

Internet and firm development

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171

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Abstract

Purpose – This paper aims to provide a survey of existing literature on the economic impacts of the internet on firm development, and outlines an overall framework of the existing studies. The purpose is to show how the internet affects firm development, which may help policymakers and other researchers to have a better knowledge of existing research characteristics, problems and future directions.

Design/methodology/approach – The authors review the studies on the economic impacts of the internet on firm characteristics and external environment, identify the characteristics of the existing literature and problems and discuss the directions of possible future research.

Findings – The authors find that the impacts of the internet on firm development mainly display two relevant mechanisms (firm characteristics and external environment), and they can be grouped into six channels (firm innovation, firm business mode, firm performance, firm productivity, firm import and export trade and firm location selection).

Originality/value – This study builds up a framework of how the internet impacts on firm development, which can add value to the future research of firm intelligent transaction modes in the crowd intelligence network.

Keywords Economic impacts, Firm development, Internet technology

Paper type Literature review

1. Introduction

Internet applications have revolutionized transactions among firms and their final consumers, with the successful implementation of new information technologies such as the internet of things, big data and cloud computing (Ghasemaghaei and Calic, 2019). In recent years, a large literature has analyzed the effects of internet usage on firm development. As a key determinant of firm development, the internet is widely accepted to lower firm transaction costs and improve firm productivity and performance, as well as increase firm

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trade efficiency and affect firm location selection. For example, internet technologies can reduce search and communication cost, improve firm production and trade productivity and accelerate firm innovation and firm agglomeration (Mack, 2012; Luo *et al.*, 2014; Paunov and Rollo, 2016; Dinerstein *et al.*, 2018; Fernandes *et al.*, 2019; Wang *et al.*, 2019).

However, internet usage may have negative effects on firm development as well. Some literature proves that the internet is not beneficial for firm development in a certain period or region. For example, Bertschek *et al.* (2013) find that the internet does not improve German firms' labor productivity in its early implement stages. Haller and Lyons (2015) show that the internet cannot significantly affect the productivity and productivity growth of the Irish manufacturing firms, unless it is used at relevant specific application scenarios, such as firms' advanced internet communication applications in services. They indicate that internet technology applications require the bearing of substantial costs by firms, especially in the short run. It is, hence, a necessity to examine whether the construction of internet communications infrastructure would affect firm development.

Research on the economic effects of the internet on firm development is quite fragmented and unsystematic. Hence, the objective of this paper is to carry out a structured overview of the extant literature on the relationships between them. To obtain appropriate guidelines for policymakers in China, we focus on literature that attempts to investigate the economic effects and mechanisms of the internet on firm development. Then, we discuss the following issues:

- Does the internet have a significant positive effect on relevant economic indicators of firm development?
- How does the internet affect firm development and what are the mechanisms?
- This paper builds up a framework that brings together the heterogeneous and fragmented extant research to answer these questions. Finally, we summarize the main conclusions, which may help policymakers and other researchers to have a better knowledge of the main research gap in the existing literature.

The remainder of this paper is organized as follows. Section 2 of this paper analyzes the economic impacts of the internet on firm characteristics such as innovation, business mode, performance and productivity. Section 3 reviews the economic impacts of the internet on a firm external environment. Section 4 summarizes the framework. Section 5 is the conclusion.

2. Economic impacts of the internet on firm characteristics

Information and communication technologies (ICTs) have substantially transformed firm production and operation environment in the past few decades. One of the key ICTs in recent year is represented by the internet, which is pervasive within firms and outside firms external environment. The internet has become a fundamental tool of firm development and its applications and usage can affect firm internal characteristics such as innovation, business mode, performance and productivity. Meanwhile, it can also affect the firm's external environment, such as import and export trade and location selection.

2.1 Firm innovation

The internet can improve the extension of firm innovation networks and open innovation resources. Kaufmann *et al.* (2003) investigate the effects of the internet on Austrian firm innovation networks in 2001. By conducting a survey of approximately 2,000 Austrian firms, the authors find that the internet is more beneficial for keeping communication among already established innovation partners on the national level than for searching new innovation partners on the global level. Moreover, they show that the internet for searching

new innovation partners has become important with decreasing face-to-face communication. [Henkel \(2006\)](#) focuses on firm open innovation resources. Using 268 firm-level data collected from developers in the field of embedded Linux, the author concludes that the firm reveals selectively about half of the developed code to the public and makes efforts to hide the other half in the internet open source software. He suggests that smaller firms can benefit more from open innovation processes if selective revealing is practiced deliberately.

