an easy mobile payment process' is critical for acceptance by consumers. Van der Heijden (2002) also identifies both, pricing and ease of use, as critical factors for consumer acceptance.

### B. Broad Cooperation Among Banks Supported by Incentives to Replace Cash

Broad cooperation among banks was likely another important factor underpinning the rapid and widespread diffusion of Swish. This is consistent with anecdotal evidence presented by Milne (2006) which suggests that the adoption of payment technologies is often easier in small countries with concentrated banking sectors, contrary to standard models of industrial organization which imply that incentives to adopt innovations are strongest in more competitive markets. In turn, Swedish banks already had a long tradition of cooperation and knew well how to set up jointly owned companies in a way that complies with competition law and is incentive compatible.[9]

The belief that cooperation among banks was a precondition for the launch of Swish is also consistent with a simple model presented by Leibbrandt (2004), whereby the benefits of a new payment system depend on its usage, whereas the costs do not. In this environment, the decision of individual banks whether to use and offer a payment instrument is a linear function of their market shares and the number of customers. In the case of Swish, the cooperation of banks led to a very large combined market share of 90 percent, implying that the banks could reasonably expect that from their combined customer base, there would be a sufficient number of adopters to cover their fixed costs.[10]

There was another side effect of the wide cooperation among banks, namely that consumers were likely to trust Swish from the onset, and trust in the security of Swish could not have plausibly been a factor inhibiting its adoption. Shin (2009) presents evidence that in addition to the perceived usefulness and ease of use, users' attitudes towards mobile payment solutions are influenced by perceived security and trust.

Despite the direct financial losses that banks were likely to suffer from Swish, given that P2P payments were offered for free, there were important indirect benefits which could have

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[9] Cooperation among Swedish banks goes at least back to the 1950s when several banks founded a clearing house, Bankgiro.

[10] Banks were planning to only initially offer P2P payments for free and then charge after the introductory period. Market shares are based on the size of the balance sheets of the banks in relation to the banking sector as a total in 2010. One additional bank soon joined and the market share increased to 91 per cent. See https://www.swedishbankers.se/media/2649/bank-and-finance-statistics-2010.pdf for additional details.

incentivized banks to participate in Swish. In addition to increasing the benefits of ordinary accounts, which are the main product of banks, banks also had strong incentives to promote the use of digital payment instruments to allow the gradual phasing out of cash usage.

In the past, the lack of success of electronic wallets was sometimes attributed to the fact that much of the true cost of cash is hidden from consumers, and that the spread of e-money is inhibited by the 'the flagrant underpricing of cash' (Van Hove, 2004). While in Sweden, this may also be the case, the costs of handling and transacting cash are very visible to banks, given that since 2007, the Riksbank stopped subsidizing the distribution of cash by closing its cash depots. At the same time withdrawals from ATMs and over the counter are typically free of charge, further weighting on the costs borne by banks.[11]

Finally, wide bank cooperation meant that all potential regulatory challenges were solved from the onset. The ACH had to notify the financial supervisor about the settlement system but otherwise the ACH and the banks had all the necessary licenses. Swish payment service was a new way of initiating credit transfers, which is otherwise an old and well-known product. The company operating Swish, Getswish, did not require a license from the financial supervisor. It is a technical supplier to the banks and does not enter a customer relation with end users and falls outside of the current regulation.

However, cooperation among banks alone does not guarantee success. Three of the four major Swedish banks launched a card-based e-money card scheme, in 1998 based on beliefs that this type of innovation would save time and lower risks and costs both for merchants and consumers. However, adoption was low, and the project was abandoned in 2004.[12]

### C. The Availability of Complementary Services

The launch and diffusion of Swish was facilitated by the fact that several complementary services with public good features were already available. First, the Riksbank enables real-time clearing 24/7 by using its central settlement system to create a liquidity bridge to the private settlement system underpinning Swish. This liquidity bridge enabled participants in the Riksbank's central settlement system to move liquidity to the private settlement system to fund their payments.[13] This arguably lowered fixed costs and up-front sunk costs of the

[11] Guibourg and Segendorf (2007) show that banks in Sweden tend to use two-part tariffs but that variable costs are poorly reflected in transaction fees charged to consumers. This study is based on data from 2002 but the pricing structure has changed little since then.

