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Is China uniform? Intra-country differences in the takeoff of new products

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ABSTRACT

Multi-national corporations (wrongly) introduce new products in China rather late. Such a strategy arises because research treats all of China as one monolithic country, thus, finding that takeoff occurs quite late. However, for large or multi-ethnic countries, intra country diversity may be quite high, rivaling or exceeding that among inter country differences of some continents (e.g., Europe). This study examines the takeoff of new products among provinces of China based on data of 30 Chinese provinces on 10 categories over 34 years. Rooted in the theory of institutions and product network externalities, this study tests the drivers of new product takeoff using a discrete time hazard model. The major results are as follows: First, time to takeoff varies dramatically across provinces in China. Second, the average time to takeoff varies substantially between products with strong and weak network externalities. Third, time to takeoff is converging across provinces. Fourth, the intra-country differences in time-to-takeoff are explained by economic institutional variables: economic wealth, trade openness, education, media and transportation infrastructure; and product characteristics: network externalities and year of introduction. Fifth, the vast differences in takeoff of new products across provinces suggest that a waterfall strategy within China might be more profitable.

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1. Introduction

Apple introduced the iPhone in China 2 years after it was introduced in the US², despite high demand in China (Mozur, 2012). In so doing, Apple lost potential revenues to rival brands and smuggled versions of its own brand (David, 2008). Such late introductions of new products in China may emerge from an inter-country waterfall strategy that recommends that new products be introduced earliest in a country where the takeoff of the new products occurs earliest (Chandrasekaran and Tellis, 2008; Tellis et al., 2003). For example, Chandrasekaran and Tellis (2008) rank China as one of the slowest countries worldwide for takeoff of new products. This conclusion emerges from their (and other researchers) assuming China is one monolithic country, where that assumption may not be valid.

The takeoff is the first dramatic and sustained increase in a new

product's sales. It is the point of transition between the introduction and growth stage of the product life cycle (Golder and Tellis, 1997). Understanding the timing and causes of sales takeoff is critically important for industry analysts and managers because a sudden and sharp increase in sales requires enormous resources in terms of manufacturing, inventory, distribution, and support (Tellis et al., 2003).

The existing literature on takeoff considers each country as a single entity, implicitly assumed within-country homogeneity. For example, Agarwal and Bayus (2002) models the takeoff of consumer durables in the United States. Tellis et al. (2003) analyze the takeoff of consumer durables across 16 Western European countries. Chandrasekaran and Tellis (2008) extend the domain to 27 countries, including some developing countries. Everdingen et al. (2009) examine the global spillover of foreign product introductions and takeoffs across 55 countries. Haapaniemi and Mäkinen (2008) analyze the effects of national attributes in the timing of takeoff.

However, for large countries, intra country diversity may be quite high. We use word diversity to refer to the heterogeneity of institutional environments on business systems across provinces (Krug and Hendrischke, 2008). As far as we know, no existing

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² The iPhone (1st generation) was introduced in US on June 29, 2007, while iPhone (3GS) was firstly introduced in China on October 30, 2009.

studies examine takeoff within a country. Relevant literature occurs in the related field of diffusion modeling. Although studies in this area are extensive (Meade and Islam, 2006), most of them typically analyze the process at a national level, ignoring variations within a country. Only a few studies examine how the parameters of the diffusion model vary across intra-country regions (Alderman and Davies, 1990; Ding et al., 2010; Redmond, 1994). Steffens (1998) empirically demonstrates that taking account of regional differences improves both short- and long-term prediction of national sales of a new product under certain conditions. Understanding what factors impact the takeoff within a country provides valuable insights that can aid in designing strategies for launch, pricing, promotion and distribution tailored to the differences.

The present study focuses on the variation in time-to-takeoff between provincial level divisions³ of the People's Republic of China (referred as China, hereafter). We choose China as a domain of analysis for two reasons. First, China is a huge emerging market with the largest population and currently the second largest economy in the world. Second, despite its size, prior research in diffusion, market entry, and product takeoff treats China as a single entity (Chandrasekaran and Tellis, 2008; Hauser et al., 2006).

This study seeks answers to the following research questions: First, how does time-to-takeoff vary across provinces in China? Second, how does time-to-takeoff of various provinces of China compares to that of various countries estimated in prior studies? Third, are the takeoff patterns across provinces diverging or converging to the shortest time or the longest time among provinces? We use "converging" to refer to the decrease in the range of the years of takeoff across provinces, which could occur in the direction of the province with the shortest takeoff or the one with the longest takeoff. Fourth, what drives the variation in time-to-takeoff across provinces: Is economic institutional environment relevant? We examine these issues by studying a heterogeneous sample of 10 categories across 30 provinces in China. This is the most extensive study ever conducted on the growth of new products within China.

To answer these questions, we draw on theories of institutions and network externalities. The acceptance and adoption of new products are inevitably affected by the institutional environment that establishes the framework in which the diffusion takes place (Zhao et al., 2007). Prior literature suggests that the institutional environment is important in the diffusion of innovation (Kshetri and Dholakia, 2005; Lynn et al., 1996). In particular, we look at economic institutional variables, including economic wealth, trade openness, education, media, and transportation infrastructure. While institutional theory emphasizes the effect of institutional environment, it does not include the effect of product characteristic. To compliment institutional theory, we also apply the theory of network externalities.

Our study differs from previous work mainly in two ways. First, it examines the factors that effect within-country variations in new product takeoff at provincial level. Previous studies consider each country as a single entity. However, for large countries, intra country heterogeneity may be quite high. Given the strategic importance of subnational regions (Porter, 1998), this study explores how the differences among within-country regions explains the timing of new product takeoffs. Second, it attempts to contribute to the current body of literature by offering an institutional explanation of new product takeoff. Institutional theory provides a valuable framework to further our understanding of the

phenomenon of new product takeoff within a country. It is different from the rational economic perspective, which emphasizes individual self-interest, conscious decision making, and economic optimization (Shi et al., 2008).

This paper is organized as follows. Section 2 presents the theory and research hypotheses. Section 3 explains the data collection, sources, measures, and model for the analysis. Section 4 describes the results. Section 5 discusses the findings, implications, and limitations.

2. Theory and hypotheses

Our theory is rooted in the theory of institutions and network externalities theory⁴. In the following subsections, we advance general arguments and derive hypotheses for new product takeoff.

2.1. Economic institutions

Institutional analysis defines institutions as 'cognitive, normative, and regulative structures and activities that provide stability and meaning to social behavior' (Scott, 1995) or as governance structures and social arrangements (Williamson, 1985). Institutions constitute the rules of the game, both formal (such as regulations and laws) and informal (such as codes of conduct and norms), that structure the economic, political, and social relationships in a society or country (North, 1990; Scott, 1995). Institutions can reduce uncertainty in transactions between people by providing a structure within societies (Eggertsson, 1990; North, 1990). According to institutional theory, the institutional environment operates at different levels (e.g., country, region, organizational level etc.) (Chan et al., 2008; Griffiths and Zammuto, 2005), provides economic infrastructure, imposes regulations, and defines social norms that set the 'rules of the game' (North, 1990) for both individual and organizational activities (Chan et al., 2010; North, 1990; Scott, 1995).

We regard provinces as territorial entities whose political boundaries coincide with their institutional boundaries (Chan et al., 2010). They shape the development of the regional institutional environment. The acceptance and adoption of new products is inevitably affected by the institutional environment that establishes the framework in which the diffusion takes place (Zhao et al., 2007). The majority of China's population belongs to the same race (BBC News magazine, 2012). Several studies have reported that China tends to be culturally homogeneous relative to large national groups such as United States and India (Gupta and Li, 1999; Jiao, 2001; Li and Shiu, 2012). The political policy and social culture are all very similar, if not identical, across provinces (Li and Shiu, 2012). Hence, we propose the primary reason for the differences of time to takeoff in China's provinces is economic institutional environment.