Internet technologies increase the probability and competency of firm innovation not only in developed countries or regions, but also in developing and emerging countries. [Soto-Acosta et al. \(2015\)](#) use Spanish manufacturing small and medium enterprises (SMEs) data to analyze the impact of internet technologies on firm innovation and factors affecting e-business. They find a positive impact of e-business usage on firm innovation and firm innovation has a mediating effect on the relationship between e-business and firm performance. [Paunov and Rollo \(2016\)](#) use firm-level panel data of 50,013 firms across 117 developing and emerging countries from 2006 to 2011 to examine the impact of the internet on firm innovation performance. The estimation suggests that internet usage brings about knowledge spillover effects on firm innovation performance and productivity. [Allgurin \(2017\)](#) explores the heterogeneous impact of the internet on firm innovation in rural and urban areas by using more than 2,000 Swedish firms survey data. He finds that broadband increases the probability of firm innovation and firms in an urban area tends to be more innovative than firms in rural places. [Ghasemaghaei and Calic \(2019\)](#) use 280 middle and top-level manager data of US firms collected in 2018 to investigate the impact of big data on firm innovation. By using the mediating effect test method to analyze the survey data, they support that variety, veracity and velocity, except the volume of big data have positive impacts on firm innovation competency. While prescriptive insight of big data does not affect firm innovation competency, descriptive and predictive insights do improve it.

Research in China also supports that the internet could affect firm innovation value network and innovation strategy, as well as an innovation resource. [Cheng \(2013\)](#) analyzes the influence of the internet on the innovation path of the firm value network. She establishes a model of firm innovation behavior under the background of the internet economy, with three positive feedback mechanisms, namely, firm innovation and industrial status, network value and node innovation and hardware and software innovations. She suggests that the internet affects the firm innovation network by changing three major factors of firm value network innovation. [Luo et al. \(2014\)](#) apply the case study method to study the mechanism of Tencent WeChat's dynamic capability on its innovation strategy in the period of mobile internet. The results show that WeChat innovation strategy under the effect of the mobile internet can be reflected in three ways, namely, catching the period of shifting toward mobile internet, dynamic capability and the quality control of collaborative innovation and micro-innovation. [Chi et al. \(2018\)](#) estimate the impact of internet usage on the relationship between municipal governors' turnover and micro-firm innovation. Using 2,197 micro-firm data of 17 prefecture-level cities in Shandong province, they find that internet usage can significantly improve micro-firm innovation vigor during the period of municipal governors' turnover. The mechanisms show that internet usage increases the accuracy and effectiveness of micro-firm to obtain information, which is helpful for the micro-firm to timely adjust innovation policy in response to the "gap year" of governors' turnover. Moreover, the application of the internet can significantly expand the innovation openness of micro-firm.

Finally, the main results of the reviewed nine papers studying the economic impacts of the internet on firm innovation are presented in [Table I](#).

Authors	Data	Methodology	Main results
Kaufmann <i>et al.</i> (2003)	204 Austrian firms	Questionnaire survey	The internet improves existing innovation networks Internet effects are cumulative Weak effect of the internet on the innovation process
Henkel (2006)	268 firm data in embedded Linux	Multi-variate analysis	The internet brings about open innovation resources Small firms benefit more from external development support Firm is beneficial if selective revealing was deliberately
Soto-Acosta <i>et al.</i> (2015)	175 Spanish manufacturing SMEs data	Structural equation modeling; and partial least squares	The internet affects SMEs innovation E-business benefits from using internet technologies Firm innovation has a mediating effect between e-business and firm performance
Paunov and Rollo (2016)	117 developing and emerging countries 50,013 firm data	Country-year fixed effects; and quantile regressions	Positive impact of the internet on firm innovation performance The internet only benefits firms with productivity levels above 50th percentile internet use promotes inclusive innovation
Allgurin (2017)	More than 2,000 Swedish firms	Logistic regression Maximum likelihood	Broadband internet positively impacts firm innovation activity Firms located in urban areas are more innovative Broadband connection can help the firm obtain other types of knowledge and market
Ghasemaghaei and Calic (2019)	280 US firms	Mediating effect test; and partial least squares	Big data characteristics (variety, veracity and velocity, except volume) positively affect data-driven insights Data-driven insights (descriptive, predictive and except prescriptive) positively affects firm innovation competency
Cheng (2013)		Theoretical modeling	The internet changes firm innovation ability and firm innovation networks Establishing three positive feedback mechanisms
Luo <i>et al.</i> (2014)	Tencent WeChat	Case study	Mobile internet affects WeChat innovation strategy Tencent WeChat's dynamic capability supports firm innovation adjustment
Chi <i>et al.</i> (2018)	2,197 China micro-firm data	Mediating effect test	Internet usage improves micro-firm innovation vigor during municipal governors' turnover

Table I.
Effects of the internet on firm innovation

2.2 Firm business mode

With the unprecedented development of the internet and e-commerce in recent years, great changes have been taken place in a firm business environment. Firm market demand and its working mechanisms had become more complicated, which made the firm manager seriously thought about how to be integrated with the internet to keep a competitive advantage in the fierce competition of the internet business environment. The impact of the internet on firm business modes lied in the emergence of new economic modes, such as platform economies and sharing economies, and the literature review of them are, respectively, depicted in [Tables II](#) and [III](#).

