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The Effects of Exports, FDI, and Innovation Competence on the Efficiency and Profitability of Privatized SOEs in China

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ABSTRACT

Purpose – This study investigates the effects of exports, foreign direct investment (FDI), and innovation competence on the efficiency and profitability of privatized Chinese state-owned enterprises (SOEs).
Design/Methodology/Approach – We apply fixed effects regressions after estimating the corporate efficiency using data envelopment analysis (DEA) methodology by industry around privatization. We use a panel dataset of Chinese listed firms from 2009 to 2017, with 10,950 year-firm data of RESSET and China Stock Market & Accounting Research (CSMAR) databases. To reflect the complicated relationships between exports, FDI, innovation competence, efficiency, and profitability of privatized firms, we apply simultaneous equations models.
Findings – First, the privatization of SOEs in China improves their innovation competence, measured in the number of patents, overall corporate efficiency, and firms' exports. Second, the innovation competence of firms improves their corporate efficiency and exporting capability, but it aggravates their profitability. Moreover, research and development (R&D) expenditures improve their innovation competence and return on assets, but these expenditures aggravate their efficiency and exports. Third, the corporate efficiency of privatized SOEs improves their profitability for 5 years after privatization, including the year. Fourth, exports have inverse U-shaped effects on efficiency and return on assets, and on their innovation competence. Fifth, overseas direct investments have inverse U-shaped effects both on innovation competence and efficiency and return on assets, whereas their effects on exports are not significant. Sixth, the positive effects of privatization on corporate profitability and such U-shaped effects of exports on corporate profitability last for one year after privatization, whereas the U-shaped effects of FDI last for 3 years.
Research Implications – The privatization of Chinese SOEs has successfully improved their technological efficiency and profitability for a short time, which turns adversely afterward. The results imply that privatized firms need improvements in the efficiency of technological innovation and R&D investments for longer-term improvements in profitability and global competitiveness.

Keywords: China, DEA, exports, fixed effects model, ROA, SEM
JEL Classifications: L10, L63, M13, O25, O31

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I. Introduction

A state-owned enterprise (SOE) is owned and operated by the government. In the market, competition can effectively allocate resources and improve economic efficiency. However, China maintained a socialist economic system for a long time; hence, most Chinese firms have been controlled by state policies and regulatory systems due to Chinese unique historical background. The government took the controlling positions in public sectors, such as energy, logistics, and finance, and in various private sectors related to general economic life. According to World Bank statistics, SOEs in China have significant advantages over private enterprises in terms of capital raising and investment, securing raw materials, and policy stability. However, they have not achieved good results from an economic viewpoint (Hong & Park, 2016; Martín & Roman, 2001; Tiemann & Schreyögg, 2012; Zhang, 2015). In other words, SOEs performed worse than private enterprises in terms of value-added and production. Moreover, they have been the cause of large losses.

Chinese economic and social structures have grown tremendously since the country's reform and opening in 1978. It has transitioned from a closed traditional agricultural economy to an industrialized market economy. One of the most important achievements of the Chinese 30-year reform was the epochal development of the economic system through SOE privatization. Additionally, exports are also known as one of the "troikas" driving Chinese gross domestic product (GDP) growth. During the reform and opening-up, the Chinese government actively attracted inward foreign direct investment (FDI) and encouraged firms and investors to make outward FDI (OFDI) (Liu et al., 2020). After the reform and opening-up, the Chinese economy has achieved unprecedented development. Recently, the Chinese government has continuously promoted the reform of its economic system, and the scientific and technological research and development (R&D) competence and global competitiveness of firms have been continuously enhanced.

The long-term firm-level database accumulated over many years has intensified privatization studies to explore the effectiveness of policies for Chinese SOEs and economic effects due to policy changes. Existing privatization studies have mainly diagnosed the motives of privatization and its economic effects from the government's perspective (Guo & Yao, 2005). Regarding the privatization policy of SOEs in China, this study uniquely examines whether the privatized SOEs have improved R&D investment efficiency, global competitiveness, and financial performance from an economic viewpoint.

The results show that privatization has a positive effect on short-term DEA efficiency and profitability, but in the long run, there is no significant sustained positive effect. Privatization increases the productivity, efficiency and/or performance of firm to a certain extent, and for a limited time. In contrast, an increase in efficiency can improve a firm's profitability for at least 5 years. Therefore, this study attempts to interpret the effect of the privatization of state-owned enterprises from a new perspective.

In this study, we used regression analyses to investigate the effects of exports, FDI, and innovation competence on the efficiency, global competitiveness, and profitability of privatized Chinese SOEs. Using RESSET and China Stock Market & Accounting Research (CSMAR) databases, we examine the efficiency and profitability of privatized firms in China compared with non-privatized firms in terms of globalization, including OFDI and exports. This study focuses on the effects of globalization, that is, whether corporate exports and FDI have a positive, negative, or quadratic (U-shaped or inverse U-shaped) effect, on their efficiency and profitability. It also evaluates whether such factors have a long-term effect on the efficiency and profitability of firms.