The development of economic institutions varies across the subnational regions within a country (Chung, 2002; Schlevogt, 2002). Five dimensions of economic institutions play an important role on new product takeoff: economic wealth, trade openness, education, media, and transportation infrastructure (Chan et al., 2008; Douglas and Craig, 2011; Holmes et al., 2013; Orr, 1987; Zhao et al., 2007). Albeit moderately correlated, these five

⁴ We do not include the effect of product price and elasticity of cross price in this study because the data is not available. Some literature explains the effect of these two economic concepts. Golder and Tellis (1997) analyze the effect of price to new product takeoff. Tarn and Hui (1999) study the price elasticity and diffusion of computers. Kim and Srivastava (2007) develop a simultaneous equation model that incorporates the cross-price effects on inter-category dynamics for technological product markets.

³ Provincial level division is the Chinese highest-level administrative division (referred as province, hereafter). Types of provinces include: municipality, province, autonomous region, and special administrative region.

dimensions are relatively independent because they tap different aspects of the institutional environment. At the same time, the five together are relatively exhaustive in determining the key drivers of takeoff as can be ascertained from the literature. We next provide the rationale for each of these dimensions. In the empirical section, we explain the measure for each.

2.1.1. Economic wealth

Economic institutions are those elements that contribute to the constitution of social systems through the allocation of resources and the generation of wealth (Giddens, 1984). The literature on comparative economics, economic history, and institutional economics suggests that institutions determine their economic performance (Hicks, 1969; North, 1990). Economic performance of the provinces influences the adoption decisions of individuals by affecting both their access and purchasing power to products. Economic institutional environment can be thought of as differences in wealth and opportunities that limit consumers' ability to purchase new products. Once new products cross a threshold of performance (Sood and Tellis, 2005), they garner considerable media visibility and generate considerable buzz. Consumers are eager to own the new products both as a prestige symbol and for the benefits that it offers (e.g., iPhone 6 in 2015). The major hindrance to the adoption of new products is affordability. Because they use new technologies that are protected by patents and have not reached economies of scale and experience (Beneito, 2006), new products are pricey relative to their exiting rivals. Thus, wealth of consumers in a country is the primary factor that ascertains the takeoff of a new product in that country. If wealth is sufficiently high, a new product is likely to takeoff. Prior research posits that wealth strongly influences the speed with which inhabitants of a specific country adopt a new product and has a strong effect on time-to-takeoff (Chandrasekaran and Tellis, 2008; Helsen et al., 1993; Tellis et al., 2003). We expect that higher wealth also reduces the time to takeoff of provinces within a country. So, we hypothesize:

Hypothesis (H1): New products takeoff faster in provinces with higher average wealth than in those with less average wealth.

2.1.2. Trade openness

Economic institutions build a system that provides the goods and services consumed by the members of a society (March and Olsen, 1989). The trade openness refers to the extent to which the region is involved in international trade (Leamer, 1988). Open economic institutional environment may speed the takeoff of new products for three reasons. First, economic openness enhances consumer access to a new product, especially at the earlier stages of diffusion. In an emerging market like China, most of the new products, especially products with weak network externalities, such as refrigerator, air conditioner, and microwave oven etc., were initially imported from developed countries. International trade openness lets more consumers observe and access new products, with a faster takeoff as a consequence. Second, exposure to international trade is a powerful stimulus to production and distribution efficiency (Ford et al., 1998; OECD, 1998; Talukdar et al., 2002). Efficiency, in turn, contributes to the reduction in costs of new products, which should make them more affordable to consumers. Third, open economic institutions allow for greater competition among firms. Such competition promotes continuous improvement in product quality, faster reduction in prices, and more aggressive promotions. All these can promote earlier takeoff of products (Golder and Tellis, 1997). So, we hypothesize:

Hypothesis (H2): New products takeoff faster in provinces with more open economic systems than in those with less open economic systems.

2.1.3. Education

Education is a powerful institution that not only helps enrich cultural heritage (Olsen, 1991) but also provides expectations for personal development and occupational achievement (Van Deth, 1995). Educational institutions develop human capital fundamental to technological development and utilization. Accessible educational systems provide individuals with the necessary skills to deal with complicated procedures and issues (Van Deth, 1995). Education also enhances one's ability to receive, decode, and understand information (Lin, 1991). These advantages of education have many benefits for new products. First, individuals with higher education like to be stimulated by news as well as technical information. These activities expose them to a constant stream of new ideas. Second, higher educated people find it easier to understand and evaluate information on new products (Nelson and Phelps, 1966). As a consequence, they are more open to new ideas and more receptive to new products. Third, education connects people to a social network consisting of other educated people. Such connections ensure that they have more opportunities to contact an adopter of a new product. In fact, a general finding in diffusion research is that more highly educated people tend to adopt new products earlier than less highly educated people (Rogers, 1995). So, we hypothesize:

Hypothesis (H3): New products takeoff faster in provinces in which the inhabitants have enjoyed higher education than in provinces in which the in-habitants have not enjoyed higher education.

2.1.4. Media

Economic institutions have the functions of communicating information between transactional parties (Chan et al., 2008). Media institutions are the system of organizations that constitutes the institution of public and mass communication (Miller, 2012; Orr, 1987). It also affects the relative importance of markets vs. governments as allocators of resources (Orr, 1987). A critically important factor in the diffusion and adoption of new products is information about these new products. A primary source of such information, especially in modern economic environments, is the media (Georgiana and Delia, 2013). ~~Media play the role of communicating information between transactional parties within economic institutions (Chan et al., 2008). It also affects the relative importance of markets vs. governments as allocators of resources (Orr, 1987).~~ When products are new and unfamiliar, it is especially important for producers to focus on increasing product awareness (Rekers, 2010). Mass media such as newspapers, TVs, play an important role in creating awareness of a new product among potential adopters (Talukdar et al., 2002). Telephone is also a kind of media which is a widely accepted means of everyday communication in both business and private settings (Cachia and Millward, 2011). By allowing us to transcend a variety of physical and social barriers, the telephone has led to a complex set of dispersed personal and commercial relationships (Katz, 2001). Prior research posits that higher media intensity reduces the time-to-takeoff of countries (Chandrasekaran and Tellis, 2008; Tellis et al., 2003). So, we hypothesize:

Hypothesis (H4) New products takeoff faster in provinces higher in media intensity than in provinces lower in media intensity.

2.1.5. Transportation infrastructure

Economic institutions also have the functions to provide physical, human, and technological infrastructure for economic transactions (Chan et al., 2008). Physical economic infrastructure involves the basic facilities, services, and installations needed for the local economy to function. Transportation infrastructure is very important for the adoption of new products for two reasons. First, the distribution of goods and services is generally efficient in provinces with better transportation infrastructure. An efficient

distribution network can support constant economic development of provinces and reduces end-user price of products (Sharifi et al., 2013). A good transportation network is particularly important for rapid distribution of new products. Second, it is easier for the inhabitants to move in provinces with better transportation system. Mobility has several benefits for the adoption and quick takeoff of new products. One, mobility of inhabitants is one of the important facilitators of interpersonal communication, which plays an important role in the adoption of new products (Krishnan et al., 2012; Mahajan et al., 1990). Two, mobility enhances consumers ability to acquire and disseminate information (Redmond, 1994). When consumers travel to the other provinces, they can get information about new products and take it back to their home provinces. Three, mobility also increases the opportunity for social interaction (Kumar et al., 1998), thus increasing people's impact on information diffusion. That is, people who travel might bring information about new products from their home provinces to visited provinces. Four, mobility also enables passive dissemination of outwardly visible new products. Travelers to less accessible regions may show off their new products purchased in high accessible regions. Alternatively, travelers from less accessible regions may see new products in highly accessible regions. Prior studies indicate that mobility is positively associated with the increase of new product penetration (Gatignon et al., 1989). We expect that the better transportation infrastructure reduces a region's new product time-to-takeoff. So, we hypothesize:

Hypothesis (H5): New products takeoff faster in provinces with better transportation infrastructure than in provinces with poor transportation infrastructure.