2.2.1 Platform economies. [Rochet and Tirole \(2006\)](#) make a definition of two-sided markets by providing a roadmap, taking advantage of the fact that the internet platform economy is based on two-sided markets. They suggest that price structure is a determinant in two-sided markets, and the platform firm should be designed with a reasonable price structure to attract participants to enhance its competitiveness. [Haucap and Heimeshoff \(2014\)](#) analyze competition characteristics in three typical internet platform firm markets,

Authors	Methodology/theory	Main results
Rochet and Tirole (2006)	Building a model encompassing internet usage and membership externalities	Make the definition of two-sided markets Price structure is a determinant in two-sided markets Price principle is replacing “cost” by “opportunity cost”
Haucap and Heimeshoff (2014)	Competition theory	The leading internet platforms, such as Google and Facebook, have non-temporary market power Policymakers would still need not to make market regulation
Dinerstein et al. (2018)	Consumer search and price competition theory	Homogeneous impact on product categories and short-and longer-run effects of eBay’s platform eBay’s platform design is effective on a narrow, yet well-defined product category
Qu et al. (2013)	Bilateral market theory; and network externality	Service price of platform firm depends on network externality The impact of network externality can be reduced through connectivity and modular operation
Sun et al. (2017)	NEIO method	Internet platform firms do not have obvious market power The large internet platform firm may not cause welfare losses of consumers
Su et al. (2018)	Monopoly competitive advantage theory	The market structure of internet platform firm presented the characteristics of “hierarchical monopolistic competition” Monopoly exists in large firms, while competition exists in small and medium-sized enterprises
Wang et al. (2019)	Building a sorting mechanism model	Sorting mechanism can effectively solve some product quality problems in Taobao Different sequencing methods have different influences on firm quality choice

Table II.
Effects of the internet
on firm business
mode: platform
economies

Table III.
Effects of the internet
on firm business
mode: sharing
economies

Authors	Methodology/theory	Main results
Botsman and Rogers (2010)	Collective consumption and shared resources	Social media and wireless networks can meet customers' need at an exact moment Collaborative consumption affects consumer behavior and maybe a fully-fledged economy
Martin (2016)	Sustainability transitions and framing theory	There are two distinct perspectives of sharing economy Sharing economy may be blocked if it were reframed as an economic opportunity
Jing and Sun (2018)	QCA	Sharing of products, sharing of services and restraint mechanisms can cause negative externalities Propose three recommendations to ensure the sound development of the sharing economies
Jin (2013)	OLS estimation	Social capital improves the knowledge sharing level of Zhihu users The impact is a dynamic relationship
Li and Liang (2016)	Long-tail theory; game theory; and principal-agent theory	Crowdsourcing is an important form of sharing economy Human resource crowdsourcing stimulates the development potential of SMEs
Didi policy research institute (2017)	Investigation study	Didi platform boosts employment Most drivers are part-time jobs and the employment of Eastern provinces are the largest
He <i>et al.</i> (2018)	Multi-disciplinary research paradigm	Cluster competitiveness affects the economic resource allocation of cluster sharing firms Cluster selection force affects cluster firm economic sharing behavior

Note: QCA = Qualitative comparative analysis; OLS = ordinary least square

namely, search engines (Google), social networks (Facebook) and online trading platforms (Amazon and eBay). From a competition theory perspective, they find that these leading internet platforms have non-temporary market power and policymakers still need not to make market regulation beyond general competition law rules. [Dinerstein *et al.* \(2018\)](#) use a platform firm design at eBay and its detailed browsing data to empirically examine the trade-off between guiding buyers to their most desired product and strengthening seller incentives to lower prices. The results show that eBay's platform design has a great impact on homogeneous product categories, and the short-run effects of platform firm design are quite different from the longer-run. An equilibrium model of consumer search and price competition in eBay's platform firm design is effective only on a narrow, yet well-defined, product category.

