Online Selling Adoption: A Real Options Approach

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1 Introduction

E-business has shown dramatic increase in the world of business. According to Statistics Canada (2007), internet use, email use, website presence, and online buying use had an average adoption rate ranging from about 40% to 80% among Canadian businesses. From 2000 to 2007, total online sales of Canadian private sectors increased sharply from CAD 5 billion to about CAD 60 billion which reflects a significant increase in sales and a shift in the importance of the online selling adoption for all sectors. As a proportion of all sales, however, online sales still constitutes a small amount. Online selling adoption rate had an average of only 9% across all Canadian sectors. Not only the proportion of firms selling online is much lower than might be expected from surge to e-business, online selling adoption rates also exhibit considerable variability across sectors ranging from about 0.50% to 30%. Figure 1 shows that the increase in online selling adopters between 2001 until 2007 (as a percentage of the sector firms) is not matching the increase in the value of sales[4]

In addition, 1 shows that some specific sectors with no significant motive for adoption of online selling surprisingly have more online sellers in 2007 than they had in 2001. This raises the question of why these firms decided to sell online and what explain theses differences in the adoption rate across various sectors. This variability in adoption rates across sectors has led researchers to seek explanations about the factors that drive firms to adopt online selling technologies. Some suggest

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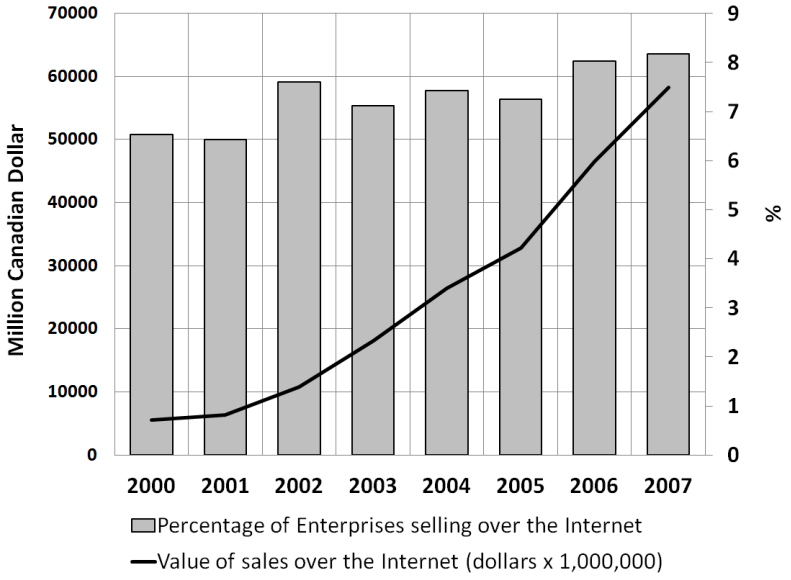
[4]Some of the increase is attributed to inflation. However, the price rising should also induce more sales.

Figure 1: Private Sector Adoption Rate and Value of Online Sales



Source: Statistics Canada, Table 358-00102.

that this variability can be attributed to external factors (e.g business environments) that encourage such adoption. Products characteristics have also been shown to play significant role in the decision not to go online such as sectors that require inter-personal contacts to deliver the product or the service, health care for example. Despite the challenging business environments that some sectors may face, and/or the inherent difficulties in selling their products within the online context, some firms within such sectors have innovated and adapted their products and/or services to sell online[5]. Other emphasizes on the internal organizational capabilities as a significant driving force for online selling adoption.

This paper contributes to this literature by investigating, empirically, the drivers for online selling adoption from a real options perspective. Specifically, we see the decision to adopt online selling as a risky irreversible investment decision. Real options literature shows that such decisions can be analyzed in a way that is similar to the way financial options are analyzed. Before the investment, the firm has a deferral option which has a value under uncertain environment. Option theory provides a way to value this option and, more importantly, determine the optimal timing of exercising the

[5]Basiouni (2012) provides interesting examples of such innovators

Table 1: Percentage of Enterprises selling over the Internet in Canadian Private Sector