This study contributes to the existing literature. First, the analytical perspective of research on the privatization of SOEs with efficiency measured by applying data envelopment analysis (DEA) as in Malmquist (1953). Second, it provides new

evidence for improving privatization efficiency for a long time up to 5 years after privatization. Third, it tests and omproves the validity of research results of its own and those of earlier ones with fixed effects models (FEMs) and panel simultaneous equations models (SEM). The methods are introduced to increase the reliability of the research results by eliminating cumulative effects in subsequent periods, and reflecting endogeneity and the relationship between corporate exports, innovative competence, efficiency, and profitability of firms.

This study proceeds as follows. Chapter II discusses related prior studies, and Chapter III develops hypotheses and research models. Chapter IV presents the findings of the empirical test results. Finally, Chapter V summarizes the empirical test results and discusses this study's implication.

II. Literature Review

We use the DEA method to measure the efficiency of technology R&D of firms, proposed by Charnes et al. (1978), a widely known CCR approach, known to have a great advantage in injecting multiple factors and managing various performance goals.

1. Efficiency of Privatized SOEs

Many studies on privatization efficiency analysis used the DEA model. For instance, Bordman et al. (1989) reported that the efficiency of privatized enterprises is significantly lower than that of SOEs and private enterprises. However, Majumdar (1998) concluded that the efficiency of privatized firms is higher (lower) than that of SOEs (private firms) through a comparative study of all Indian firms as a study sample. Meanwhile, Shleifer et al. (1994) stated that government intervention through state ownership seriously reduces the efficiency of optimal resource allocation and does not help improve the firms' R&D efficiency. La Porta et al. (1999) showed that the privatization of Mexican SOEs improves their operating profit level, and that the efficiency of private equity funds is higher than that of state-owned capital.

Moreover, Martín and Roman (2001) analyzed the technical efficiency of Spanish airports using the DEA model and argued that privatization can improve airport efficiency, and that an appropriate economic control process must be present. Tiemann and Schreyögg (2012) confirmed the improvement of DEA efficiency of privatized hospitals in Germany after privatization. In contrast, Kim et al. (2014a) found that the efficiency of the DEA method does not improve even after the privatization of four Japanese public firms. Furthermore, Kang (2009) showed that the technological efficiency of all firms is less than 1 through the CCR model (Charnes et al., 1978) using the DEA method; thus, the technology is inefficient both before and after privatization.

In Korea, Lee (2010) diagnosed the efficiency of 12 government-invested institutions through the DEA model using time-series data for 18 years from 1990 to 2007. The results revealed that SOEs with a partial stake ranked lower than SOEs with 100% government equity, which is generally contrary to the expectation that privatization through the sale of government ownership will increase efficiency. Moreover, Hong and Park (2016) analyzed the effect of improving efficiency and productivity in the privatization process using DEA (Malmquist approach). They concluded that the efficiency between privatized and public firms varies, and that privatization led to productivity improvement for firms.

In China, Zhang (2015) diagnosed the efficiency of SOEs and privatized SOEs based on the DEA method using time-series data from Xinjiang province from 2000 to 2013. He reported that privatized enterprises' performance is better than SOEs' performance. However, Chen and Zhou (2014) suggested that the efficiency level of privatized listed water supply firms in China is relatively low, when measured using the DEA analysis method.

2. DEA Model and R&D Efficiency

Research on the efficiency of R&D investment started relatively early in the United States and other countries. Malmquist (1953) and Shephared (2015), presented a distance function methodology, making it a great leap forward in the field of empirical research on efficiency. Moreover, using 27 Asian countries and regions in research, Lee and Park (2005) measured and compared the R&D investment efficiency across countries and regions, through the DEA method. Consequently, Singapore had the highest overall R&D efficiency, whereas China, Taiwan, and Korea had low overall R&D efficiency.

Kumbhakar et al. (2012) measured the R&D efficiency of European high-tech firms and showed a difference in the effect of market positioning of firms with different skill levels on innovation performance. In similar DEA research, Kim et al. (2021) tried diagnosing the effects of government support and corporate technological innovation efforts from 2008 to 2016 on the efficiency, profitability, growth potential, and long-term cumulative excess return of Korean start-ups. Although the efficiency of technology is low in earlier stages, it improves through technological innovation activities later.

The DEA model, a nonparametric method to diagnose the relative efficiency study, was first applied in China by Wei and Cui (1989). Moreover, Wang et al. (2018) constructed a two-step DEA model considering innovation performance and its application. They used panel data of Chinese manufacturing firms listed from 2012 to 2016 from the perspective of mixed-ownership reform. Meanwhile, Li et al. (2017) used a three-step DEA model to calculate the R&D efficiency of 10 high-tech industrial clusters in China from 2008 to 2012. They reported that the R&D efficiency of each high-tech industry increases significantly after excluding environmental and random factors. They also found that the local GDP and the number of graduate students positively affect R&D expenditure and the number of R&D personnel in two stages.