2.2. Product characteristics

Based on prior research, product characteristics variables are likely to affect the time-to-takeoff of new products at intra-country level (Chandrasekaran and Tellis, 2008). Two important characteristics are important in product takeoff: product class and year of introduction. We next provide the rationale for each of these characteristics.

2.2.1. Network externalities

We distinguish between two important types of products: products with network externalities and products without network externalities. Due to its significance to industries like communications, entertainment, and technology, network externality has received considerable attention in the past two decades. Network effects can influence adoption and hence the diffusion of goods and services (Church and Gandal, 1993; Peng et al., 2011; Schoder, 2000; Tellis et al., 2009b). There are two kinds of network externalities: direct and indirect network externalities. Direct network externalities exist when consumers derive utility from a product based on the number of other users (Katz and Shapiro, 1985b). Indirect network externalities exist when the expected utility of the primary product increases as more complements become available; In turn, this availability of complements depends on the installed base of the primary product (Stremersch et al., 2007).

From a social perspective, direct network externalities can arise from social influence (Swanson and Ramiller, 2004) and learning (Kraatz, 1998). Quite often, early adopters create a "bandwagon" effect so that potential users would like to follow earlier adopters and become users of the same technology (Economides and Himmelberg, 1995; Rohlfs, 2001; Shapiro and Varian, 1999; Swanson and Ramiller, 2004). Sometimes, it is the information and status of the adopters that generate a social pressure, causing more potential adopters to adopt, thereby reinforcing the

bandwagon pressure. Increased adoption of products with direct externalities will create more opportunities and contacts for potential adopters to overcome barriers and to learn related knowledge, thereby facilitating further adoption (Kraatz, 1998).

For products with indirect network externalities, the number of available complementary goods has a positive influence on the utility of the entire system to the consumer (Church and Gandal, 1992; Katz and Shapiro, 1985a), so drawing more consumers to adopt the new product (Rogers, 1995). In turn, the product consumer heterogeneity and base positively affects complementary companies' decisions to make more kinds of complementary goods available (Church and Gandal, 1993; Gandal, 2002). The more consumers who adopt the product with indirect network effects, the larger is the demand for complementary goods and thus the larger is the impetus for manufacturers of complementary goods to provide them to consumers (Stremersch et al., 2007). This positive feedback loop stimulates the takeoff of the product. Hence we argue that network externality will promote the takeoff of new products with those benefits. So, we hypothesize:

Hypothesis (H6): New products with strong network externalities takeoff faster than products with weak network externalities.

2.2.2. Year of introduction

Year of introduction reflects the changing social and economic context when the products entered the market. The Comprehensive Economic Reform of China started in 1978, represented a change in paradigm and a shift in ideology. True to the historical and cultural traits of China, the early stages of the reform were experimental, limited, and somewhat timid (Hou, 2011). The Chinese economy was still operating mostly under the old planning system before 1992 (Fleisher et al., 2010). A sharp acceleration in China's gradual "growth out of the plan" followed Deng Xiaoping's famous spring, 1992 "South Trip" (Naughton, 1995; Ortmann, 2012; Zhang, 2012). During this trip, Deng reaffirmed his belief in new policies that he had allowed and encouraged, Chinese citizens to follow the profit motive in the quest of personal wealth. After this "South Trip", the country moved much quickly towards an open market economy. With the deepening of market oriented reforms, the market mechanism played an increasing role in China's economic system (Fleisher et al., 2010). Given the availability of a better economic climate after Deng's "South Trip", the diffusion of the benefits of innovations took a shorter time than before. This shift over time led to faster acceptance and takeoff of new products (Clark et al., 1984; Kumar et al., 1998; Wacziarg and Welch, 2008). So, we hypothesize:

Hypothesis (H7): New products whose year-of-introduction is after "South Trip" takeoff faster than products whose year-of-introduction is before "South Trip".

3. Method

This section describes the data collection, measures for the analysis, and modeling of takeoff.

3.1. Data collection

Due to data unavailability and in the interests of consistency, we include only Chinese mainland provinces in this present study. Moreover, as the Chongqing area was given a municipality status from 1997 and data are very limited, we do not include it. Hence, this study involves 30 provincial level divisions: 3 direct-controlled municipalities, 5 autonomous regions, and 22 provinces (See Table 1).

We use the term product broadly to refer to both goods and

Table 1
List of provinces in this study by types.

Types of provincial level divisions	Description	Provincial level divisions
Municipality	A higher level of city directly under the administration of Chinese central government	Beijing, Shanghai, and Tianjin
Autonomous region	Minority entity which has higher population of a particular minority ethnic group	Inner Mongolia, Guangxi, Ningxia, Tibet, and Xinjiang
Province	Standard provincial region of China	Anhui, Fujian, Gansu, Guangdong, Guizhou, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Qinghai, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, and Zhejiang

services. We selected ten products in this study. The products with weak network externalities are: refrigerator, air conditioner, motorcycle, camera, and microwave oven; the products with strong network externalities are: color TV, VCD, computer, Internet, and mobile phone (Doganoglu and Grzybowski, 2007; Stremersch et al., 2007). In total, we succeeded in obtaining data on 255 product–province combinations (See Fig. 1 for examples).

The market penetration and explanatory variables were collected mainly from publications of the National Statistical Bureau of China and Statistical Bureau of each province, which mainly include:

- China Statistical Yearbooks.
- China Rural Statistical Yearbooks.
- China Light Industry Yearbooks.
- China Population Statistical Yearbooks.
- China Social Economic Yearbooks.
- Statistical Yearbooks of each province.
- Rural Statistical Yearbooks of each province.

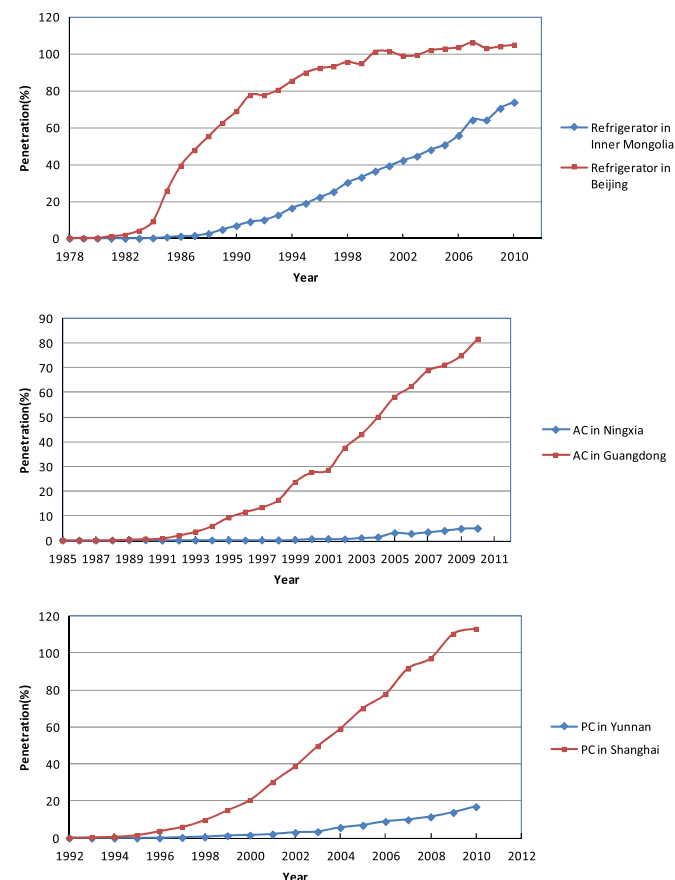


Fig. 1. Illustration of takeoff in selected provinces.