Sector [NAICS Sector Code]	2001 (%)	2007 (%)
Utilities[22]	1.380	3.000
Construction[23]	0.710	3.730
Manufacturing[31-33]	11.450	14.690
Wholesale trade[41]	12.540	13.980
Retail trade[44-45]	10.340	12.720
Transportation and warehousing[48-49]	1.790	3.580
Information and cultural industries[51]	19.720	27.340
Finance and insurance[52]	9.440	9.050
Real estate and rental and leasing[53]	6.800	4.850
Professional, scientific and technical services[54]	5.670	6.370
Management of companies and enterprises[55]	3.240	1.740
Administrative and support, waste management and remediation services[56]	10.580	6.120
Educational services[61]	13.920	NA
Health care and social assistance[62]	0.300	2.010
Arts, entertainment and recreation[71]	9.730	23.620
Accommodation and food services[72]	3.730	NA
Other services (except public administration)[81]	3.270	6.590
Public sector	12.220	15.940

Source: Statistics Canada, Table 358-00102.

option, i.e. starting the investment.

The paper is organized as follows: section 3 gives theoretical background on the factors affecting the decision to adopt online selling. Section 3 lay out the research model utilized to investigate this problem. Section 4 describe the data-sets used in the empirical investigation and section 5 presents the results and discuss its implications. Conclusion is given in the last section.

2 Theoretical Background

Much of the research work on IT technology adoption have shown that there are different factors affecting the adoption of IT related activities. In general, these factors can be divided into two main categories: external factors and internal factors. External factors are related to the business environment and product characteristics. On the other hand, internal factors are related to the organizational internal capabilities (see Del Aguila-Obra and Padilla-Melendez (2006) and Basiouni (2012))

The literature has explored many external factors that might impact technology adoption and can help explain the differences seen in the adoption across sectors. Many studies have identified firm's product characteristics (Bakker (2000); OECD (2001); Loane et al. (2004); Loane et al. (2007)), deficiencies in the firms online infrastructure (Loane et al. (2004)), reluctance to change the current business model (Jhon-Huggins (2007)), and associated costs as causes for benefiting from online sales (Loane et al. (2007)). The literature also discusses security issues (Jhon-Huggins (2007); Efrim Boritz and No (2005))

Regarding the internal factors, earlier research studies have pointed to a lack of managerial support (Yap et al. (1992); Boynton et al. (1994)) and employee knowledge (Yap et al. (1992)) in the general information technology context. Others have researched whether the development of internal organizational processes affects e-business adoption (Debbie and Oliver (2011)). Basiouni (2012) provides a recent review on the literature of the internal factors and found that these factors are under-researched in the online selling adoption context. Moreover, he found that the development of internal net-enablement capability is a key issue that characterized successful online sellers compared with non-online sellers, regardless of the level of online selling adoption. Adopters who implemented online selling tools were found to possess better-developed capability compared to non-online sellers across different sectors and different rates of online selling adoption.

The decision to adopt online selling (or to adopt online selling as a new sale channel) can be seen as an irreversible investment decision. Real Options theory shows that such decision embodies various types of real options. The theory has been applied to describe a broad range of investments and industries (for the general theory see Dixit and Pindyck (1994) and Schwartz and Trigeorgis (2004), and for real options in information technology investments, see Benaroch (2002) and Wu et al. (2010)). Examples of such investment are option to wait, option to expand and option to abandon[6]. Real options theory provides both theoretical basis and analytical tools to evaluate the valuable flexibility resulted from these real options.

In this research, we see the decision to adopt online selling as a risky irreversible investment decision. The firm has a deferral option which has a value under uncertain environment. Option theory provide a way to value this option and, more importantly, determine the optimal timing of exercising the option, i.e. starting the investment.

[6]Table 2 in Benaroch (2002) provides a list of real options seen in IT investment with their description and investment features.

Various uncertain factors affect this timing. In a comprehensive framework, Benaroch (2002) explains that to optimally decide about the investment in information technology (IT) investments, one needs to consider various related risk factors which can be grouped into three categories:

- Firm-specific risks which are due to uncertain endogenous factors such as the adequacy of the firm's development capabilities to a target investment.
- Competition risk factors which give rise to the possibility that the investing firm might loss part or all of the investment opportunity.
- Market risk factors which are mainly the result of uncertainty about customer demand for the products or services a target investment yields.

This framework is used in this study to investigate empirically the impact of theses types of uncertainties on the decision to adopt online selling.