3. Effect of Exports on Corporate Performance

The differences between exporting and non-exporting firms have been the topic of economic research. This trend in the trade literature was partly attributable to the recent availability of firm-level databases (Bernard et al., 2007a). They contributed to identifying relevant and durable heterogeneities across firms and industries (Bartelsman et al., 2009; Bottazzi & Peri, 2007; Dunne et al., 1988; Jensen & McGuckin, 1997). According to Grazzi (2012), exports affect profits, market shares, and average productivity in their industry, as the factors explaining observed differences among firms. Sun (2001) claimed that FDI supports international trade and that rapid development in export benefits the Chinese economy.

In addition, Sun (2001) pointed out that the effect of FDI on exports varies across Chinese regions, depending on their economic situations, degree of economic openness, and FDI policy. He also pointed out that FDI plays a more important role in promoting exports from the eastern coastal regions than the central and western regions. According to Zhang (2005), FDI has a positive effect on Chinese exports, and the effect of FDI is larger than that of local capital, especially in labor-intensive industries.

According to Kim and Seol (2013), firms with higher export ratios are better at managing currency risk due to their ability to deal with exchange rate fluctuations. Kim, et al. (2014b) mentioned that when exports grow, their financial performance improves, and the firms' capacity to employ derivatives has a beneficial effect on financial performance. Moreover, Kim (2015) stated that FDI, local direct investment, and exports all positively affect Korean firms' financial performance.

4. Effects of Outward FDI on Corporate Performance

The rapid growth of FDI has generated much scholarly interest in entry modes, location

decisions, and the financial performance of OFDI firms (Denisia, 2010). Resource exchange (Barney, 1991), and organizational behavior (Ruigrok & Wagner, 2003) have all been used in studies to understand better the strategic behavior of FDI firms in both developed and developing nations. According to Makino et al. (2004), FDIs from Japanese firms in developing countries are more likely to have higher financial performance with a more extensive range. As a result, they will have a lower departure rate than FDIs from developed countries. In the early stages of globalization, they found that global diversification has negative (positive) effects on corporate financial performance in developing (developed) countries.

Glaum and Oesterle (2007) reported that research on FDI firms would improve their financial performance in foreign countries. FDI is the most advanced and risky option in terms of globalization, as it means committing considerable resources to a foreign market for the long-term competitiveness of global firms. Similarly, Kim (2015) found that FDIs of Korean firms positively affect financial performance. Meanwhile, Yang and Martins (2010) determined a positive relationship between globalization and firm performance. However, they noticed that investments in developing countries have a higher effect on financial performance than those in developed countries.

According to Gu and Reed (2011) the abnormal returns of listed firms surge dramatically on the day of the mergers and acquisition (M&A) announcement, showing knowledge leaking and inside trading in the Chinese stock market. Moreover, medium- to long-term (1–3 years) stock market abnormal returns on overseas M&As increased significantly, based on the research of 157 Chinese firms' stock price returns in M&As from January 1994 to December 2009. Cao and Yi (2014) investigated the effects of overseas M&As from 2007 to 2010 on 61 sample firms' financial indicators, including profitability, solvency, development capacity, and operating capacity, for 5 years after OFDI. They showed that financial performance falls from the year of the investment until 2 years after the investment, then reverts to its previous performance before the investment in the third year after the investment. It indicated that the firm's OFDI harms short-term financial performance, and that long-term performance has a strong rising tendency but does not exceed previous performance before the OFDI. It revealed that a firm OFDI harms short-term financial performance, whereas its long-term performance has a significant rising trend does not exceed past performance prior to the OFDI.

III. Hypotheses and Test Models

1. Hypotheses

Privatization has been known to promote productivity growth and reduced costs eventually, regardless of the degree of market competition and regulation. However, Ehrlich et al. (1994) noted that the short-term effect on efficiency and cost-of-ownership shifts are less pronounced and important in the long run. Meanwhile, Tiemann and Schreyögg (2012) reported that privatization improves DEA efficiency in Germany. Conversely, Kim et al. (2014b) found that the efficiency of the DEA method does not improve after the privatization of four Japanese public firms. Due to the lack of market competitiveness of SOEs, the primary purpose of the privatization of the Chinese government is to improve the efficiency of firms (Tiemann & Schreyögg, 2012). Accordingly, we establish the following research hypotheses:

H1a: Privatization of SOEs improves short-term efficiency.
H1b: Privatization of SOEs improves long-term efficiency.

Prior studies have reported the positive effect of exports on firm efficiency (Bernard et al., 2007b; Melitz, 2003). De Loecker (2010) also showed that exports increase the productivity of enterprises by 7.36%. Similarly, we expect nonlinear, or more precisely inverse U-shaped, effects of economic growth, export, and FDI on efficiency of firms in

China. While the efficiency of privatized SOEs increases up to a certain level with increases in exports, it then decreases. Thus, we establish the research hypotheses as follows.