These are the only data sources covering a reasonably long period of time. Some of the data series from these sources overlapped. When sources overlapped, normally the data were identical and occasionally they differed. When data did not match, we used the data from the source that provided the greater amount of overall data across series.

3.2. Measures

This subsection explains the measures for dependent variable, independent variables and control variables in our model.

3.2.1. Dependent variable

Our dependent variable is the event of new product takeoff. To determine if the new products takeoff, we collect data on market penetration of the products, year of introduction and year of takeoff.

3.2.1.1. Market penetration. For market penetration, we use the measure of possession of products per 100 households. Most of the penetration data are recorded separately for urban households and rural households in the publications. We calculated the market penetration of such product–province combinations i at time t through a weighted average as follows:

$$Penetration_{it} = (Urban\ Penetration_{it} * Number\ of\ Urban\ Households_{it} + Rural\ Penetration_{it} * Number\ of\ Rural\ Households_{it}) / (Number\ of\ Urban\ Households_{it} + Number\ of\ Rural\ Households_{it}) \quad (1)$$

We also collected annual data of mobile phone and Internet subscribers. For these two products, the penetration data of product–province combination i at time t were calculated as:

$$Penetration_{it} = Number\ of\ Subscribers_{it} / Number\ of\ Households_{it} \quad (2)$$

3.2.1.2. Year of introduction. The exact introduction years of products in provinces are not explicitly published in journal articles or in Statistical Yearbooks. We use a combination of rules to obtain reasonable estimates of the approximate year of introduction that best reflects individual products.

In case of telecommunication products (mobile phone and Internet), the year of introduction is dependent on the province's development of complementary infrastructure, hence, we look for the earliest year of introduction for each province from the data published in various sources. For mobile phone, we use the date of first adoption of cellular technologies in the province. For Internet, we define the introduction year of a province as the launching year of ChinaNET, which initially is the only entrance for households to access the Internet services. We look for these data from Statistical Yearbooks and journals in CNKI database, newspapers in INFORBANK database, and website of some telecommunication companies.

For other products, we use the national introduction year as a

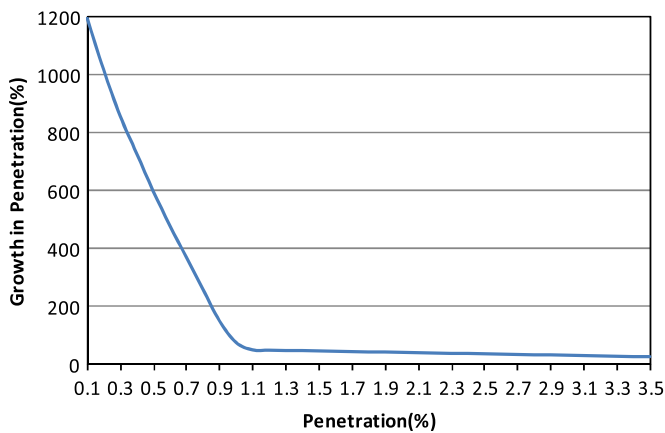


Fig. 2. Thresholds for takeoff.

common introduction year across all provinces. The national introduction year is the earliest year for which the data of penetration is available. We search for the penetration or sales data of each product from CNKI database and INFORBANK database. We further validate each of these dates by checking that penetration in the year of introduction has not exceeded 0.5%, which is similar to Tellis et al. (2003).

3.2.1.3. Year of takeoff. Takeoff is the rapid growth in sales at the beginning of the growth stage in a product's life cycle. Following Tellis et al. (2003), we define takeoff as the first year when penetration growth rate crosses the threshold, which is a standard plot of growth in penetration at a year versus market penetration at the same year (See Fig. 2). Time to takeoff is the difference between the year of takeoff and the year of introduction. We have time-to-takeoff for all 255 product–province combinations by using this rule.

To ascertain the robustness of our threshold rule, we repeated the entire descriptive and hazard analysis applying an alternative method used by Chandrasekaran and Tellis (2008), who define takeoff as the first year when market penetration is or crosses 2%. The main results are robust to the alternate measure of takeoff.

3.2.2. Independent variables

We measure economic wealth by real GDP per capita in thousands of U.S. dollars. We calculate them from nominal GDP per capita by dividing a fixed-base consumer price index where the reference year is 1978. We measure trade openness by a province's level of international trade, which encompasses the exports and imports per capita in thousands of U.S. dollars. As a composite measure, we use the sum of exports and imports per capita in thousands of U.S. dollars as a percentage of nominal GDP (Levine et al., 2000; Osman et al., 2011). For education, we use the literacy rate, which is defined as percentage of population⁵ “who can read and write simple statement on their everyday life.”

We measure media intensity through telephone main lines (fixed telephone lines that connect a subscriber's terminal equipment to the public switched telephone network and that have a port on a telephone exchange) per 100 inhabitants⁶. We do not include TVs per 100 inhabitants as a measure of media because the 1990s is the beginning of consumer advertising (Zhou and Meng,

1997), while six products in our study were introduced before 1990. Television production and transmission began in China in the late 1950s. However, the first advertisement appeared on Chinese television in 1979 (Li, 1991). The number of television stations accepting advertising was only 57 in 1983 and increased to 747 in 1990 (Liang and Jacobs, 1993). In addition, among all the goods advertised, 70–80 percent were industrial goods in the earlier 1980s. This percentage diminished to around 50 percent by the mid-1980s (Yu, 1993). Further, most of the advertising was to a large extent seller-oriented, unlike highly buyer-oriented advertising in the West countries (Semenik et al., 1986).

We measure transportation infrastructure through the density of road network, which includes both railway road and highway road. To account for differences between products with strong and weak network externality, we include the product class as a dummy variable, coded 0 for products with weak externality and 1 for products with strong externality. We introduce a dummy variable to indicate the year of introduction is before or after “South Trip” (the year of 1992), code 0 for the products introduced before 1992, and code 1 for products introduced after 1992. To control temporal factors, we also include year dummies. Year dummy variable is coded 1 if the product–province combination was introduced in that year, 0 otherwise.

3.2.3. Control variables

Adding some variables as controls helps us isolate the effects of the hypothesized variables and reduce the bias of omitted variables. Based on prior research, two control variables are likely to affect the time-to-takeoff of new products: prior takeoffs, and population density (Chandrasekaran and Tellis, 2008).

3.2.3.1. Prior takeoffs. A new product's takeoffs in other provinces can speed up takeoff in a target province (Gatignon et al., 1989; Kalish et al., 1995; Tellis et al., 2003). First, as the product takes off in some provinces, the national media and local media of the target province are more likely to report its use or popularity, increasing its awareness in the target region (Tellis et al., 2003). Second, takeoffs in other provinces imply more adopters, thus inhabitants in a target province have a higher probability of contacting an adopter from the other provinces. Such a contact can increase acceptance of the new product (Gatignon et al., 1989; Kalish et al., 1995). Third, with takeoffs in other provinces, the potential consumers in the target province have more opportunity to observe the benefits of a new product, and therefore, the perceived risk of buying the new product is reduced (Ganesh et al., 1997; Kumar et al., 1998). For the number of prior takeoffs, we use the generic measure that counts the total prior takeoffs across all provinces.