3 Research Model

The model of this paper exploit the real option framework suggested by Benaroch (2002) for IT risk management. Thus, it seeks to combine the effect of the three risk categories, firm internal factors, competition factors and market-related risk factors, to predict the online selling adoption decision.

Generally, for a firm to adopt online selling, the following has to be satisfied:

$$\Pi^* = E\left(NPV^{online}\right) - E\left(NPV^{offline}\right) - I > 0 \tag{1}$$

where $E\left(NPV^{online}\right)$ is the expected net present value if the firm adopt online selling, $E\left(NPV^{offline}\right)$ is the expected net present value if the firm chose not to adopt online selling and I is the cost associated to uncertainty about the benefit of online selling or the value of seeking additional information or, in the real option jargon, the value of the option to wait. Given the above framework, I is a function of the three risk categories: Internal factors, competition and market uncertainty.

Regarding the firm internal factors, Wheeler (2002) Net-Enabled Business Innovation Cycle (NEBIC) model is adopted as the framework to measure the strength of a firm internal capabilities. NEBIC model is a theoretical framework for studying the process of implementing e-business tools as technology innovations for business growth. According to the NEBIC model, three interacting

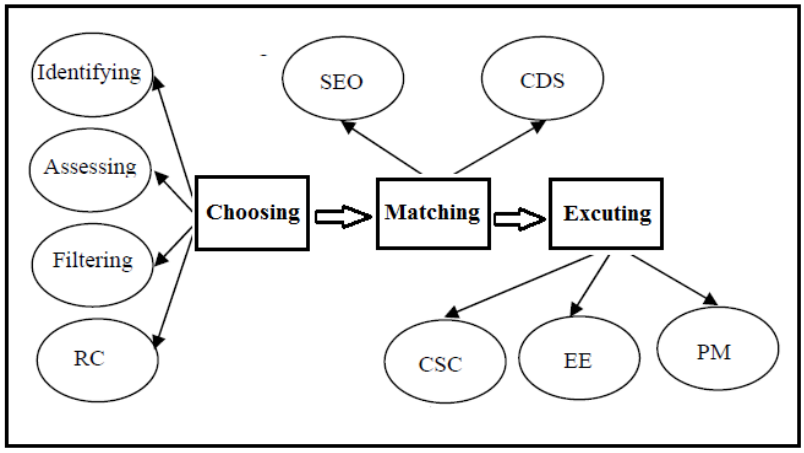


Figure 2: Nebic model: one cycle

constructs were adapted to measure net-enablement capability for technology adoption: (1) choosing enabling technologies; (2) matching proposed technologies with economic opportunities ; and (3) the ability to successfully execute the information technology tool. Each one of the three construct has different dimensions (also called second-order factors, process, or routines) that are measured by different set of questions. The first construct has four dimensions : (1) the ability to identify, (2) to assess, (3) to filter, and (4) to reach conclusions (RC) regarding the timing and viability of the suggested IT tool. The second construct has two dimensions. First, the ability of selecting appropriate economic opportunities (SEO) to create both strategic options and business value from the new technology adoption. Second, a dimension for both continual dialogue and sense-making (CDS) ensures a firms readiness and successful reconfiguration of resources utilizes the use of the new technology with its new economic opportunities from the adoption. The third construct incorporates a dimension for measuring the strength of project management (PM), a dimension for employee education (EE), and a dimension to measure the creation of a supportive culture (CSC) within the firm. Using NEBIC model, Basiouni (2012) has shown that companies which have not adopted online selling have developed less internal capabilities than those which have already adopted online selling and that the difference is significant. .

In relation to the option to wait, the higher the internal capabilities the less the company feel it needs to wait for additional information and, thus, the less valuable is the option to wait. For

example Koundouri et al. (2006) shows that farmers who have better information about farming, which is an example of an internal capability, put lower value on the option to wait and more likely to adopt new technology than others. Accordingly, we form the following hypothesis:

H_1: Companies with higher internal capabilities are more likely to adopt online selling.

For the competition risk, some researchers have shown that strong competition deteriorates the value of the option and, in turn, makes the likelihood for the firm to invest higher than otherwise. For example, Bulan et al. (2003) show that volatility has a smaller impact on the option exercise for real estate developments if surrounded by a larger number of potential competitors. Basiouni (2012) has shown that companies in sectors that are characterized by high rate of online sellers as a percentage from the total firms are more inclined to adopt online selling. Thus, we form the following hypothesis:

H_2: Companies in more competitive industries are more likely to adopt online selling.