H2a: Exports have an inverse U-shaped effect on the efficiency of privatized SOEs.
H2b: Exports improve the long-term efficiency of privatized SOEs.

Prior studies (De Loecker, 2007; Dunning, 1998; Melitz, 2003) found that exports can improve corporate productivity. Based on Liu et al. (2020) who reported nonlinear effects of economic growth, export and FDI on the Chinese economy, we also expect nonlinear, or inverse U-shaped more precisely, effects of economic growth, export and FDI on efficiency of firms in China. Thus, we establish the following research hypotheses:

H3a: OFDI has an inverse U-shaped effect on the efficiency of privatized SOEs.
H3b: OFDI improves the long-term efficiency of privatized SOEs.

Market competition induces firms to increase R&D efforts and improve their efficiency through competition. Li et al. (2017) reported that the R&D efficiency of high-tech industrial clusters in 10 cities in China leads to a higher number of graduate students and GDP in the region and R&D expenditure of the firms. Meanwhile, Aghion and Griffith (2008) argued that market competition compels innovation. Therefore, as firms develop new technologies through innovative investments, they improve their efficiency to cope with competition. Accordingly, the following hypotheses are established:

H4a: Innovation competence improves the short-term efficiency of privatized SOEs.
H4b: Innovation competence improves the long-term efficiency of privatized SOEs.

The effect of privatization on the performance of SOEs is of interest in much literature. Most studies in developed countries have shown that privatization of SOEs can improve corporate performance (Boubakri & Cosset, 1998; Dewenter & Malatesta, 2001; Megginson & Netter, 2001; Megginson et al., 1994). Liu and Li (2005) found that government equities have a significant negative effect on corporate performance, but privatization has a positive effect on corporate performance after privatization. In the 1980s, the lack of effective market competition mechanisms in Chinese state-owned enterprises, not only put Chinese enterprises at a disadvantage in international market competition but also brought serious financial burdens to the government budget, Following the reform and opening up, China began the process of privatizing enterprises in order to address the problem of low efficiency in enterprises and improve the market competitiveness of enterprises. Therefore, this study establishes the following hypotheses:

H5a: Privatization of SOEs improves the short-term profitability of privatized SOEs.
H5b: Privatization of SOEs improves the long-term profitability of privatized SOEs.

Empirical research in international trade has shown that exporting firms display higher productivity than their non-exporting competitors (Grazzi, 2012). According to Sun (2001) and Grazzi (2012), exports are a factor explaining differences in firm performance. Kim et al. (2014a) found that exports improve corporate financial performance, although unrelated to the direct effect of privatization. Following Liu et al. (2020), we expect nonlinear, or inverse U-shaped more precisely, effects of exports on the profitability of firms in China. Thus, we establish the research hypotheses as follows.

H6a: Exports have a U-shaped effect on the short-term profitability of privatized SOEs.
H6b: Exports have a U-shaped effect on the long-term profitability of privatized SOEs.

Recent research has found important and persistent heterogeneities across industries and firms (Bartelsman et al., 2009; Bottazzi & Peri, 2007; Kim & Seol 2013; Kim et al. 2014a). Similar to Kim et al. (2014b), Zhang (2005) mentioned that FDI positively affects Chinese exports. Cao and Yi (2014) found that the performance of these firms generally falls after the OFDI. However, they found that the long-term trend of the firms' financial performance is not affected by the OFDI. As before, following Liu et al. (2020), we expect nonlinear, or inverse U-shaped more precisely, effects of FDI on the profitability of firms in China. Thus, we establish the research hypotheses as follows.

H7a: OFDI has a U-shaped effect on the short-term profitability of privatized SOEs.
H7b: OFDI has a U-shaped effect on the long-term profitability of privatized SOEs.

Empirical studies using corporate data confirm that innovation has a significant effect on privatized firm's performance. For example, Crépon et al. (1998) reported that innovation positively affected the number of patents and sales of new products using data from French manufacturing firms. Criscuolo and Haskel (2003) reported that product innovation positively affects firm performance using United Kingdom firm data. Using manufacturing sector data from four European countries, Griffith et al. (2006) found that product innovation had a statistically significant effect on efficiency in France, Spain, and the United Kingdom. Meanwhile, using Italian firm data, Hall et al. (2009) found that product and process innovation had a positive effect on the performance of privatized firms. Accordingly, the following hypotheses are proposed:

H8a: Innovation competence improves the short-term profitability of privatized SOEs.
H8b: Innovation competence improves the long-term profitability of privatized SOEs.

2. Empirical Models

DEA is a nonparametric efficiency measurement method, developed as a linear programming model to evaluate the relative efficiency of a decision-making unit(DMU) with multiple inputs and multiple performance measures. It is considered the most suitable method in studying whether the R&D investment efficiency of a firm has improved using many factors.