[12] See https://www.bis.org/cpmi/publ/d62.pdf and https://www.bis.org/cpmi/publ/d78.pdf for details on this scheme. It failed not least because retailers had to make up-front investments to be able to accept this card and because the benefits relative to existing payment instruments were limited.

[13] The funding of the accounts in the private settlement system (BiR) is done via transfers from the participants accounts in Riksbank's central settlement system (RIX) to a special fiduciary account for Bankgirot/BiR in RIX. Bankgirot then registers the received transfer in RIX into the participant's settlement account in BiR. Payments between banks in BiR then take place as transfers between the banks' settlement accounts in BiR. The sum of funds on all settlement accounts in BiR is thus always equal to, and backed by, the funds in central bank money on the Bankgiro/BiR fiduciary account. The Riksbank has no information of the payment transactions that takes place within BiR.

(continued…)

participating banks. In addition, a common, publicly provided and open underlying platform for settlements constitutes a competition-neutral solution that plausibly lowered risks of coordination failures or competing standards among banks.

Second, ease of signing up required the availability of an electronic identification service. When Swish was launched, this type of service was already available and well established. This implies that new users of Swish could seamlessly and instantly sign up through their online banking systems. This is necessary for a secure first-time identification and to link a bank account to the Swish service. The electronic identification services was free of charge, therefore facilitating further the time and efforts needed to onboard.[14]

## IV. Correlates of Swish Use—Evidence from Individual-Level Survey Data

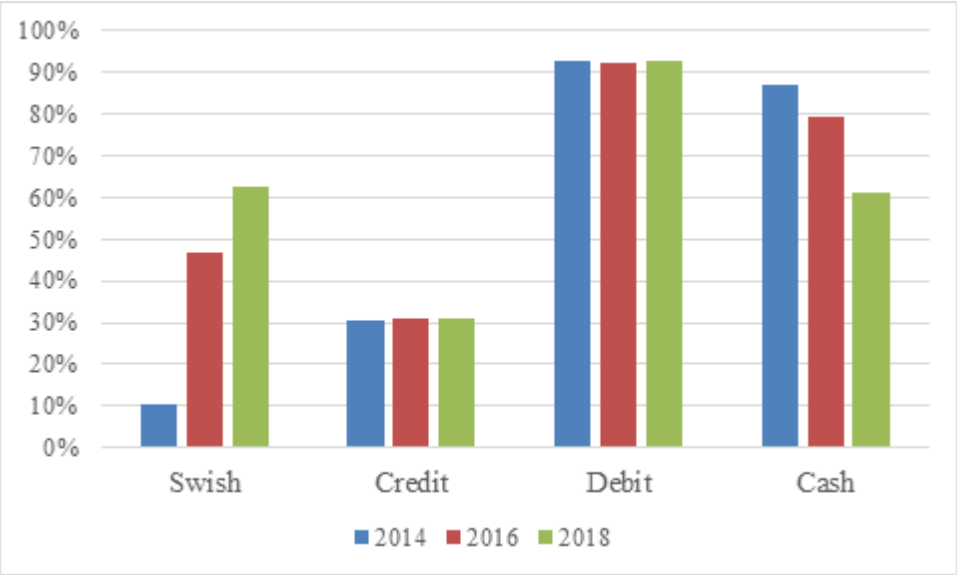
This section examines to what extent individual user demographics affect the decision to use and adopt Swish. To examine the patterns and correlates of Swish use in payments, we use data from a representative survey of individuals conducted by the Risksbank every two years since 2014. The survey covers a random sample of individuals between the ages of 18 and 85.[15] The 2018 and 2016 surveys covered approximately 2,000 individuals that were asked the question about whether they use Swish, while the 2014 survey only included around 1,000. The surveys are repeated cross-sections implying that individual respondents cannot be tracked over time.