Regarding the demand uncertainty, real options literature asserts that the option to delay gains higher value as the demand uncertainty increases (see Dixit and Pindyck (1994) for a general theory, Bulan et al. (2003) for real estate market and Benaroch and Kauffman (2000) for electronic banking expansion). This result implies that higher uncertainty in the product demand makes it optimal to wait and not to invest which leads to the following hypothesis:

H_3: Companies characterized by high demand uncertainty are less likely to adopt online selling

The above discussion implies that I in equation (1) is an increasing function of market uncertainty, decreasing function of the degree of competition and increasing function of the firms level of internal capabilities. Note that equation (1) can not be estimated using the available data-sets because, as shown below, they only observe the market at a single point of time. Instead, we estimate the following reduced form equation:

$$\begin{aligned} Pr[\Pi^* > 0] &= Pr[X_i \cdot \beta_x + Z_i \cdot \beta_z + \epsilon_i > 0] && (2) \\ &= Pr[\epsilon_i > -(X_i \cdot \beta_y + Z_i \cdot \beta_z)] && (3) \\ &= \Phi(X_i \cdot \beta_y + Z_i \cdot \beta_z) && (4) \end{aligned}$$

where X is a set of explanatory variables to account for the variables that might impact the net present value of the investment. Z contains the proxies of the three risk categories. We focus on the impact of the three risk categories on the likelihood to adopt online selling. Given that, the likelihood of firm i to adopt online selling, denoted by $\mathcal{L}_i$ is then:

$$\mathcal{L}_i = Y_i \cdot ln\big(\Phi(X_i \cdot \beta_y + Z_i \cdot \beta_Z)\big) + (1 - Y_i) \cdot \big(ln\,(1 - \Phi(X_i \cdot \beta_y + Z_i \cdot \beta_Z)\,\big) \tag{5}$$

From equation (5) the sample likelihood can be calculated and then maximum likelihood (ML) estimation method is used to estimate the parameters in β_x and β_z.

4 Data Description

This study relies on a combination of primary and secondary data sets gathered from the Canadian markets. The primary data-set of data is taken from a comprehensive survey about the internal capabilities of Canadian companies collected in 2011. The survey is sent to a random sample of Canadian firms to assess the strength of their internal capabilities related to online selling adoption. The firms internal capabilities is measured by a set of questions designed to measure the NEBIC constructs. Among various questions, the survey examines if the firm has adopted online selling. Details about the data gathering, the survey questions and the validity analysis can be found in Basiouni (2012). A total of 811 valid responses were collected. The survey involves a set of demographic variables: the size of the company by the number of employee, the amount of sales in the last year, the company sector based on North American Industry Classification System (NAICS) and the year the company was founded. A total of 20 sectors have been identified. Table 2 provide a summary of this data sets.

The secondary data-sets are obtained from Industry Canada which provides industry statistics on a number of economic indicators using the latest annual data sources from Statistics Canada. The following data sets are obtained for each sector in the identified in the above survey.

- Monthly time series of the value of the gross domestic product (GDP) of each sector.
- Data on the percentage of enterprises with sales over the internet and the barriers of selling online for each sector. The data is extracted from the 2012 survey of digital technology

Table 2: Firms Surveyed and Their Industries Online Selling Adoption Rate

Industry [NAICS]	Sector Adoption Rate	Number of firms survied	Portion of the firms that sells online	
			Yes	No
Agriculture, forestry, fishing and hunting[11]	3.5	13	6	7
Mining, quarrying, and oil and gas extraction[21]	Na	8	2	6
Utilities[22]	Na	10	4	6
Construction[23]	4.8	20	5	15
Manufacturing[31-33]	13.6	105	37	68
Wholesale trade[41]	21.3	36	16	20
Retail trade[44-45]	17	26	16	10
Transportation and warehousing[48-49]	8.2	18	6	12
Information and cultural industries[51]	35.4	45	24	21
Finance and insurance[52]	10.4	11	5	6
Real estate and rental and leasing[53]	8.6	5	2	3
Professional, scientific and technical services[54]	7.8	245	64	181
Management of companies and enterprises[55]	10.3	23	10	13
Administrative and support, waste management and remediation services[56]	11	4	0	4
Educational services[61]	30.2	45	29	16
Health care and social assistance[62]	3.7	14	4	10
Arts, entertainment and recreation[71]	25.5	14	7	7
Accommodation and food services[72]	17.2	2	1	1

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and internet use, barriers to Internet use, by North American Industry Classification System (NAICS). The survey estimates the digital technology use based on a sample of approximately 17,000 private Canadian enterprises.

