

# E-commerce Adoption by Taiwan Entrepreneurs

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## Abstract

*As one of leading countries in the digital economy, Taiwan has a significantly higher number of Internet hosts per capita. With Taiwan's manufacturing sector as a case study, this paper aims to explore the determinants of e-commerce adoption by manufacturers. Drawing on the database of the recent industrial census, the empirical results show that high-quality human capital will benefit firms in engaging in technology-led organizational change, enabling them to further grasp the fruits of e-commerce. This research also confirms the firms with export orientation to have higher incentive to carry out E-commerce. In addition, e-commerce popularity among incumbents, deeply and positively influence adoption of e-commerce by manufacturers.*

## 1. Introduction

Knowledge has emerged as a source of competitiveness and offered a new model for conquering poverty and ensuring economic development. Entrepreneurship has been an engine of economic and social development throughout the world. The role of new information and communication technologies (ICT) and e-commerce in driving the global economy is widely recognized. ICT and the Internet reach many firms and people, have wide geographical coverage and are efficient in terms of time and cost. They facilitate access to markets, commercial information, new processing technologies and knowledge.

Despite having a disproportionately high share of global production and ICT exports, Taiwan, similar to many East Asian countries, has much lower e-readiness than developed counterparts [1]. It should be interesting to unravel whether ICT popularity with incumbents and attributions of firms determine the likelihood of manufacturers adopting e-commerce. Drawing on Taiwan's industrial census datasets,

section 2 explores the determinants of entrepreneurial firms in joining production networks with e-commerce. Section 3 demonstrates the empirical results. In section 4, we summarize our findings.

## 2. E-Commerce adopted by Manufacturing Firms

The 2002 Industrial and Commercial Census conducted by the Directorate-General of Budget, Accounting and Statistics was a simple e-commerce survey of Taiwanese manufacturing and service sectors. Drawing on the data, we empirically explore e-commerce determinants of manufacturing firms. Possible impacts of external characteristics and firm attributions on adoption of e-commerce are examined by means of an econometric model, which takes the following form:

$$EC = \alpha + \beta_1 Firm + \beta_2 D \times Firm + \gamma_1 EXT + \gamma_2 D \times EXT + D + u \quad (1)$$

where a dependent variable,  $EC$ , refers to the degree of E-commerce of the surveyed firm, measured by the ratio of online sales and procurement,  $FIRM$ , the set of firm-specific variables,  $EXT$ , the set of external-condition variables, dummy variable,  $D$  denotes an incumbent firms, takes the value of "1" if the surveyed firm with age beyond two-years old or "0" otherwise, and  $u$  the disturbance term.

The set of firm-specific characteristics variables,  $FIRM$ , includes some theoretically important variables, such as firm size, human capital and knowledge stock.  $EXT$ , the set of external condition variables includes industrial concentration ratio and E-Commerce popularities. The cross-terms of  $D$  with  $FIRM$  and  $EXT$ , are designed to compare the new firms and their incumbent counterparts in their determinants of E-commerce.

We outline the presumption of these variables on the degree of E-commerce as follows, and summarize the measures of each explanatory variable and corresponding summary statistics in Table 1.

**Table 1 Variable definitions and summary statistics**

Variables	Definitions	Manufacturing sector	
		Mean	Std. Dev.
SIZE	Number of employees, taken natural logarithm	4.367	1.408
RDR	R&D intensity	0.024	0.203
WAGE	Average annual wage per worker (NT\$1,000), taken natural logarithm	6.058	0.472
EXR	Export propensity	0.285	0.345
IEU	Propensity of e-commerce adopted by incumbents, taken natural logarithm	0.090	0.103
HHI	Industrial concentration index	0.185	0.177
<i>D</i>	Dummy variable, takes 1 if surveyed firm's age is beyond two years old, and takes 0 otherwise.	0.872	0.334
Sample Size		2603	

**Firm Size (SIZE):** The total number of employees is adopted to proxy firm size (SIZE), taken natural logarithm. [2] argued that larger firms are more likely to adopt new inventions or new technologies, a phenomenon which is also known as the Schumpeterian tradition, or the Schumpeter Mark II Regime [3]. [4] also argued that usually, firms could not instantly recoup all of the benefits from investment in adopted technologies. Therefore, larger firms were in a better position to withstand often protracted time lags before eventually recouping maximum benefit from investment in technology. On the other hand, in the Schumpeter Mark I Regime [3], new and small firms are seen as entrepreneurs or innovators, that eager to test on new ICT technologies. In light of the above mentioned analysis, we can not presume the exact effect of SIZE variable on *EC*. However, for incumbent, we hypothesize that the SIZE variable will have a positive impact on *EC*.