3.2.3.2. Population density. Greater density of population encourages better communication among inhabitants, which may encourage faster takeoff. So, new products might takeoff faster in countries that have a higher population density than countries that have a lower population density (Chandrasekaran and Tellis, 2008). We use number of people per square kilometer as a measure for population density.

3.3. Modeling takeoff

Takeoff is a time-dependent binary event that can be best modeled by the hazard model. Prior studies have used the proportional hazard model or the parametric hazard model to analyze takeoff (Chandrasekaran and Tellis, 2008; Golder and Tellis, 1997). However, in the presence of time varying parameters, such models may lose information because they treat each country–category as one observation. This study uses a discrete-time hazard model,

⁵ The data before 1990 is the percentage of population aged 12 and above, while after 1990, the data is the percentage of population aged 15 and above.

⁶ We also collected data of the circulation of newspapers and magazines per 100 inhabitants. However, the correlation coefficient between it and GDP per capita is 0.71. Hence, we do not use it in our analysis.

which allows for great flexibility in specifying the time function and for incorporating time-varying explanatory variables (Allison, 1982; Allison, 1995; Singer and Willett, 1993).

In the present study, the event is the takeoff of product i in a province j . The hazard of takeoff is the probability that product i takes off in province j in a given time given no prior takeoff. In our treatment of the discrete time hazard model, we follow (Allison, 1982).

The observed time unit in the present study is annual. We assume that time t is positive integer ($t = 1, 2, 3 \dots$), and we have a total of n product–province combinations ($i = 1, 2, \dots, n$) beginning with $t = 1$. For each product–province combination, we have a set of distinct observations, one for each unit of time until either the takeoff occurs or the series is censored. For each of these observations, the binary dependent variable is set equal to 1 if takeoff occurs during that time unit, otherwise 0. No data is maintained for that product–province once takeoff is occurred. Also observed is a vector of explanatory variables x_{it} , which may take on different values at different discrete times.

Let T be the discrete random variable giving the time of event occurrence. The conditional probability that takeoff occurs at time t , given that it has not already occurred, can be written as:

$$h_{it} = \Pr[T_i = t | T_i \geq t, x_{it}] \quad (3)$$

To specify how this hazard rate depends on time and the explanatory variables, the corresponding discrete-time hazard function is given by:

$$h_{it} = 1 - \exp[-\exp(\alpha_t + \beta'x_{it})] \quad (4)$$

where the coefficient vector β' is a $K \times 1$ vector of constraints, α_t ($t = 1, 2, \dots$) is a set of constants, which summarize the duration dependence in the hazard model common to each i . Eq. (2) may be solved to yield the complementary log–log function (Allison, 1982):

$$\log[-\log(1 - h_{it})] = \alpha_t + \beta'x_{it} \quad (5)$$

Positive β' coefficients increase the probability of takeoff and negative β' coefficients decrease the probability of takeoff.

We specify a flexible functional form of α_t :

$$\alpha_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 \quad (6)$$

Thus, the hazard function consists of time-varying covariates, time-invariant covariates, and the effect of time. The latter can be used to compute the baseline hazard function. The complementary log–log model is particularly useful when data from discrete time intervals are used to capture a continuous underlying process (Allison, 1995; Chandrasekaran and Tellis, 2011; Prins and Verhoef, 2007). We use STATA procedure cloglog allowing for the clustered robust standard error option, which specifies that the standard errors allow for intra-group (here a product–province combination) correlation. That is, the observations are independent across groups (clusters) but not necessarily within groups. We test the robustness of the analysis to an alternate LOGIT specification.

4. Empirical results

This section first presents some descriptive statistics for initial insights into the phenomenon of takeoff in China's provinces. Second, we test the hypothesized variation in time-to-takeoff using the discrete time hazard model. Third, we test whether there is convergence in time-to-takeoff over calendar time across provinces. Finally, we assess the robustness of the results.

4.1. Descriptive statistics

The first purpose of this study is to explore the time-to-takeoff differences across provincial regions in China. Descriptive statistics help to answer this question.

On average, the time-to-takeoff in China is 7.1 years, having a standard deviation of 3.8 (Table 2A). The time-to-takeoff is significantly different from product to product. Across product classes, the time-to-takeoff is different too (Table 2B). As we expect, the products with weak network externalities generally have a longer time-to-takeoff than products with strong network externalities. The mean time-to-takeoff for products with weak network externalities is nearly two times of the products with strong network externalities.

Another categorical variable that affects takeoff is the province. As shown in Table 3, provinces vary widely in terms of the mean time-to-takeoff. The most innovative province in terms of time-to-takeoff is almost two and a half times more innovative than the least innovative province. This difference is analogous to difference between Western Europe (Tellis et al. 2003).

To provide a visualization of time-to-takeoff across provinces, we develop a heat map takeoff (Fig. 3). The figure shows the time-to-takeoff across provinces represented by the color spectrum from white to dark gray for long to short. Provinces with very short times-to-takeoff are represented by of dark gray, short times by middle gray, medium times by light gray, and long times by white. The takeoff heat map shows an anti-clockwise drift in time-to-takeoff, from south east to north east and west. The explanatory variables of wealth, openness, mobility and education explain this variation. One exception is Xinjiang province, in the extreme north-west of China. Its time-to-takeoff is shorter than some other western provinces. The probable reason is investment in Xinjiang in education, physical infrastructure, to exploit its minerals. Xinjiang has abundant reserves of coal, crude oil and natural, has benefited a lot from the China Western Development policy introduced by the State Council to boost economic development in Western China.

4.2. Hypotheses tests via hazard model

Before testing hypotheses, we examine multicollinearity among 5 independent variables. We first compute the correlation coefficients among the variables (See Table 4). Morrison (2003) and Tabachnick and Fidell (2006) suggest that when the correlation between two multicollinear independent variables is larger than 0.7, the outcomes could be unreliable. All the coefficients in Table 4 are not bigger than 0.5. The variance inflation factor (VIF) is another commonly used diagnostic for detecting the severity of multicollinearity in the data (Neter et al., 1990; Riley, 2009).

Table 2A
Time-to-takeoff by products.

Product	Provinces	Time-to-takeoff	
		Mean	Standard deviation
Air condition	30	13.00	5.40
Microwave oven	16	10.44	2.00
Motorcycle	29	8.17	2.98
Refrigerator	29	7.90	1.68
Camera	24	7.46	1.67
PC	30	7.33	1.47
Mobile phone	30	4.40	1.43
Color TV	23	4.17	1.11
Internet	30	3.70	0.65
VCD	14	3.57	0.51
Total	255	7.10	3.80

Table 2B
Time-to-takeoff by product classes.

Product class	Product–province combinations	Time-to-takeoff	
		Mean	Standard deviation
Products without network externalities	128	9.40	3.86
Products with network externalities	127	4.80	1.84
Total	255	7.10	3.80

Table 3
Innovativeness of provinces sorted by increasing average time-to-takeoff of new products.