In measuring the efficiency of a firm using the DEA method, the CCR methodology developed by Charnes, Cooper, and Rhodes (1978) is applied. Equation (1) presents this measure as the weighted average of the output, compared with the weighted average of the input factors. In this study, we use the R&D expenditure, the number of employees, and total assets as our input factors, and the number of patents, sales, and operating profits are selected as output factors to analyze the relative efficiency of R&D of a firm measured by DEA. We apply DEA methodology as shown in (1).

$$DEA = \frac{y_1u_1 + y_2u_2 + \ldots + y_nu_n}{x_1v_1 + x_2v_2 + \ldots + x_mv_m} = \frac{\sum_{j=1}^{n} y_j u_j}{\sum_{i=1}^{m} x_i v_i} \quad (1)$$

m: number of inputs
n: number of outputs
x_i: usage of the i-th input
y_j: production of the j th output
v_i: weight for the i-th input
v_j: weight for the j th output

In this study, R&D expenditure, the number of employees, and total assets are selected as input factors, and the number of patents, sales, and operating profits are selected as output factors to analyze the relative efficiency of R&D input and output of a firm as shown in (2).

$$DEA_{i,t} = \frac{\text{Ln\_}PAT_{i,t}\,v_{1,t} + \text{Ln\_}Sales_{i,t}v_{2,t} + \text{Ln\_}OIPS_{i,t}v_{3,t}}{\text{Ln\_}RD_{i,t}\,u_{1,t} + \text{Ln\_}EMP_{i,t}u_{2,t} + \text{Ln\_}ASSET_{i,t}\,u_{3,t}} \tag{2}$$

$DEA_{i,t}$: Efficiency of firm i in year t
Ln_$PAT_{i,t}$: Ln(number of patents)
Ln_$Sales_{i,t}$: Ln(sales)
Ln_$OIPS_{i,t}$: Ln(operating profit)
Ln_$RD_{i,t}$: Ln(R&D expenditure)
Ln_$EMP_{i,t}$: Ln(number of employees)
Ln_$ASSET_{i,t}$: Ln(total assets)
$v_{j,t}$: Weight for the j th input of year t
$v_{k,t}$: Weight for the k th output of year t

Empirically, we use panel regression analyses. To study the efficiency of a firm, we estimated the DEA index. Moreover, to understand the performance of privatized firms, we used the return on assets (ROA) as a dependent variable. A dummy variable to represent privatized firms (Privatization_D) is introduced as an explanatory variable. To diagnose the effect of global corporate competence, we employed the export ratio (Export_R) and OFDI ratio (FDI_R) of a firm as explanatory variables. The number of patents held (Ln(Patent)) calculated in the natural logarithm is introduced as an explanatory variable representing corporate innovation competence. Additionally, market share (Market_Sh), the concentration of ownership (HHI), total asset turnover (Turnover), manufacturing firm dummy (MFG_D), and inventory ratio (Inventory_R) are used as control variables. The variables used are presented in the following empirical analysis equation.

Concerning H1-H4, we show the fixed effects panel regression models to diagnose the effects of privatization, exports, innovation competence on the efficiency of privatized firms for j years after privatization in (3).

$$\begin{aligned} DEA_{i,t} = {} & \beta_0 + \beta_1 \text{Priv\_}D_{i,t-j} + \beta_2 \text{Export\_}R_{i,t-j} + \beta_3 \text{Export\_}R^2_{i,t-j} \\ & + \beta_4 FDI\_R_{i,t-j} + \beta_5 FDI\_R^2_{i,t-j} + \beta_6 \text{Ln}(Patent)_{i,t-j} \\ & + \beta_7 RD\_\text{Exp}R_{i,t} + \beta_8 Gov\_Sh_{i,t} + \beta_9 Market\_Sh_{i,t} + \beta_{10} HHI_{i,t} \\ & + \beta_{11} Turnover_{i,t} + \beta_{12} MFG\_D_{i,t} + \beta_{13} Inventory\_R_{i,t} \\ & + \beta_{14} Tang\_R_{i,t} + \beta_{15} DEBT\_R_{i,t} + \beta_{16} Exchang\_R_{i,t} \\ & + \beta_{17} \text{Ln}(Asset)_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t} \end{aligned} \tag{3}$$

Moreover, to study the long-term effects of such factors related to the financial performance or profitability of a firm, we established the empirical analysis equation for j years after privatization in (4)

$$\begin{aligned} ROA_{i,t} = {} & \beta_0 + \beta_1 \text{Priv\_}D_{i,t-j} + \beta_2 \text{Export\_}R_{i,t-j} + \beta_3 \text{Export\_}R^2_{i,t-j} \\ & + \beta_4 FDI\_R_{i,t-j} + \beta_5 FDI\_R^2_{i,t-j} + \beta_6 \text{Ln}(Patent)_{i,t-j} \\ & + \beta_7 RD\_\text{Exp}R_{i,t} + \beta_8 Gov\_Sh_{i,t} + \beta_9 Market\_Sh_{i,t} \\ & + \beta_{10} HHI_{i,t} + \beta_{11} Turnover_{i,t} + \beta_{12} MFG\_D_{i,t} + \beta_{13} Inventory\_R_{i,t} \\ & + \beta_{14} Tang\_R_{i,t} + \beta_{15} DEBT\_R_{i,t} + \beta_{16} Exchang\_R_{i,t} \\ & + \beta_{17} \text{Ln}(Asset)_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t} \end{aligned} \tag{4}$$

Here, i denotes firm i, and t denotes year t whereas j denotes j years after privatization in the variables summarized in Table 1.