Using the above data-sets we construct the following variables for each firm of the 811 surveyed firms:

Y_i	Takes on the value of 1 if the firm i sells online and 0 if it does not.
$Capability_i$	This variable measures the level of firm i internal capabilities using NEBIC framework. Note that since NEBIC model is sequential (see figure 2), the relevant construct will then be the last one, i.e. *Execute*. This is because it incorporates the other two constructs. However, to make a full use of the whole information in the three constructs, we apply principal component analysis (PCA) on the three constructs dimensions and then use the first principle component as a measure of the internal capability level of the firm.
$Comp_i$	Takes on the value of 1 if the firm i sector has high adoption rate and 0 otherwise. In the online selling context, the competition in the sector is measured by the sectors adoption rate, the percentage of firms that sell online in a given sector. The classification to high or low is based on the sectors average.
σ_i	Measure the firm i sales volatility. Below, we explain how this is obtained.
Σ_i	Takes on the value of 1 if the firm i sector has high variability and 0 otherwise. This variable is constructed using sectors GDP returns volatility from 2007 to 2011. The calculated volatilities are then classified into tow groups: high or low, based on the sectors average.

Other controlling variables are constructed as following:

$Sales_i$	Measures the value of the firms i sales per employee. It is obtained by dividing the firm revenues level by the size of the firms measures by the number of employees.
$Size_i$	Measures the size of the firms based on the number of employees.
Exp_i	Measures of the firm i experience in terms of the number of years since foundation.
$Unsuitable_i$	Takes on the value of 1 if the firm i sector is not suitable for online selling. The unsuitability of the sector is measured by the percentage of the sector firms that have said online selling is not required to their businesses as the main barrier to go online.

In equation 5, X_i includes: $Sales_i$, $Size_i$, Exp_i, and $Unsuitable_i$ while Z_i includes: $Capability_i$, σ_i, Σ_i and $Comp_i$.

To get a good estimate value of σ_i, which is a measure if the firm sales risk, time series data for each surveyed firm is needed. However, the available data observed a cross section of the firms at single point of time. We follow Koundouri et al. (2006) and use the cross-sectional values of sales to estimate the sales distribution function, and accordingly, the riskiness of the firms sale. First, $Sales_i$ regressed on a set of explanatory sets of variables. That is,

$$Sales_i = x_i \cdot \beta + v_i$$

where $Sales_i$ is the level of the firm revenue. x_i is a set of explanatory variables. The OLS estimates of β are consistent and thus the error estimates are consistent too. Second, the squared error term, $\hat{v}_i^2$ is then regressed on the same set of variables. The fitted values of this regression is then used as estimates of the second moment, i.e. the variance, of each firms sales. We include in x_i the following variables: C_i, $Size_i$, Exp_i and sector dummies. Koundouri et al. (2006) has done similar procedure to study technology adoption in farming industry.

Table 3: Correlation Matrix of Sector-level Variables

	$Comp$	$Unsuitable$	Σ
$Comp$	1.000		
$Unsuitable$	0.068	1.000	
Σ	0.711	0.227	1.000

There are 20 sectors.

5 Results and Discussion

Table 3 presents the correlation matrix for a group of sector-level variables. It shows that the adoption rate of a sector is positively correlated with the sector variability. That is, sectors with high variability are associated with high online sellers. Interestingly, the competition to sell online, measured by the percentage of sector firms that sell online, is not correlated with the unsuitability of the sector. In other words, the low online selling adoption rate in a sector is not related to the unsuitability of online selling to the sector business operations.

Table 4 shows the results of the t-test of means equality for the firm-level variables across the online sellers and non-online sellers. It shows that the difference between the level of the two groups internal capabilities is significant. Online sellers have developed better internal capabilities than non-online sellers. The same table also shows that online sellers tend to be newer relative to non-online sellers. That is, recent companies are relatively more keen to sell online than old ones. Finally, the table shows, however, that the difference between larger companies and smaller ones are not significant. Moreover, the average sales for adopters and non-adopters are highly not significant.