The main variable of interest for our purposes comes from the survey question "*Which means of payment have you used in the past month?*". Figure [x] shows that the use of Swish increased significantly over time. While only 10 percent of individuals responded that they used Swish in 2014, in 2016, this number was close to 47 percent and, by 2018, it exceeded 62 percent. In contrast, the use of debit cards was very stable and pervasive throughout this period: roughly 92 percent of individuals used debit cards in the previous month. Given that the use of debit cards and of Swish requires having a bank account, the fact that by 2014 most people used debit cards suggests that the use of Swish was not constrained by access to a bank account. Figure [x] also shows a fairly steady use of credit cards and a declining use of cash, as mentioned before.

[14] A recent report by Citi also underlines the importance of digital identification systems for payment innovations; see https://www.citi.com/tts/sa/flippingbook/2019/the-age-of-consent/gra30727_TTS_age_of_consent/ for details.

[15] Some of the surveys might include individuals younger than 18 or older than 85 but the age groups that the survey focuses on include only those between 18 and 85.

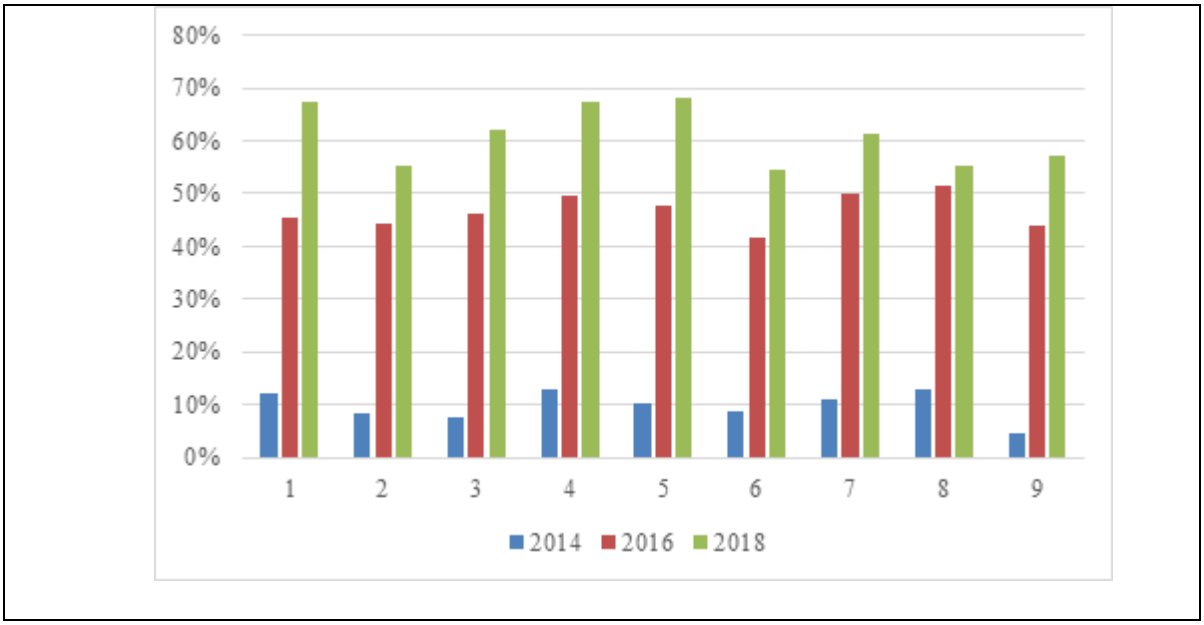
**Figure 1. The use of Swish Relative to Other Payment Methods**




Together with questions about the use of Swish and other payment methods, the survey captures personal information about survey respondents including: age, gender, education level, income, and location.[16] Related to location, Figure ** shows that while for any year there are differences in the use of Swish across 1-digit zip codes, the use over time increased steadily across all regions.