Literature analysis of platform economies business mode in China has recently focused on the impacts of the internet on platform firm competition environment, market power and market structure and quality choice. [Qu *et al.* \(2013\)](#) consider the pricing and competition mechanism of e-business platforms based on the theory of the bilateral market and establish the competition mode of e-business platforms by taking network externality into account. The results show that the service price of platform enterprise depends on network externality. Meanwhile, the market structure of e-business platform enterprises has characteristics of competitive monopoly under the background of the knowledge economy with technological innovation. [Sun *et al.* \(2017\)](#) apply a new empirical industrial organization (NEIO) method to

measure the market power of the internet platform firms and to determine its welfare loss. By using data of 20 large e-commerce companies, they find that the internet platform firms do not have obvious market power, although the internet industry has formed a scale economy. The authors also suggest that there exists a phenomenon of scale effect and competitive vitality co-existence in the internet platform market, and the large internet platform firms may not cause the welfare losses of consumers. [Su et al. \(2018\)](#) focus on the market structure characteristics and formation mechanism of the internet platform firm behavior. The study shows that the market structure presents the characteristics of “hierarchical monopolistic competition,” with large firms and small and medium-sized firms compete and flow. The platform firm business mode of the internet industry exists in a special market structure environment of monopoly competition. A monopoly exists mainly in the main business of large firms, while competition exists mainly in the derivative business of small and medium-sized firms. They achieve the long-term equilibrium of the market structure. [Wang et al. \(2019\)](#) examine how the platform influences firm quality choice as firm scales expand continuously. By building the sorting mechanism model and combining with a sample data of sunshade and display in Taobao, they find that the sorting mechanism can effectively solve some product quality problems in Taobao. Further analysis shows that different sequencing methods, such as quality priority ranking, a comprehensive ranking of quality and credit, bidding ranking, have different influences on firm quality choice.

2.2.2 Sharing economies. [Botsman and Rogers \(2010\)](#) explore the internet economic modes based on collective consumption and sharing resources. By taking Freecycle, eBay, Zwaggle, Swaptree and many other platform firms, for example, they suggest platform firms can use social media, wireless networks and data to meet customers’ needs at the exact moment. Moreover, collaborative consumption on the internet economy greatly impacts consumer behavior and maybe a fully-fledged economy in the next few years. [Martin \(2016\)](#) points out that successful internet usage of Airbnb and Uber at Silicon Valley has catalyzed a vibrant sharing economy discourse. They conclude that the sharing economy may unlikely to drive a pathway to a sustainable economy if it were reframed as an economic opportunity by regime actors. [Jing and Sun \(2018\)](#) examine the source of negative externalities in the sharing economies by using qualitative comparative analysis (QCA) method. They find that three sources can cause negative externalities in the sharing economy, namely, sharing of firm products, sharing of services and restraint mechanisms. Finally, they propose three recommendations to ensure the sound development of firms in the sharing economy.

Recent studies of sharing economies’ business mode in China concentrate on knowledge sharing, crowdsourcing, employment of the sharing platform firm and co-creating values of clustered firms. [Jin \(2013\)](#) explores the dynamic relationship between knowledge sharing and social capital in Zhihu, which is one of the largest online question-and-answer community firms in China. Using 1,271 data of questions, answers and dynamic information in Zhihu users, she finds that social capital significantly improves the knowledge sharing level of Zhihu users under the internet environment. Moreover, the impact of social capital on knowledge sharing among Zhihu users is dynamic and heterogeneous. [Li and Liang \(2016\)](#) shed light on the impact of the internet on human resource crowdsourcing using the long tail theory of the sharing economy, game theory in crowdsourcing and principal-agent theory. They point out that human resource crowdsourcing is helpful for integrating idle human resources, seizing the long tail of the SMEs’ human resource market, stimulating the development potential of SMEs. [Didi policy research institute \(2017\)](#) investigates the impact of sharing economies on employment on DiDi platform. The survey reveals that DiDi platform fosters the employment of about 1.37 million zero-employment family members and 1.33 million unemployed people. Meanwhile, most drivers on DiDi platform are taking it

as part-time jobs, and the employment on the Didi platform is positively correlated with regional economic development. [He et al. \(2018\)](#) study the sharing economy mode of cluster firms by integrating theories of firm sharing economies, industrial cluster and social entrepreneurship. They indicate that “cluster competitiveness” affects the economic resource allocation of cluster firms, while “cluster selection force” can evaluate the social value of cluster firm economic sharing behavior.