Province	Product	Time-to-takeoff	
		Mean	Standard deviation
Beijing	7	4.00	2.00
Shanghai	8	4.88	2.59
Guangdong	8	5.00	1.51
Jiangsu	8	5.38	2.13
Tianjin	8	5.38	2.39
Fujian	9	6.44	2.88
Zhejiang	8	6.63	2.56
Hubei	7	6.71	2.63
Xinjiang	8	6.75	3.62
Anhui	9	6.78	2.05
Ningxia	9	6.78	5.47
Shandong	10	6.90	3.00
Hainan	5	7.00	4.30
Shaanxi	10	7.10	2.73
Jiangxi	10	7.20	2.86
Hebei	8	7.38	2.00
Liaoning	8	7.38	3.93
Inner Mongolia	9	7.44	4.85
Guangxi	10	7.50	3.17
Hunan	10	7.50	3.34
Shanxi	10	7.50	3.81
Heilongjiang	9	7.56	4.03
Jilin	9	7.78	3.87
Gansu	9	7.89	5.09
Henan	9	8.11	3.06
Tibet	8	8.13	5.11
Guizhou	9	8.22	5.17
Sichuan	7	8.29	2.63
Qinghai	7	9.00	7.92
Yunnan	9	9.44	6.91
Total	255	7.10	3.80

Multicollinearity is problematic when the maximum VIF is greater than 10 (Neter et al., 1990; Schlosser et al., 2006). The maximum VIF is 1.83 (Table 5). Thus, multicollinearity is not a serious issue in our data.

We use the STATA cloglog procedure to estimate the model. Recall that positive β coefficients increase the hazard of takeoff and negative β coefficients decrease the hazard of takeoff (See Table 6).

As hypothesized (H1 and H2), the coefficients of economic wealth and trade openness are significantly different from zero and in the expected direction. Products takeoff faster in wealthier provinces than in poorer provinces. Products also takeoff faster in provinces with more open economic systems than in provinces with less open economic systems. Products takeoff faster in provinces in which the inhabitants have enjoyed higher education than in provinces in which the inhabitants have not enjoyed higher education (H3). The coefficient of telephone main line per 100 inhabitants is significant and in the expected direction (H4). As hypothesized (H5), better transportation infrastructure of

provinces is associated with a shorter time-take-off. Network externalities have significantly positive effect on new product takeoff (H6). As hypothesized (H7), economic context of year of introduction has significantly positive effect on new product takeoff. That is, products introduced after Deng's "South Trip" (year 1992) takeoff faster than products introduced before Deng's "South Trip".

4.3. Convergence in time-to-takeoff

Our results indicate that there are substantial differences in time-to-takeoff across provinces. Another key issue is whether this takeoff patterns across provinces are converging or diverging. We use the word convergence to refer to the decrease over time in the time-to-takeoff range across the provinces.

According to the introduction year, we separate the product–province combinations into two clusters: products introduced between 1978 and 1987 (Cluster 1), and products introduced between 1988 and 1997 (Cluster 2). The ranges of mean time-to-takeoff of product–province combinations across provinces for these two clusters are considerably different (See Table 7). The range of Cluster 1 is almost three times that of Cluster 2. Since the difference might be affected by product class, we examine the ranges of mean time-to-takeoff across provinces of the two clusters for products with strong and weak network externalities separately. We find that the range of time-to-takeoff for both products with strong network externalities converges from 5.0 to 3.0 and products with weak network externalities from 9.67 to 7.0. In all cases, convergence occurs in the direction of the fast takeoff regions or shorter time to takeoff.

However, even for recently introduced products (Cluster 2), the range of mean time to takeoff across provinces is considerable, amounting to 3.33 years. For products with weak network externalities, this number is 7 years. This result shows that even currently, provinces within China differ substantially in time to takeoff and the whole country should not be treated as one.

4.4. Predictive ability

To estimate the predictive ability of the model, we use a type of Jackknifing technique (Abdi and Williams, 2010; Sood and Tellis, 2011). The name "Jackknife" refers to two related but different techniques and is sometimes a source of confusion (Abdi and Williams, 2010). First, a cross-validation technique used to estimate the bias of an estimator. Second, a prediction technique, used to assess a model that predicts the value of dependent variable from a set of independent variables. In our study, we refer to the second technique. In this context, our goal to assess the value of our proposed Hazard model to predict the future takeoff of a new product. We first hold out one target product–province combination, re-estimate the model on the other product–province combinations, and then use the estimated parameters to predict takeoff for the held-out target product–province combination. We re-estimate the model n times, where n is the number of product–province combinations in our sample.

Among the independent variables and control variables, the prior takeoffs, and product class are their actual values. We forecast other variables (wealth, openness, education, media, transportation infrastructure, and population density) of the target product–province combination one year ahead. These forecasts are obtained from the values of these variables for the last year. That is: $X_i(t) = X_i(t - 1)$.

For product–province combination i , the discrete-time hazard function at time t is:

$$h_{it} = 1 - \exp\left[-\exp(\alpha_0 + \alpha_1 t + \alpha_2 \log(t) + \beta' X_{it})\right] \quad (7)$$

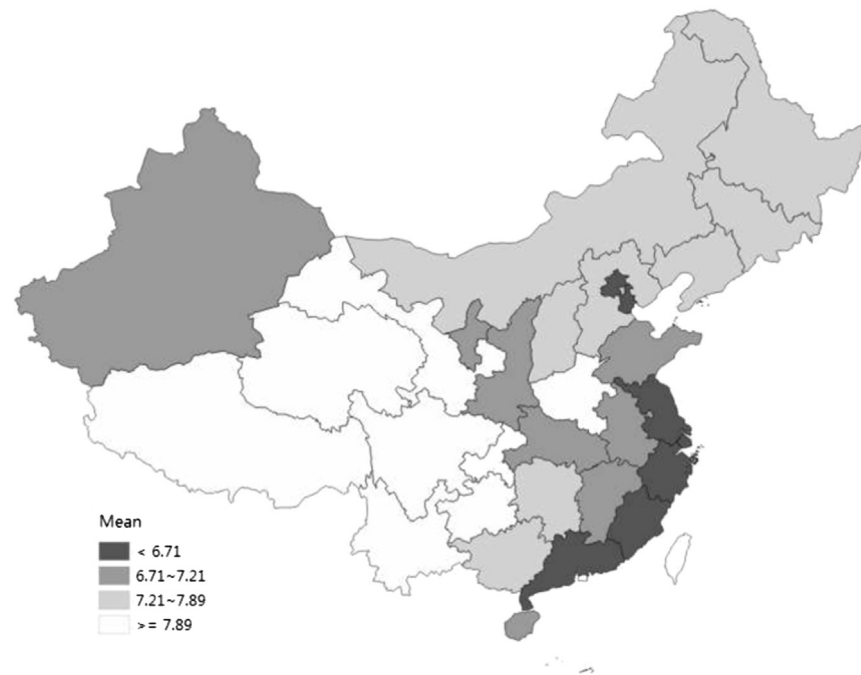


Fig. 3. Heat map of the time-to-takeoff.

Table 4
Correlation matrix for independent variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Economic wealth (1)</i>	1.00						
<i>Trade openness (2)</i>	0.20	1.00					
<i>Education (3)</i>	0.15	0.28	1.00				
<i>Media- telephones (4)</i>	0.06	0.34	0.36	1.00			
<i>Transportation (5)</i>	0.39	0.48	0.50	0.31	1.00		
<i>Product network externalities (6)</i>	-0.10	0.17	0.16	0.28	0.13	1.00	
<i>Year of introduction (7)</i>	-0.12	0.07	0.09	0.33	0.05	0.48	1.00

Table 5
Variance Inflation Factor (VIF).