To test the multilateral effects of exports, FDI, and innovation competence on the efficiency and profitability of privatized SOEs, we use panel simultaneous equations models (SEM) to increase the reliability of the research results by eliminating cumulative effects in subsequent periods, while controling the endogeneity and the relationships between corporate exports, innovative competence, efficiency, and profitability of firms. More realistic empirical models, similar to those of Kim et al. (2021), improve their reliability and validity compared with those of previous studies, and thus we introduce an SEM as in (5):

$$\begin{aligned}\mathrm{Ln}\_Patent_{i,t} &= \beta_0 + \beta_1 \mathrm{Priv}\_D_{i,t} + \beta_2 \mathrm{Export}\_R_{i,t} + \beta_3 \mathrm{Export}\_R_{i,t}^2 \\ &+ \beta_4 FDI\_R_{i,t} + \beta_5 FDI\_R_{i,t}^2 + \beta_6 DEA_{i,t} \\ &+ \beta_7 RD\_\mathrm{Exp}R_{i,t} + \beta_8 ROA_{i,t} + \beta_9 Gov\_Sh_{i,t} \\ &+ \beta_{10} Market\_Sh_{i,t} + \beta_{11} HHI_{i,t} + \beta_{12} Turnover_{i,t} + \beta_{13} MFG\_D_{i,t} \\ &+ \beta_{14} Inventory\_R_{i,t} + \beta_{15} Tang\_R_{i,t} + \beta_{16} DEBT\_R_{i,t} \\ &+ \beta_{17} Exchang\_R_{i,t} + \beta_{18} \mathrm{Ln}(Asset)_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t}\end{aligned} \tag{5}$$

$$\begin{aligned}DEA_{i,t} &= \beta_0 + \beta_1 \mathrm{Priv}\_D_{i,t} + \beta_2 \mathrm{Export}\_R_{i,t} + \beta_3 \mathrm{Export}\_R_{i,t}^2 \\ &+ \beta_4 FDI\_R_{i,t} + \beta_5 FDI\_R_{i,t}^2 + \beta_6 \mathrm{Ln}(Patent)_{i,t} + \beta_7 RD\_\mathrm{Exp}R_{i,t} \\ &+ \beta_8 ROA_{i,t} + \beta_9 Gov\_Sh_{i,t} + \beta_{10} Market\_Sh_{i,t} \\ &+ \beta_{11} HHI_{i,t} + \beta_{12} Turnover_{i,t} + \beta_{13} MFG\_D_{i,t} \\ &+ \beta_{14} Inventory\_R_{i,t} + \beta_{15} Tang\_R_{i,t} + \beta_{16} DEBT\_R_{i,t} \\ &+ \beta_{17} Exchang\_R_{i,t} + \beta_{18} \mathrm{Ln}(Asset)_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t}\end{aligned}$$

$$\begin{aligned}\mathrm{Export}R_{i,t} &= \beta_0 + \beta_1 \mathrm{Priv}\_D_{i,t} + \beta_2 DEA_{i,t} + \beta_3 FDI\_R_{i,t} \\ &+ \beta_4 FDI\_R_{i,t}^2 + \beta_5 \mathrm{Ln}(Patent)_{i,t} + \beta_6 RD\_\mathrm{Exp}R_{i,t} \\ &+ \beta_7 ROA_{i,t} + \beta_8 Gov\_Sh_{i,t} + \beta_9 Market\_Sh_{i,t} \\ &+ \beta_{10} HHI_{i,t} + \beta_{11} Turnover_{i,t} + \beta_{12} MFG\_D_{i,t} \\ &+ \beta_{13} Inventory\_R_{i,t} + \beta_{14} Tang\_R_{i,t} + \beta_{15} DEBT\_R_{i,t} \\ &+ \beta_{16} Exchang\_R_{i,t} + \beta_{17} \mathrm{Ln}(Asset)_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t}\end{aligned}$$

$$\begin{aligned}ROA_{i,t} &= \beta_0 + \beta_1 \mathrm{Priv}\_D_{i,t} + \beta_2 \mathrm{Export}R_{i,t} + \beta_3 \mathrm{Export}R_{i,t}^2 \\ &+ \beta_4 FDIR_{i,t} + \beta_5 FDIR_{i,t}^2 + \beta_6 \mathrm{Ln}(Patent)_{i,t} + \beta_7 RD\_\mathrm{Exp}R_{i,t} \\ &+ \beta_8 DEA_{i,t} + \beta_9 Gov\_Sh_{i,t} + \beta_{10} MarketShare_{i,t} \\ &+ \beta_{11} HHI_{i,t} + \beta_{12} Turnover_{i,t} + \beta_{13} MFG\_D_{i,t} \\ &+ \beta_{14} Inventory\_R_{i,t} + \beta_{15} Tang\_R_{i,t} + \beta_{16} DEBT\_R_{i,t} \\ &+ \beta_{17} Exchang\_R_{i,t} + \beta_{18} \mathrm{Ln}(Asset)_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t}\end{aligned}$$

Table 1 provides the list of variables, and their notations, definitions and descriptions.