**Research-and-Development Intensity (RDR):** RDR is defined as the ratio of R&D expenditure to sales. R&D intensity is used as a proxy for knowledge stock of a firm. A firm with high R&D intensity may have a strong incentive to adopt e-commerce. We expect that firms with higher R&D intensity will place greater emphasis on external information gathering and,

therefore, hypothesize that the coefficient of RDR variable on *EC* will be positive.

**Human Capital (WAGE):** Average annual wages per worker for surveyed firms are measured in NT\$1,000, taken natural logarithm. We hypothesize that firms possessing higher labor quality or higher ratio of skilled labor are more likely to possess greater human-capital stock, which may in turn, lead to higher average wage levels. [5] argued that a firm associated with high levels of human capital had a greater capacity for undertaking effective organizational change and therefore enjoy the benefits from using ICTs. In light of the above studies, we presume that the higher the manpower quality and proportion of white-collar a firm possesses, the greater their ability to engage in adoption of e-commerce.

**Export Propensity (EXR):** The [6] study of the electronics industry in South Korea found that spatial-allocation structure was an important contributing factor in firm likelihood to adopt computer-network systems so as to enhance internal coordination and production efficiency. Likewise, in this study, we hypothesize that there is a greater firm likelihood to adopt e-commerce if firms have higher propensity in engaging in exports. We, thus, expect that variables EXR will have positive impacts on *EC* variables.

**Intensity of e-commerce Utilization by Incumbents (IEU):** Concerning adoption of e-commerce by new firms, one has to bear in mind that e-commerce-adoption intensity by incumbents may reflect industry-network effect. We measure this industrial-network effort with proportion of firms adopting e-commerce for each of the three-digit manufacturing industry. We hypothesize that *IEU* will have positive effects on *EC*.

**Industrial concentration index (HHI):** We calculate the Herfindahl-Hirschman Index for the four-digit industry classification as a proxy for degree of industry concentration. Where an industry has a higher concentration, this suggests that it is more likely to be dominated by a few firms. By contrast, firms within the industry with a lower HHI value have much less monopolistic power and are, therefore, more likely to engage in keen market competition. For new comer or small firms, high industrial concentration may indicate some common market distortions or asymmetric information. However, it was shown that under an on-line, fiction system (such as e-commerce) where firms can participate in a higher transparent market, firms have equal chance to success, regardless of the real world market structure [7]. Therefore, whether firms in a more monopolistic industrial structure have higher or

lower propensity to adopt e-commerce is still uncertain and will be tested by our empirical model.

### 3. Empirical results

In order to find empirical evidence on influence of new firm attributions and external conditions on adoption of e-commerce, we estimated equation (1) by means of the Tobit model for manufacturing sector. Empirical results are presented in Table 2, showing that  $\chi^2(13)$  reaches significance at the 5 percent level, which suggests that explanatory variables have significantly high explanatory power.

**Table 2 Tobit estimation for E-commerce, 2002**

		Coefficients (Marginal effects)	t-values
Intercept		-2.72**	-3.37
FIRM:	<i>SIZE</i>	-0.06	-1.40
	<i>RDR</i>	0.65**	4.12
	<i>WAGE</i>	0.34**	2.57
	<i>EXR</i>	0.71**	4.14
D*FIRM:	<i>D×SIZE</i>	0.14**	3.05
	<i>D×RDR</i>	-0.51**	-2.81
	<i>D×WAGE</i>	-0.33**	-2.32
	<i>D×EXR</i>	-0.38**	-2.07
EXT:	<i>IEU</i>	1.37**	2.50
	<i>HHI</i>	-0.62	-1.25
D*EXT:	<i>D×IEU</i>	0.13	0.23
	<i>D×HHI</i>	0.54	1.06
D		1.45*	1.69
$\chi^2(13)$		213.34**	
Log Likelihood		-1520.48	
Number of Observations		2,565	

Note: Numbers in parentheses are asymptotic t statistics. Coefficients of industry dummies on both equations are not reported. \*\* indicates statistical significance at the 5 percent level, and \* indicates statistical significance at the 10 percent level.

The coefficient of *SIZE* variable is statistically insignificant and negative, but the coefficient of *D×SIZE* is significant and positive. This implies that the effect of firm size upon e-commerce adopting mainly in the incumbent domain. This empirical result is partially consistent with [2] and [8], indicating that large firms are more capable of absorbing costs of potentially protracted delays in recouping benefits of ICT-related investment.