Table 5 shows the estimation results of the maximum likelihood estimation method for the probit model in equation (5). The model has a week fitting (R-squared is 5.5 %) which means that other variables are needed to fully predict the firms online adoption. However, the LR test is highly significant which indicates that the coefficients are highly jointly significant.

Table 4: t-test of Means Equality for Firm-level Variables

	C_i	σ_i^2	Exp	$Size$	$Sales$
The Mean for Adopters ($Y = 1$)	0.622	1.582	17.686	1.662	2.362
The Mean for Non-Adopters ($Y = 0$)	-0.294	1.426	20.716	1.867	2.355
$p - value$	0.002	0.013	0.033	0.054	0.942

Table 5: The Results of Probit Model ML Estimation

Coefficient	Value	z-Statistic	Prob.
Constant	-1.3151	-4.6515	0.0000
$\beta_{Cababilities}$	0.0843	3.6113	0.0003
β_{Comp}	0.3893	1.9189	0.0550
β_{σ^2}	0.2990	2.3314	0.0197
β_{Σ^2}	0.4960	2.5212	0.0117
β_{Exp}	-0.0118	-2.3238	0.0201
β_{Sales}	-0.0004	-0.0062	0.9950
$\beta_{Unsuitable}$	0.4376	2.3148	0.0206
Log likelihood		-380.280	
McFadden R-squared		0.055	
S.D. dependent var		0.480	
LR statistic		44.460	
Prob(LR statistic)		0.000	
Obs with $Y = 0$		396	
Obs with $Y = 1$		221	
Total obs (after deleting missing values)		617	

The table shows that, taking into account the unsuitableness of the sector to the selling over the Internet, the level of the firm size, the level of its revenue and its experience, the firm is more likely to sell online if it has more internal capabilities ($\beta_{Cababilities} > 0$), falls in a highly competitive sector ($\beta_{Comp} > 0$), has high sales variability ($\beta_{\sigma^2} > 0$) or falls in a sector with high variability ($\beta_{Unsuitable} > 0$).

This results support the first (H_1): the hypothesis that firms with high level of internal capabilities are more likely to sell online than those that have week internal capabilities. Firms with strong internal capabilities associate less value to the option to wait even in highly uncertain environment. Firms that are skillful in choosing the potential IT technology, good in matching it with economics opportunities and good in project management will chose to sell online, even under uncertain environment, faster than those which lacks these capabilities.

The results also support the second hypothesis (H_2): the higher the competition for online selling in a sector, the more likely, or the faster, the firms in that sector to adopt online selling. Online selling in such sector becomes a strategic move and, thus, firms will associate less value to the option to wait to gain competitive advantage in the sector market.

The model results seem to not support the third hypothesis (H_3), High uncertainty reduce the tendency of firms to go online. Although β_{σ^2} and $\beta_{Unsuitable}$ are significant, they have positive sines which indicates that, given our data-sets, the higher the firm specific risk, measured by its revenues variability, and the higher the firm sector risk, measured by sector GDP variability; the more likely the firm to sell online. In real option perspective, demand uncertainty reduces the value of the option to wait. One explanation to this result is the fact that online selling helps firms to adjust vary efficiently and less costly in downturn cycles than offline selling. In other words, firms invest in online selling tools as a mean to hedge against the cost of downturn cycles in their business. A similar result, but in different context, has been observed in Koundouri et al. (2006). They found that the grater the variance of profit a farmer faces, the more likely she will adopt new irrigation technology that has efficient water usage which allows the farmer to reduce the production risk in the periods of water shortages.

6 Conclusion

In this paper, the decision to invest in online selling have been analyzed from a real options perceptive using the Benaroch (2002) framework. In particular, the impact of the three risk categories, i.e firm specifics risk factors, the competition risk factors and the demand risk factors, on the decision to adopt online selling. The firm specific risk factors are measured by the Net-Enabled Business Innovation Cycle (NEBIC) model, developed by Wheeler (2002). The competition risk factors and the demand risk factors are measured by the sector adoption rate and sector GDP variability respectively. We found that the firm is more likely to sell online if it has stronger internal capabilities, if it falls in a highly competitive sector, if it has high sales variability or falls in a sector with high variability.

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