Table 1. Variables, Notations, Definitions and Descriptions

Variables	Definitions	Descriptions
Efficiency measured by DEA	DEA	Refer to equation (1)
Return on assets	ROA	[Net income(t)/Total assets(t)]
Privatized firm dummy	Priv_D	Dummy for a privatized firm. 1 if true, 0 otherwise
Export ratio	Export_R	[Export(t)/Total assets(t)]
Square of export ratio	(Export_R)^2	[Export(t)/Total assets(t)] squared
FDI to asset ratio	FDI_R	[Foreign direct investment(t)/Total assets(t)]
Square of FDI to asset ratio	(FDI_R)^2	[Foreign direct investment(t)/Total assets(t)] squared
Number of patents held	Ln(Patent)	[Ln(number of patents held)]
R&D investment ratio	RD_ExpR	[R&D investment expenditure(t)/Total assets(t)]
Government ownership	Gov_Sh	[Share of the government ownership/Total shares]
Market share	Market_Sh	[Total corporate sales/Industry sales]
Herfindahl-Hirschman Index	HHI	$[\sum_{n=1}^{5}(SH_{n,t})^2]/[(\sum_{n=1}^{5}SH_{n,t})^2]$
Turnover to total assets	Turnover	[Sales (t) / Total assets (t)]
Manufacturing firm dummy	MFG_D	Dummy for a Manufacturing firm. 1 if true, 0 otherwise
Inventory ratio	Inventory_R	[Inventory assets (t)/Total assets (t)]
Tangible asset ratio	Tang_R	[Tangible assets(t)/Total assets(t)]
Debt ratio	Debt_R	[Total debts(t)/Total assets(t)]
Exchange rate	Exchang_R	[Yuan/US dollar]
Firm size	Ln(Asset)	Natural log of total assets in 1,000 yuan
Firm specific effects	μ_i	Effect of firm i
Firm specific effects	λ_t	Effect of year t
Error terms	$\epsilon_{i,t}$	Error terms

Table 2. Sample Distribution of Privatized and Non-Privatized Firms

Year	Total Samples(A)	Privatized Firms (B)	Non-Privatized Firms	Proportion (C=B/A)
2009	315	132	183	41.90%
2010	525	238	287	45.33%
2011	561	289	272	51.52%
2012	1,211	662	549	54.67%
2013	1,506	900	606	59.76%
2014	1,622	998	624	61.53%
2015	1,606	977	629	60.83%
2016	1,690	1,056	634	62.49%
2017	1,914	1,227	687	64.11%
Total	10,950	6,479	4,471	59.17%

Table 3. Descriptive Statistics

Variable	Obs.	Mean	Median	Std. Dev.	Minimum	Maximum
DEA	10,950	0.9215	0.922	0.0335	0.7248	1.0000
ROA	10,950	0.0366	0.033	0.0595	-0.6829	0.4939
Priv_D	10,950	0.5917	1.000	0.4915	0.0000	1.0000
Export_R	10,950	0.0234	0.000	0.0851	0.0000	2.5337
FDI_R	10,950	0.5258	0.269	0.6777	0.0000	4.8163
Ln(Patent)	10,950	3.0895	3.091	1.5283	0.0000	8.8445
RD_ExpR	10,950	0.0197	0.017	0.0161	0.0000	0.0998
Gov_Sh	10,950	0.0348	0.000	0.1210	0.0000	0.8947
Market_Sh	10,950	0.0966	0.022	0.1733	0.0000	0.9973
HHI	10,950	0.1544	0.127	0.1101	0.0005	0.7939
Turnover	10,950	0.6175	0.536	0.3934	0.0035	4.8847
MFG_D	10,950	0.8254	1.000	0.3797	0.0000	1.0000
Inventory_R	10,950	0.1391	0.119	0.1013	0.0000	0.8223
Tang_R	10,950	0.9200	0.951	0.0916	0.2229	1.0000
Debt_R	10,950	0.4156	0.406	0.2017	0.0080	0.9994
Exchang_R	10,950	6.4420	6.494	0.2848	6.0969	6.9370
Ln(Asset)	10,950	21.9858	21.847	1.1220	17.8061	26.6507