**Figure 2. Use of Swish over Time across One-Digit Zip Codes**

[16] Age is measured in 4 buckets: 18–24, 25–44, 45–64, 65–85. Education levels refers to primary, high-school or university. Income is measured in 4 groups: SEK 240,000 or less, SEK 240,000–SEK 360,000, SEK360,000–SEK 500,000, and more than 500,0000. Location refers to the 1-digit or 2-digit zip code where the individual resides. There is also a variable that captures whether the individual resides in a city with less than 3,000 inhabitants, with between 3,000 and 40,000 inhabitants and with more than 40,000 inhabitants.




To more rigorously analyze the factors correlated with Swish use, we begin by regressing the dummy for the use of Swish on individual-level demographic and socio-economic characteristics that are captured in the survey waves, while controlling for the individuals' location (2-digit zip codes). This is captured by equation (1) below:

$$\text{Probability } (Y_{ijt}=1)= \beta \text{Age}_{ijt} + \gamma \text{Education}_{ijt} + \delta \text{Income}_{ijt} + \theta \text{Female}_{ijt} + \pi \text{Single member household}_{ijt} + \eta \text{Small City}_{ijt} + \mu_j + \varepsilon_{it} \quad (1)$$

where $Y_{ijt}$ is a dummy that equals one when individual i residing in the 1-digit zip code j uses Swish at time t and is zero otherwise. *Age* refers to a series of dummies to control for different age groups: *age 18–24*, *age 25–44*, and *age 45–64*. The age category 65–85 is the omitted category. Education refers to the dummies *primary* and *high school* that equal one for individuals that completed a primary and high school education, respectively. University education is the omitted category. Income includes three dummies for individuals in the *low income (*less than SEK 240,000), *low-middle income* (SEK 240,000–SEK 360,000), and *mid-upper income* (SEK 360,000–500,000) brackets. The omitted category corresponds to individuals with incomes about SEK 500,000. *Female* is a dummy equal to one for women. *Single member household* is a dummy for individuals in households with a single member and *Small city* is a dummy for individuals living in cities with less than 3,000 inhabitants.

We estimate equation (1) as a logit model with 2-digit zip code fixed effects captured by $\mu_j$.[17] Table [x] reports the marginal effects from estimating this model. These capture the increase in the probability of Swish use resulting from a unit change in the regressors. Since these are dummy variables, effectively the marginal effects capture the increase in the likelihood of

[17] This is equivalent to a conditional logit model.

Swish use when a dummy variable switches from 0 to 1. We estimate the model for the pooled sample (i.e., 2014, 2016, 2018) as well as for each separate survey year.

Table [x] shows that the use of Swish is most consistently associated with individuals' age since the age group dummies are significant in the pooled sample and in each of the survey years. This pattern is consistent with the stylized facts generated from Swish enrollment data presented above. Notably, the age group dummies are the only variables associated with Swish use in 2014, at the beginning of the survey sample. The impact of these age group dummies is also quite large. If we consider the pool sample without controlling for year fixed effects, for example, we see that the probability of using Swish, measured on a scale from 0 to 1, is 0.47 higher for a person in the 18–24 age cohort relative to an individual who is between 65 and 85 years old (the omitted category). With the exception of the regression for 2014, the measures of income and the dummies for female gender, and single member household are significantly associated with Swish use. In particular, relative to the highest income bracket, the likelihood of Swish use is between 0.19 and 0.22 lower among individuals in the lowest income bracket. Female respondents have between a 0.06–0.07 higher likelihood of using Swish relative to their male counterparts. In turn, in years other than 2014, individuals in single member households have a 0.04 to 0.10 lower probability of using Swish. These findings are broadly consistent with evidence on the usage of debit and credit cards; see for instance Stavins (2001), Boeschoten (1998) and Mantel and McHugh (2001).