2.3 Firm performance

A large strand of studies supports the idea that the internet significantly improves firm performance. [Zhu and Kraemer \(2002\)](#) study the relationship between e-commerce capability in internet-enhanced firms and firm performance, using 260 manufacturing firms in the USA. The results demonstrate that e-commerce capability significantly improves firm performance, and indicates that traditional firms should enhance the resource complementarity between their existing information technology infrastructure and e-commerce capability. [Akerman et al. \(2015\)](#) use data of Norwegian firm workers from 2000 to 2008 to analyze the effect of broadband internet on firm performance, as well as wages and employment of skilled workers. They find broadband internet positively impacts skilled worker wages, and then increases firm performance. Meanwhile, the result indicates that the firm outputs can increase 0.4 with the raising 10 per cent of broadband availability. [Yang and Liu \(2018\)](#) focus on the impact of the internet plus in China on traditional enterprise performance, based on 5,004 listed firms from 2013 to 2015. The study shows that the internet plus increases firm performance with an average of about 31 per cent in earnings per share and 24 per cent in return on assets. The mechanism analysis shows that the internet improves firm performance mainly through differentiation and quality of firm surplus. [Canzian et al. \(2019\)](#) evaluate whether the advanced broadband internet (ADSL2+) diffusion increases firm performance in Italian rural areas. Exploiting an internet infrastructure upgrade policy between 2011 and 2014 for a quasi-experiment, they find that advanced broadband increases total factor productivity by an average of 9.1 per cent and firm performance by an average of 14.8 per cent.

However, there is still some literature concluded that the internet does not play an important role in improving enterprise performance. [Bertschek et al. \(2013\)](#) analyze the causal links between the internet and German firm performance by using survey data from more than 4,400 German firms from 2001 to 2003. The result shows that the internet does not improve German firm performance in the early stages of the internet. However, the authors suggest the internet might have a positive impact on the firm process or product innovation. [DeStefano et al. \(2018\)](#) assess the impact of the internet on the performance of UK firms in urban regions. Using survey data of 4,871 firms, the estimations indicate that broadband internet increases firm employment and sales rather than firm performance.

In conclusion, [Table IV](#) lists these six papers and provides a brief overview of the effects of the internet on firm performance.

2.4 Firm productivity

Similar to the research of the impact of the internet on firm performance, the studies of the relationship between the internet and firm productivity also cannot come to a consistent conclusion. Most studies conclude that there exist positive effects of internet usage on firm productivity.

[Grimes et al. \(2012\)](#) analyze the impact of different types of internet access on firm productivity in New Zealand. They estimate the ordered probit model of different types of firm internet connectivity, using a sample of 6,060 firms, and prove that broadband adoption

Authors	Data	Methodology	Main results
Zhu and Kraemer (2002)	260 US manufacturing firms	Field study	E-commerce capability improves firm performance Enhance resource complementarity
Akerman <i>et al.</i> (2015)	Norwegian firms from 2000 to 2008	Intention-to-treat analysis	The internet increases firm performance Internet adoption complemented skilled workers in performing abstract tasks
Yang and Liu (2018)	5,004 China listed companies	Mediating regulating effect	The internet plus increases firm performance Differentiation and quality of firm surplus are the mechanisms
Canzian <i>et al.</i> (2019)	Firm longitudinal balance sheet data	DID method	The internet increases firm performance in the rural area The internet increases firm total factor productivity
Bertschek <i>et al.</i> (2013)	4,400 German firms	Instrument estimation	The internet does not increase firm performance The internet may affect firm production process or innovation
DeStefano <i>et al.</i> (2018)	4,871 UK firms	Instrument estimation	The internet increases firm employment and sales rather than firm performance

Note: DID = Difference-in-differences

Table IV.
Effects of the internet
on firm performance

improves firm productivity by around 7-10 per cent. Further analysis shows that these effects are consistent between firms in rural and urban areas, as well as in high and low knowledge industries sectors. Bertschek and Niebel (2016) explore whether employees' mobile internet adoption improves firm productivity, based on a data set of 2,143 German firms in 2014. The analysis shows that mobile internet significantly improves firm productivity when mobile internet is still at a relatively early stage in German. Wang (2016) suggests that the internet plus may improve firm productivity through reducing transaction costs, changing industry supply chain and training human capital. Based on the survey data of the World Bank about 2,848 manufacturing firms in China, the estimation shows that the internet significantly improves firm productivity. Heterogeneity analysis suggests that the internet has weak impacts on firm productivity of the labor-intensive industry. Bartelsman *et al.* (2019) use firm-level panel data from 2002 to 2010, based on a data set containing 117,000 firm-year observations, to investigate the relationship between firm productivity and broadband connectivity. Estimations reveal that the share of broadband connected is positively related to firm productivity except for one country, and this relationship is more important than the significant relationship between product innovation and productivity.