Variables	Variance inflation factor (VIF)
<i>Economic wealth</i>	1.23
<i>Trade openness</i>	1.38
<i>Education</i>	1.55
<i>Media-Telephones</i>	1.58
<i>Transportation</i>	1.83
<i>Product network externalities</i>	1.38
<i>Year of introduction</i>	1.40

Once we have estimates of the coefficients (in Stata), we multiply the estimated coefficients with the values of the variables of the excluded target product–province combination (in Excel). Then, we can determine the probability of takeoff. This probability will change over time based on changes in time and the values of independent variables. We predict the takeoff to occur in the year when the probability of no takeoff (commonly referred to as the survival probability) falls below 50%. The probability of the event occurring in each year is conditional on all prior years. Therefore, for product–province combination, the estimate for probability of no takeoff after year 1 is $(1 - h_{i1})$; after 2 years, $(1 - h_{i1}) * (1 - h_{i2})$; after 3 years, $(1 - h_{i1}) * (1 - h_{i2}) * (1 - h_{i3})$; etc. (Helsen and Schmittlein, 1993).

Table 6
Coefficients of the estimate of discrete time hazard model of takeoff.

Variables	Coefficients (Std. dev.)
Independent variables	
<i>Economic wealth</i>	2.51*** (0.56)
<i>Trade openness</i>	0.84** (0.43)
<i>Education</i>	2.27** (0.89)
<i>Media (Telephones)</i>	0.07*** (0.02)
<i>Transportation infrastructure</i>	1.54** (0.74)
<i>Product network externalities (1: strong network externalities; 0: weak network externalities)</i>	2.04*** (0.45)
<i>Year of introduction (1: introduced after 1992; 0: introduced before 1992)</i>	1.96*** (0.60)
Control variables	
<i>Prior takeoffs</i>	0.11*** (0.02)
<i>Population density</i>	-0.00* (0.00)
<i>Year dummies</i>	INCLUDED
Log likelihood	-457.08
Observations	2064

Notes:

- * $p < 0.1$;
- ** $p < 0.05$.
- *** $p < 0.01$.

Table 7
Mean time-to-takeoff across provinces by cluster of year of introduction.

Mean time-to-takeoff across Provinces	Cluster 1 (Introduced from 1978 to 1987)	Cluster 2 (Introduced from 1988 to 1997)
Mean	8.48	5.59
Range	10.08	3.33

In total, there are 255 iterations for predictions and 1809 predictions for updated forecasts. We show the predictive accuracy of the hazard model in two ways: predictive statistics, and error in the prediction of takeoff.

4.4.1. Predictive statistics

Traditional summary statistics of the accuracy of hazard model are *specificity* and *sensitivity*. *Specificity* and *Sensitivity* are the power of the model to detect true negatives and true positives, respectively, computed as follows (Sood and Tellis, 2011):

$$\begin{aligned} \text{Specificity} &= \frac{\text{True Negatives}}{\text{Actual Negatives}} \\ &= \frac{\text{True Negatives}}{\text{True Negatives} + \text{False Positives}} \end{aligned} \quad (8)$$

$$\begin{aligned} \text{Sensitivity} &= \frac{\text{True Positives}}{\text{Actual Positives}} \\ &= \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}} \end{aligned} \quad (9)$$

The false positive rate and the false negative rate are $(1 - \text{Specificity})$ and $(1 - \text{Sensitivity})$, respectively. The out-of-sample specificity (true negative rate) is 89.8%, and the out-of-sample sensitivity (true positive rate) is 63.5%.

4.4.2. Error in prediction of takeoff

We define the error in prediction of takeoff as the absolute difference in years between when the model predicts a takeoff and when the takeoff actually takes place. The mean absolute error is 1.2 years.

4.5. Test of robustness

This section describes various tests of robustness on the measure of takeoff, unobserved heterogeneity, and hazard model specification.

4.5.1. Measure of takeoff

Recall that we used the threshold rule to measure the year of takeoff. To evaluate the robustness of our results, we compare the year of takeoff as measured by our threshold rule to the year of takeoff as measured by the 2% penetration rule proposed by Chandrasekaran and Tellis (2008). Using the 2% penetration rule, takeoffs have occurred in all product–province combinations except air conditioner in Yunnan and Qinghai. We find that, overall, in 87% of the cases the absolute differences in the year of takeoff between the two rules are less than or equal to one year, while they match exactly in 41% of the cases (Table 8). We repeated the hazard analysis applying the 2% penetration rule. The main results are robust to the alternate measure of takeoff (See Model A.1 in Appendix).

4.5.2. Alternative hazard model specification

We first test the robustness of the analysis to the inclusion of another specification of time $\alpha_t = \alpha_0 + \alpha_1 t + \alpha_2 \log(t)$ in the hazard model. The main results remain consistent with prior results (See Model A.2 in Appendix).

Second, we test the robustness of our analysis to an alternate logistic specification. We use the STATA LOGIT procedure on the same data set and find that the results are very similar with our complementary log–log model (See Model A.3 in Appendix).

5. Discussion and conclusion

This section summarizes the key findings, explains the reasons

Table 8

Absolute difference between 2% penetration and penetration threshold rule.

	Abs Diff=0	Abs Diff=1	Abs Diff=2	Abs Diff > 2
Number	105	117	18	15
Percent	41.2%	45.9%	7.0%	5.9%
Cumulative percent	41.2%	87.1%	94.1%	100%

for some findings, discusses the implications of findings, and lists limitations of the study.

5.1. Key findings

While the takeoff of new products is an important phenomenon, most prior studies treat the whole country as a single entity. Due to this, China is often ranked as the slowest country for the takeoff of new products, resulting in late introduction in China of new products of MNCs. Because China is a huge heterogeneous emerging market with the largest population and currently the second largest economy in the world, it is a good context in which to study the differences in intra-country takeoff of new products. We analyzed the takeoff of 10 consumer durables across 30 provinces in China. Our study leads to several new findings:

- Time-to-takeoff differs dramatically across provinces. In terms of time to takeoff, the most innovative province is almost two and a half times more innovative than the least innovative province. Products takeoff fastest in Beijing, followed by other Eastern economic region provinces, like Shanghai, Guangdong, Tianjin, and Jiangsu. New products in some of these provinces takeoff faster than in some Western European countries. For example, Chandrasekaran and Tellis (2008) find that the average takeoff in Germany, Netherlands, and Switzerland is 7.1, 6.1, 6.3 years, respectively. However, we find that the takeoff in Beijing, Shanghai, and provinces are 4.00, 4.88, and 5.00 years respectively.
- Across product classes, time-to-takeoff differs considerably. The time to takeoff of products with weak network externalities is almost twice as long as that of products with strong network externalities.
- Differences in economic wealth, trade openness, education, media intensity (telephone main lines per 100 inhabitants), and transportation infrastructure account for differences in time-to-takeoff across provinces. Economic institutional environment of provinces have a strong significant effect on time-to-takeoff. However, television, as a main kind of mass media, does not have significant positive effect on the takeoff of products.
- Product network externalities have positive effect on product takeoff. This result is consistent with Peng et al. (2011) and Tellis et al. (2009b).
- Economic context of year of introduction has significantly positive effect on new product takeoff. That is, products introduced after 1992 takeoff faster than products introduced before 1992.
- The time-to-takeoff is converging over calendar time across provinces, towards that of the fastest province. As for products introduced from 1978 to 1987, the range in the average time-to-takeoff for 30 provinces is 10.1 years, while for products introduced from 1988 to 1997, the range is only 3.3 years. In addition, the time-to-takeoff of products with strong network externalities is converging faster over time than that for products with weak externalities. This convergence across provinces is similar with the trends across countries (Chandrasekaran and Tellis, 2008).
- Out of sample predictive analysis shows good sensitivity (true positive rate) and specificity (true negative rate).

5.2. Explanations

Our finds raise several questions that deserve some explanation.

First, what is the reason for the big differences in time to takeoff across provinces? Following government policy to “let some people get rich first”, China’s east coastal areas were the first to attract outside investment and have benefited the most from economic reforms (Yeung and Hu, 1992). So, tremendous economic disparity has emerged between coastal cities and hinterland regions (Khan et al., 1992). This economic disparity is the reason for the big differences in time to takeoff across provinces.