Like other network-based services, such as for example mobile phones and social media, payment services are frequently characterized by exhibiting network effects or externalities where each user's payoff from the use of a product and the incentives to use it, increase as others use it. To investigate whether network effects play a role in the use of Swish, we expand equation (1) by including two different measures of the network of Swish users. First, we include a geographical network measure defined as the share of Swish users in the same 2-digit zip code for each year in the survey. Second, we incorporate a social network measure defined as the share of Swish users within the same age and education cohort in a given year. On top of adding 2-digit zip code fixed effects, to control for the level of financial development that could affect both the network of Swish users and an individual's choice to use this product, we include a variable capturing the share of the population within each | 2-digit zip code area that uses debit cards.

Table [x] shows the estimations exploring the significance of network effects. The results show that both the geographical and social networks of Swish users have an impact on individuals' use of Swish (see columns 1 and 2), even after controlling for the use of debit cards at the zip code level as a measure of digitalization of the payments market in the zip code area (column 4). In terms of economic significance, the results in columns (3) and (4) suggests that the size of the impact of the geographical network of Swish users is twice as large as the impact of the social network. At the same time, the use of debit cards within the zip code seems to have no impact.

## Table 1. Individual-Level Correlates of Swish Use

| | 2014 | 2016 | 2018 | Pooled No year FE | Pooled with Year FE |
|---|---|---|---|---|---|
| 18-24 years | 0.456*** | 0.556*** | 0.472*** | 0.469*** | 0.487*** |
| | (5.84) | (15.43) | (10.30) | (20.34) | (21.72) |
| 25-44 years | 0.346*** | 0.386*** | 0.332*** | 0.346*** | 0.349*** |
| | (6.33) | (20.46) | (14.39) | (25.65) | (23.90) |
| 45-64 years | 0.175* | 0.240*** | 0.206*** | 0.220*** | 0.217*** |
| | (2.30) | (12.11) | (8.73) | (14.48) | (13.10) |
| Primary education | -0.242 | -0.0937* | -0.0680 | -0.111*** | -0.091*** |
| | (-1.93) | (-2.44) | (-1.58) | (-4.09) | (-3.56) |
| High school education | -0.00407 | -0.00270 | 0.00858 | 0.00344 | 0.00334 |
| | (-0.08) | (-0.13) | (0.34) | (0.24) | (0.23) |
| Low income | -0.132 | -0.227*** | -0.194*** | -0.229*** | -0.189*** |
| | (-1.34) | (-5.27) | (-4.10) | (-8.00) | (-7.54) |
| Mid income | -0.0733 | -0.115** | -0.119** | -0.139*** | -0.100*** |
| | (-0.92) | (-3.15) | (-2.94) | (-5.70) | (-4.50) |
| Mid-upper income | -0.0994 | -0.0829* | -0.0486 | -0.0604** | -0.0618** |
| | (-1.13) | (-2.33) | (-1.28) | (-2.63) | (-2.78) |
| Female | 0.0771 | 0.0670*** | 0.0628** | 0.0555*** | 0.0548*** |
| | (1.66) | (3.41) | (2.76) | (4.13) | (4.15) |
| Single member household | -0.00266 | -0.108*** | -0.0549* | -0.0384* | -0.0727*** |
| | (-0.05) | (-4.94) | (-2.10) | (-2.51) | (-4.94) |
| Small city | -0.0317 | -0.0736** | -0.0164 | -0.0214 | -0.0401* |
| | (-0.41) | (-2.59) | (-0.51) | (-1.11) | (-2.11) |
| N | 587 | 1,750 | 1,516 | 4,101 | 4,101 |
| Year | No | No | No | No | Yes |