Conversely, some scholars find that internet usage has no positive and significant impact on the improvement of firm productivity. Colombo *et al.* (2013) examine the impact of broadband internet adoption on SMEs' productivity, using a sample of 799 Italian manufacturing and service firms from 1998 to 2004. Principal component analyzes method and two-step system generalized method of moments estimation is used, and they find that both basic broadband adoption and mere advanced broadband adoption do not have significant effects on firm productivity. Haller and Lyons (2015) estimate the effects of

digital subscriber line (DSL) broadband internet adoption on Irish manufacturing firm productivity and productivity growth. The analysis is based on more than 2,200 Irish manufacturing firms' data from 2002 to 2009, and the results show that broadband adoption does not have a statistically significant impact on firm productivity or productivity growth, and only when firms use broadband internet at specific application scenarios, could it obtain an improvement of firm productivity. [Fabling and Grimes \(2016\)](#) use data from New Zealand's longitudinal business database to explore whether ultrafast broadband (UFB) adoption affected firm productivity between 2010 and 2012. Using an IV strategy, the authors prove that UFB adoption does not significantly affect employment and firm productivity growth. However, after making concurrent investments in organizational capital, the firm can obtain productivity growth.

To systematize the insights from the effects of the internet on firm productivity, [Table V](#) points out relevant literature and makes a brief conclusion.

3. Economic impacts of the internet on firm external environment

The external environment is the area or region in which firms conduct their business. Existing research focuses on the changes in the firm's external environment triggered by the growth of the internet. The internet may reduce firm geographical and search costs, thus

Authors	Data	Methodology	Main results
Grimes <i>et al.</i> (2012)	6,060 firms in New Zealand	Ordered probit model	The internet improves firm productivity The effects are consistent in rural and urban areas and in high and low knowledge industries sectors
Bertschek and Niebel (2016)	2,143 German firms	Ordered probit model; and PSM	The mobile internet improves firm productivity The impacts are at the early stage of the internet implementation
Wang (2016)	2,848 China manufacturing firms	OLS estimation	The internet improves manufacturing firm productivity The impacts are weak in a labor-intensive industry
Bartelsman <i>et al.</i> (2019)	117,000 firm-year panel data	OLS estimation	The internet increases firm productivity except for one country Innovations are not related to productivity in the majority of countries
Colombo <i>et al.</i> (2013)	799 Italian firms	Principal component analyzes; and GMM	The internet does not increase firm productivity It depends on three contingent factors
Haller and Lyons (2015)	2,200 Irish manufacturing firms	Two-stage least squares	The internet does not affect firm productivity or productivity growth Only at specific application scenarios can the internet make an effect
Fabling and Grimes (2016)	New Zealand's longitudinal business database	Instrument estimation	UFB does not affect employment and firm productivity growth The impacts are depending on investments in organizational capital

Table V.
Effects of the internet
on firm productivity

Notes: PSM = propensity score matching; GMM = generalized method of moments

promote firm import and export trade. Meanwhile, internet penetration can improve broadband availability in a certain place, especially in rural areas, so that the decision of firm location selection may change.

3.1 Firm import and export trade

As the pioneering research of [Freund and Weinhold \(2002\)](#), more and more scholars have begun to pay attention to the relationship between the internet and trade. However, many early studies mainly focused on this relationship at the national level. After the introduction of heterogeneous trade theory, scholars began to explore the effect of the internet on trade from the firm level.

[Ricci and Trionfetti \(2012\)](#) apply a firm survey data set conducted by the World Bank to test the effect of the internet on firm exports. The results reveal that a firm with better internet communication networks has a higher export probability by about 15 per cent. However, the firm may reduce exports if they suffer from unionization or state ownership. [Yadav \(2014\)](#) looks at the impact of internet usage on firm export and import probability in Sub-Saharan Africa and Asia. He finds that internet usage positively affects firm export and import behavior. However, this impact is subjected to specific conditions and only occurs in manufacturing firms, not service firms. [Fernandes et al. \(2019\)](#) focus on the impact of the internet on firm exports in the pre-Alibaba era in China. Combining firm-level manufacturing panel data with provincial internet penetration between 1999 and 2007, the empirical results show that the internet boosts firm export in China even before the emergence of Alibaba. Meanwhile, they reveal that the internet significantly reduces trade costs and improves overall firm performance.