Both coefficients of R&D intensity variable (*RDR*) and quality of firm human capital (*WAGE*) are positive and statistically significant, but both coefficients of

cross-terms variables, *D×RDR* and *D×WAGE* are negative and statistically significant. However, in case of incumbent firms (dummy variable, *D=1*), both totaled coefficients of *RDR* (0.65-0.51) and *WAGE* (0.34-0.33) remain positive respectively. This empirical result confirm our hypothesis and which suggests that firms possessing higher manpower quality or more intensive R&D activities will demonstrate a higher propensity for adoption of e-commerce. As shown in Table 2, it can be concluded that the adoption of e-commerce by firms is heavily dependent on quality of labor. Under such circumstances, it could be argued that higher labor quality is a precondition to extracting benefits from adoption of e-commerce, especially for these new firms.

In this research, empirical results confirm that *EXR* has a positive and significant impact on EC, but the coefficient of cross-term *D×EXR* is negative and statistically significant. However, the coefficient of *EXR* for the incumbent firms on their *EC* (0.71-0.38) remains positive. This suggests that a firm, especially for a new firm, with more export connection has more incentive to adopt e-commerce. On the one hand, this can be probably attributed to keen competition in international markets, which impels these firms to adopt new transaction technology for efficiency. On the other hand, Taiwanese firms generally serve the export market through joining the global production network, led by flagships, and taking original equipment manufacturing (OEM) and original design manufacturing (ODM) tasks. In order to keep cross-border outsourcing relationships, these export-oriented firms would like following flagships to adopt E-commerce.

Variable *IEU*, which measures intensity of e-commerce adoption by incumbents for each industry, can also be considered as a measurement of external or stock effect of e-commerce. If the majority of incumbents in a certain industry adopt such technology, this would then put very strong pressure on new firms that have not yet adopted such technology to follow suit. Our empirical results in Table 2 confirm such an external-stock effect and a significant network effect. However, the coefficient of *D×IEU* is positive but insignificant. This implies that such effect only weakly determines the incumbents' E-commerce adoption. These empirical results may underlie the fact that new firms have a comparative advantage in adopting E-commerce by taking network-externality.

Finally, industrial concentration is measured in our empirical model by variable HHI. We cannot, however, ensure whether E-commerce will be more widely applied within more concentrated industrial structures

or within more competitive industrial structures. As shown in Table 2, both the *HHI* and *DxHHI* variables have statistically insignificant impact on *EC* in firms of manufacturing industry.

#### 4. Summary and conclusion

Taiwan's vibrant manufacturing sector has actively embraced information technologies. This paper aims to explore the e-commerce adopted by manufacturing firms, and especially targets the difference between new firms and incumbents in the adoption decision. By taking Taiwan's manufacturing firms as case study, this study examines the determinants of E-commerce adoption, including the effects of external conditions and firm's specific attributions.

It is well recognized that firms adopting E-commerce need to persuade their trading partners to use the same transaction system. This may lead to a barrier to technology adoption, derived from significant relationship specificity and technology lock-in effect. However, these barriers can be conquered, our empirical evidences reveal, some firms with specific advantages in plenty of knowledge stock and human capital are able to reduce organizational costs derived from using e-commerce.

This result confirms that high-quality human capital will benefit firms in engaging in technology-led organizational change, enabling them to further grasp the fruits of e-commerce. This research also confirms the firms with export orientation to have higher incentive to carry out E-commerce. This may be attributed to pressure from keen international market competition and requirements from client firms—the flagships of global production networks.

In addition to firm attributes, external conditions considered by this paper include industrial concentration and popularity of e-commerce adopted by incumbents. In many aspects of business operations, industry-specific external-stock effect plays an important role in enhancing e-commerce. However, our study could not demonstrate that a more competitive industrial structure will induce firms within the industry to more aggressively pursue the latest ICT developments.

More interesting, the empirical evidence underlines the significant difference between the new firms and their incumbent counterparts in adopting e-commerce. In general, the external or stock effect of e-commerce

is insignificantly different between both new firms and incumbents in adopting such information technology. However, new firms have the disadvantage derived from lacking of business experience, which may be part of knowledge stock in some way. This seems to discourage new firms to use the new transaction technology. For compensating their disadvantages, new firms need aggressively to improve their knowledge stock and human capital in order to overcome such barriers. The evidence may imply that firm-specific conditions in the knowledge stock and human capital more importantly determines e-commerce adoption by new firms.

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