## Table 2. The Importance of Network Effects in the Use of Swish

| | Controlling for Swish network within 2-digit zip code | Controlling for Swish network within age and education cohort | Controlling for Swish network within 2-digit zip code + Swish network within age and education cohort | Repeating (3) controlling for use of debit cards within 2-digit zip code |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| 18–24 years | 0.218*** | 0.271*** | 0.0934* | 0.174* |
| | (5.99) | (3.58) | (2.20) | (2.31) |
| 25–44 years | 0.154*** | 0.163* | 0.0549 | 0.101 |
| | (6.15) | (2.56) | (1.78) | (1.89) |
| 45–64 years | 0.0951*** | 0.0888* | 0.0292 | 0.0542 |
| | (5.92) | (1.96) | (1.47) | (1.55) |
| Primary education | -0.0392** | -0.0184 | -0.00539 | -0.00998 |
| | (-2.93) | (-0.55) | (-0.45) | (-0.46) |
| High school education | 0.000614 | 0.0158 | 0.00486 | 0.00891 |
| | (0.10) | (1.14) | (1.03) | (0.97) |
| Low income | -0.0833*** | -0.177*** | -0.0599** | -0.113** |
| | (-4.32) | (-7.09) | (-3.16) | (-2.95) |
| Mid income | -0.0450*** | -0.0926*** | -0.0320** | -0.0596** |
| | (-3.35) | (-4.31) | (-2.67) | (-2.59) |
| Mid-upper income | -0.0266* | -0.0575** | -0.0191* | -0.0354* |
| | (-2.30) | (-2.74) | (-2.04) | (-2.02) |
| Female | 0.0249*** | 0.0510*** | 0.0178** | 0.0335** |
| | (3.56) | (4.12) | (2.87) | (2.63) |
| Single member household | -0.0331*** | -0.0671*** | -0.0235** | -0.0437** |
| | (-3.80) | (-4.79) | (-2.94) | (-2.76) |
| Small city | -0.0187* | -0.0374* | -0.0135 | -0.0246 |
| | (-2.05) | (-2.12) | (-1.89) | (-1.84) |
| Use of Swish within 2-digit zip code | 0.373*** | | 0.265*** | 0.518*** |
| | (12.93) | | (4.98) | (3.35) |
| Use of Swish within age and education cohort | | 0.329** | 0.113*** | 0.215* |
| | | (3.07) | (3.37) | (2.45) |
| Use of debit cards within 2-digit zip | | | | -0.155 |
| | | | | (-1.20) |
| N | 4101 | 4101 | 4101 | 4101 |
| Year fixed-effects | yes | yes | yes | yes |

## V. CONCLUSIONS

This paper documents the stellar rise of Swish, which contrary to predictions of the earlier literature and past experiences, overcame any adverse network externalities in the payments market in record time. First, we find that in broad terms, the initial focus on the P2P and low costs helped incentivizing users to adopt Swish. Broad cooperation among banks and the availability of complementary services, including the underlying publicly provided settlement platform and an existing ID verification system provided by the banking sector, were also likely to be critical factors facilitating Swish adoption. Second, we find that people from larger cities that are well off, young, and well educated are more likely to use Swish. This is in line with earlier and more general evidence that the young and affluent are more inclined to use electronic instruments (Leibbrandt, 2004, and Mantel and McHugh, 2001). We also document the existence of network effects whereby usage is highly correlated with usage by others that are socially or geographically close. This is consistent with evidence for the usage of debit and credit cards by a number of earlier papers including Stavins (2001), Boeschoten (1998) and Mantel and McHugh (2001).

Our findings have important policy implications, in particular in light of current policy debates and challenges, including on digital currencies and on the objective of the European Commission and the ECB to promote pan European instant payment solutions. The case of Swish offers useful lessons about how that can (or cannot) be achieved. In addition, the results show that innovations in payment systems risk that some parts of the population are at best slow adopters and are left behind. In the case of CBDC, which could be legal tender, this suggests that the careful design of the interface and strategies to include these groups may be critical. However, some features of the institutional environment and the banking sector in Sweden which facilitated the diffusion of Swish may not exist elsewhere so that introducing payment innovations can be more difficult in other settings.

We leave several issues for future research. While we show network effects played a role in the diffusion process, we did not study their role and nature in greater detail. In particular, future research could examine network economics in the spread of Swish to a greater extent, including to what extent and under what conditions the participation of peers in Swish induces adoption and whether new users are ‘recruited’ by existing users to be able to transact in Swish.

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