Chinese scholars mainly support that the influence of the internet on firm import and export trade are positive and promoted. [Shi \(2016\)](#) matches the Chinese customs database with the Chinese industrial enterprise database between 2003 and 2009, and measures the internet by bilateral and bidirectional hyperlinks, to explore the effects and channels of the internet on firm export. He confirms that the internet increases firm export volume, and the mechanisms are that the internet increases the firm export probability and duration, reduces the export price and then improves the export quantity. [Yue and Li \(2018\)](#) introduce the e-commerce platform into the study of firm export on the Alibaba platform. They use three sources of data to test the impact of e-commerce platform applications on firm export from 2000 to 2009. They find that the e-commerce platform has a positive effect on the scale of firm export, which mainly comes from the diversity of export products and the number of exporting countries. Further analysis shows that the e-commerce platform boosts the scale of firm export by lowering the threshold of firm export, increasing transaction matching efficiency and improving production efficiency.

[Table VI](#) shows the literature in this paper on the effects of the internet on firm import and export trade

3.2 Firm location selection

The external environment the firms confront significantly affects their operation address selection. For example, an area with better internet infrastructure construction may increase firm entry possibility.

[Mack \(2012\)](#) uses the exploratory spatial approach to evaluate the causal link between broadband internet and knowledge-intensive firm clusters in the USA. The results highlight that broadband reinforces firm clusters in large urban areas. In addition, the relationship is heterogeneous, broadband internet proves to be effective in areas with good business conditions. [Kim and Orazem \(2017\)](#) analyze the effect of broadband deployment on firm location decisions in the rural US. Based on a sample of 63,341 establishments during the

Authors	Data	Methodology	Main results
Ricci and Trionfetti (2012) Yadav (2014)	Firm survey data set conducted by World Bank 23,789 firms in 52 developing countries	OLS estimation Binary-choice model; and standard treatment effects model	The internet improves the firm export probability Internet usage affects firm export and import behavior The effect occurs in manufacturing firms and not service firms
Fernandes <i>et al.</i> (2019)	China manufacturing firms	DID	The internet boosts firm exports in China even before the emergence of the Alibaba The internet reduces trade costs and improves overall firm performance
Shi (2016)	China customs database; and China industrial firm database	OLS estimation	The internet increases the firm export volume It reduces the export price and improves the export quantity
Yue and Li (2018)	China customs database; and Alibaba China station	PSM-DID	The internet increases the firm export scale The internet can lower firm export threshold, increase transaction matching and production efficiency

Table VI.
Effects of the internet on firm import and export trade

Note: FDI = foreign direct investment

years 1990-1992 and 2000-2002, the authors find that broadband availability increases new firms' entry to rural areas. However, these rural areas tend to be around the metropolitan area and have a greater population density, which suggests an agglomeration economy. McCoy *et al.* (2018) implement a count framework to measure the impact of broadband infrastructure and other influence factors on the location of new business establishments in Ireland. The results indicate that both initial DSL and middle-mile fiber broadband positively affect the firm location. In addition, they show that pre-existing levels of human capital in a certain place, particularly in the high-technology sectors, determine and absorb new business establishments. Wang *et al.* (2018) take an example of community internet firms in Yangzhou City among 2006, 2012 and 2016 to analyze the location selection influence factors and spatial pattern evolution of different internet industries. The results show that the number of internet firms cluster in the inner suburbs of the city, and experience the life cycle of low-high-low form. Wei and Cao (2018) investigate the effect of internet penetration on location selection of Chinese firm foreign direct investment in seven Asian countries. They indicate that host country internet penetration positively affects the location selection of Chinese firm foreign direct investment. In addition, these effects are heterogeneous because the internet penetration of high-income countries affecting firm location selection is larger than low- and middle-income countries.

Studies of the effects of the internet on firm location selection in this paper are shown in Table VII.

4. A summary framework

According to the above literature review, we summarize and outline an overall framework, which is depicted in the diagram in Figure 1. We focus on internal firm characteristics

Table VII.
Effects of the internet on firm location selection

Authors	Data	Methodology	Main results
Mack (2012)	Firm data in 3,109 US counties	Exploratory techniques; and spatial econometric approaches	The internet reinforces firm cluster in urban areas The impacts are heterogeneous
Kim and Orazem (2017)	63,341 firms in the USA	DID	The internet increases new firm entry to rural areas These rural areas tend to be around the metropolitan area
McCoy <i>et al.</i> (2018)	858 firms of 192 urban fields in Irish	Spatial autoregressive model; and the spatial Durbin model	The internet affects the firm location Pre-existing condition also affects firm location choice
Wang <i>et al.</i> (2018)	Community internet firms in Yangzhou	Negative binomial regression model	Internet firms present the largest in the inner suburbs of the city They experience a life cycle of low-high-low form
Wei and Cao (2018)	Firm FDI in seven Asian countries	OLS estimation	Internet penetration affects the location selection of Chinese firm FDI The effects are heterogeneous