Second, why is the time-to-takeoff converging over calendar time across provinces? Convergence in the time-to-takeoff occurs because the underlying drivers are converging. After concentrating on the coastal region for most of the 1980s, Chinese leaders explicitly noted that the state might need to address regional inequality by helping the less-developed regions (Lai, 2002). In 1999, the “Western Development Program” was launched to boost the economic development of Western provinces. These Chinese government’s programs and efforts to reduce regional inequality have had some initial success, growth rates of GDP per capita across provinces exhibited some convergence (Fan and Sun, 2008). In addition, most provinces are enjoying better access to the information which facilitates the diffusion of new products, and the improvement of undeveloped provinces is much greater. Nevertheless, the economic institutional environment is still different across provinces, for example, in 2011, the highest nominal GDP per capita is 13.19 thousand dollars (Tianjin), while the lowest is 2.54 thousand dollars (Guizhou). Hence, there is still great disparity in time-to-takeoff across provinces (Table 7).

Third, why are some provinces of China (such as Beijing, Shanghai, Guangdong) more innovative than some countries of Western Europe? We propose two reasons. First, the growth rates of GDP per capita in these regions have been growing fast for more than two decades. People have more disposal incomes and high expectations of their future growth. Such individuals are more likely to adopt new products than those not exposed to such economics advances. **Second, these provinces are located in eastern part of China**, that benefiting much more from the government policy especially in terms of road and rail networks, media, and education institutions. All these are well known drivers of innovativeness (Tellis et al., 2009a). For example, according to the “Communiqué of the National Bureau of Statistics of People’s Republic of China on Major Figures of the 2010 Population Census”, in 2010, Beijing’s literacy rate is 98.3%, and the percentage of the population with tertiary education is about 31.5%. These numbers are equal to or higher than those for some southern European countries.

5.3. Implications

The findings of our study provide managers with a better understanding about the diffusion of new products across provinces within China at the early stage of the product life cycle. There are several main implications of these findings.

First, many MNCs introduce new products in China later than in other countries. This strategy emerges from research studies on new product takeoff and diffusion that treat China as one monolithic country and find it is a laggard in the adoption of new products. For example, in the ranking of countries on speed to adoption of new products, Chandrasekaran and Tellis (2008) rank China as last. However, viewed through the lens of provinces, some provinces of China (e.g., Beijing, Shanghai) can be treated as moderately innovative countries in terms of adoption of new products, ranking ahead of several countries of Western Europe (such as Italy, France,

Spain and Portugal). The findings of our study clearly show that subnational (provincial) economic context have an important impact on the takeoff of the new products. Considering the extent of economic institutional change differs widely across subnational regions and the process of economic transition is more spatially uneven in emerging economies (Chan et al., 2010), firms and researchers need to treat China and other large emerging countries as heterogeneous economic and cultural entities.

Second, takeoff in one province increases the likelihood of takeoff in other provinces. This finding has an important implication for managers of all new products and public policy administrators, who may want to stimulate the takeoff of a new environmentally friendly product (e.g., electric car). Such decision makers should introduce the new products first in more innovative provinces (such as, Beijing, Shanghai, Guangdong) and stimulate the takeoff in these provinces. Further, they should showcase the takeoff of the new product in the innovative provinces to stimulate takeoff in less innovative provinces.

Third, the vast differences in takeoff of new products across provinces suggest that a waterfall strategy (sequential introduction of new products across provinces) might be more effective and efficient especially for products with strong network externalities. Such a strategy reduces huge risk from failure and increases learning from prior mistakes. Further, such a waterfall strategy may precede parts of a global waterfall strategy. That is, managers could introduce in some provinces of China (e.g., Beijing) before they do in some countries of Europe (e.g., France) and some countries of Asia (e.g., Thailand or Malaysia). Moreover, if a manager chooses a waterfall strategy, our analysis suggests provinces that are the best for early introduction. The best provinces for early introduction would be Beijing, Shanghai, or Guangdong of the Eastern region. New products may takeoff in some of these provinces before they do in some developed markets, such as France or Italy. If a sprinkler strategy (simultaneous introduction of new products across provinces) is desirable to pre-empt competition, such a strategy might be feasible for products with strong network externalities. Our analysis indicates that: in terms of time-to-takeoff, the range for products with strong network externalities is smaller and converging faster than products with weak network externalities across provinces.

Fourth, for marketers of new products, our predictive model can be used to predict when a takeoff is likely in each province. Since the takeoff involves a great increase in inventory, manufacturing, marketing, and distribution, such predictions can be used to time expenditures and reduce wastage in materials, labor, and costs.

Fifth, our findings of strong differences between provinces suggest that this approach to the study of global diffusion should be extended to other multi-ethnic countries previously considered as monolithic. In this context, use of the institutional theory proposed here may be useful. For example, we suspect that such big differences in propensity to adopt new products may be found between regions of others countries such as:

- US: coastal states and interior states or between so called “blue states” and “red states.” For example, in the top 10 states for broadband penetration in the US in 2009 year (Horrigan and Satterwhite, 2012), 7 states are “blue states” (voted Democratic in both 2008 and 2012 year); and of the bottom 10 states, 8 states are “red states” (voted Republican in both 2008 and 2012 year).
- UK: England, Wales, and Scotland.
- Belgium: Flemish Belgium and Wallonia or French Belgium.
- India: southern and northern states or between coastal and interior states.

5.4. Limitations

This study suffers from several limitations.

First, like all studies on new product growth, our study cannot include all factors that may characterize provinces and products. For example, we do not account for the role of some important strategic variables, such as culture, price, and firm entry.

Second, we use a simple measure of prior takeoffs of other provinces to capture cross-province spillover. A more sophisticated mixing model may be relevant.

Third, we do not investigate the takeoff across provinces or states of other large countries such as India, USA, Brazil, and Russia. All these remain useful areas for future research.

Fourth, the findings, conclusions and suggestions of our study are only especially aimed at China. It will be helpful to generalize a theory framework suitable for other developing countries.

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Appendix A1. : Coefficients of robustness tests models

See Table A1

Variables	Model A.1 (Std. dev.)	Model A.2 (Std. dev.)	Model A.3 (Std. dev.)
Independent variables			
<i>Economic wealth</i>	3.46*** (0.69)	3.00*** (0.63)	2.70*** (0.69)
<i>Trade openness</i>	1.62*** (0.38)	0.73 (0.46)	1.09* (0.63)
<i>Education</i>	1.69** (0.83)	1.99** (0.90)	2.46** (1.12)
<i>Media (Telephones)</i>	0.07*** (0.02)	0.08*** (0.02)	0.08** (0.04)
<i>Transportation infrastructure</i>	0.79 (0.83)	1.89** (0.77)	2.27** (0.98)
<i>Product network externalities (1: strong network externalities; 0: weak network externalities)</i>	1.60* (0.84)	1.37*** (0.44)	1.81*** (0.51)
<i>Year of introduction (1: introduced after 1992; 0: introduced before 1992)</i>	2.98*** (0.77)	1.86*** (0.80)	1.83*** (0.63)
Control variables			
<i>Prior takeoffs</i>	0.10*** (0.02)	0.13*** (0.02)	0.15*** (0.03)
<i>Population density</i>	-0.00** (0.00)	-0.00* (0.00)	-0.00 (0.00)
<i>Year dummies</i>	Included	Included	Included
<i>Log likelihood</i>	-434.38	-435.74	-462.67
<i>Observations</i>	2265	2064	2064

Notes:

- * $p < 0.1$;
- ** $p < 0.05$;
- *** $p < 0.01$.

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