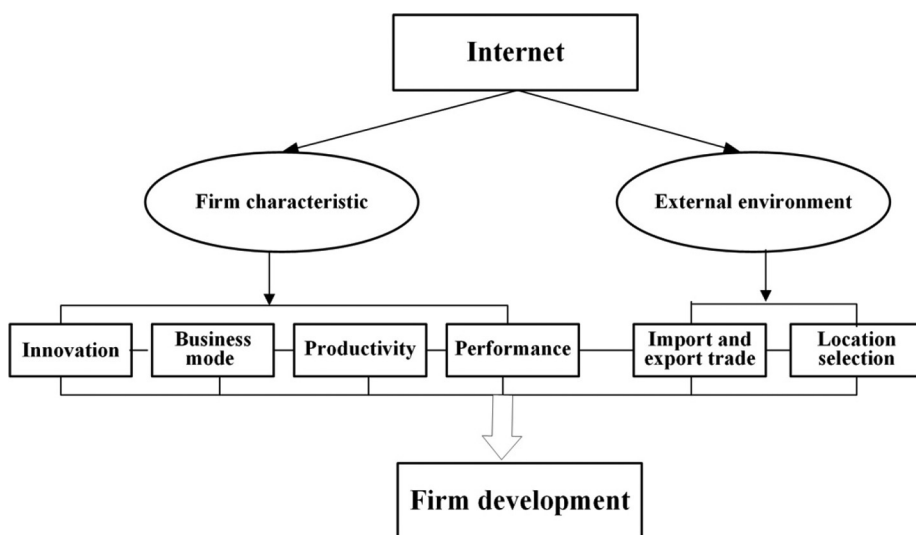


Figure 1.
A framework on the economic impacts of the internet on firm development

(innovation, business mode, performance and productivity) and external environment (import and export trade and location selection) by literature review. The diagram shows the main relationships of internet usage in affecting firm behavior characteristics and providing a better external environment for firm trade or other economic activities. For example, in the crowd intelligence networks, an intelligent transaction can affect firm transaction behavior or activity (Qiu *et al.*, 2019) and provide good external firm development conditions.

Consequently, we analyze the economic impacts of the internet on firm development from the internal and external environment by literature review.

5. Conclusion

This paper provides a survey of existing literature on the economic impacts of the internet on firm development, and finally, outlines an overall framework of their links. The paper aims to show how the internet affects firm development and may help policymakers and other researchers to have a better knowledge of existing research characteristics, problems and future direction.

5.1 Existing research characteristics

From the micro-level analysis, with more and more micro-level firm data available, studies can summarize them to the city or provincial level to find a heterogeneous relationship between the internet and firm development across cities or provinces.

From the macro-perspective analysis, the development of the internet has changed existing research from single level analysis to comprehensive level analysis. For example, more influence factors of firm behavior and external environment are taken into consideration, and more firms across countries or regions are compared and analyzed.

From the methodological perspective, endogenous issue of the internet and firm development has been paid attention to, so as to make the research results solid. Solving the endogenous issue is important because regulation and broadband infrastructure investment could be revised by regulators to reach specific development of a certain area.

5.2 Problems

Existing literature lacks a coherent and holistic framework taking both firm internal characteristics and external environment conditions into consideration. Meanwhile, existing research on the relationship between the internet and firm development mainly just uses a single discipline of economics or management. It still lacks a multi-discipline comprehensive analysis, which may combine with sociology, geography and psychology.

Research on the impact of the internet on firm business mode focuses more on the successful or large state-owned enterprise. However, the internet industry is changing fast and there are many complicated factors affecting firm development, the negative effects should not be ignored.

Micro-level firm data usage is of vital importance to estimate how the internet affects firm development. However, many studies use only a very short period of data for analysis because of the limitation and shortage of relevant data. It cannot explore the dynamic relationship between the internet and firm development.

5.3 Future direction

In general, different speeds of the internet will have different economic impacts on firm development, and [DeStefano et al. \(2018\)](#) points out that some firms may benefit only from advance broadband. As a result, future research should focus on the impact of the differential internet speed on firm development.

The new internet technologies, such as robotics and artificial intelligence, maybe further applied in firm production and management. These technologies may lead to profound changes in terms of firm development, the effects of which can be the topics of future study.

Studies reveal that public subsidies of external internet popularization and investment of internal firm internet applications are beneficial to firms in urban areas, where more and

more firms agglomerate. However, suburban and rural areas may not benefit from this investment, so there is a need to estimate the impacts and cost-benefit of different policies, especially in suburban and rural areas.

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