Table 4. Pair-wise Correlation Matrix between Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
ROA	0.57***	1.00														
Priv_D	-0.02**	0.13***	1.00													
Export_R	0.05***	0.01	0.07***	1.00												
FDI_R	0.15***	0.04***	0.02**	0.26***	1.00											
Ln(Patent)	0.10***	0.03***	0.01	0.06***	0.14***	1.00										
RD_ExpR	0.09***	0.18***	0.13***	0.10***	0.15***	0.17***	1.00									
Gov_Sh	0.02*	-0.04***	-0.32***	-0.01	0.09***	0.04***	-0.04***	1.00								
Market_Sh	0.22***	0.02*	-0.16***	0.04***	0.09***	0.01	-0.06***	0.08***	1.00							
HHI	0.13***	0.06***	-0.19***	-0.04***	0.02*	0.04***	-0.06***	0.18***	0.13***	1.00						
Turnover	0.44***	0.11***	-0.15***	0.08***	0.37***	0.01	0.13***	0.02**	0.15***	0.12***	1.00					
MFG_D	-0.40***	-0.01	0.02**	0.04***	0.15***	0.24***	0.02*	-0.01	-0.17***	0.00	0.06***	1.00				
Inventory_R	0.03***	-0.08***	-0.09***	-0.03***	0.10***	0.04***	-0.08***	0.03***	0.08***	0.04***	0.15***	0.07***	1.00			
Tang_R	0.03***	-0.02*	-0.16***	-0.05***	0.07***	0.07***	0.02***	0.06**	0.04***	0.12***	0.18***	0.15***	0.23***	1.00		
Debt_R	-0.07***	-0.37***	-0.30***	-0.02**	0.10***	0.02**	-0.23***	0.15***	0.18***	0.07***	0.19***	-0.04***	0.24***	0.12***	1.00	
Exchang_R	0.01	0.01	0.00	0.14***	-0.03***	0.03***	-0.03***	0.02**	0.00	-0.06***	-0.07***	-0.03***	-0.07***	-0.12***	0.01	1.00
Ln(Asset)	0.15***	0.00	-0.29***	-0.01	0.05***	0.14***	-0.20***	0.21***	0.36***	0.22***	0.06***	-0.10***	0.03***	-0.01	0.47***	0.10***

Notes: 1. Numbers in parentheses: (1) for DEA, (2) for ROA, (3) for Priv_D, (4) for Export_R, etc.

2. ***, ** and * denote a statistical significance at 1%, 5%, and 10% levels in two-tailed tests, respectively.

Table 5. Group Mean Tests between Privatized and Non-Privatized Firms

Variables	Privatized Firms(A)	Non-Privatized Firms(B)	Difference (A-B)	t-statistic
DEA	0.921	0.922	-0.001**	-2.179
ROA	0.043	0.027	0.016***	13.759
Export_R	0.028	0.017	0.011***	6.960
FDI_R	0.539	0.507	0.032***	2.408
Ln(Patent)	3.108	3.063	0.044*	1.492
RD_ExpR	0.022	0.017	0.004***	14.008
Gov_Sh	0.002	0.082	-0.079***	-35.579
Market_Sh	0.074	0.129	-0.055***	-16.561
HHI	0.137	0.179	-0.042***	-19.845
Turnover	0.568	0.689	-0.121***	-16.049
MFG_D	0.833	0.814	0.019***	2.526
Inventory_R	0.132	0.15	-0.019***	-9.449
Tang_R	0.908	0.938	-0.030***	-17.291
Debt_R	0.365	0.489	-0.124***	-33.111
Exchang_R	6.442	6.441	0.001	0.195
Ln(Asset)	21.714	22.379	-0.665***	-31.876

IV. Data and Regression Analyses

1. Samples and Descriptive Statistics

This study uses the RESSET and CSMAR for information on firms listed on Shanghai and Shenzhen stock markets from 2009 to 2017. It applies the following exclusion criteria in the selection of sample firms. First, only firms that have provided financial information for at least two consecutive years to use the financial ratio using the previous year's asset size, etc., during the 2009-2017 sample period are included. Second, only a few outliers that might cause serious errors in the regression analyses are excluded. Third, firms without information on the variables used in the study are excluded. Fourth, firms in the financial industry with different accounting principles applied and thus hard to compare are excluded.

Table 2 summarizes the numbers of samples classified by year and group, privatized and non-privatized firms. From 2009 to 2017, privatized firms accounted for about 59.2% of Chinese firms. Among all firms, privatized firms accounted for 41.9% in 2009, 51.52% in 2011, 59.76% in 2013, and 64.11% in 2017, showing that privatization has been accelerating over the years since 2009.

Table 3 presents summary statistics of the variables used. First, the average of corporate efficiency (DEA) index is about 0.921, and its standard deviation is 0.0335. Profitability (ROA), another dependent variable reflecting corporate performance, has an average of 3.66% with a standard deviation of 6.00%. The averages of the dummy variable for privatized firms (Priv_D), export ratio (Export_R), and FDI (FDI_R) are 59.17%, 2.34%, and 52.58%, respectively, and the average patent rights owned in natural logarithm (Ln(Patent)) is about 3.09.

Table 6. Effects of Privatization, Exports, FDI and Innovation Competence on Efficiency

Variable DEA	(1) Full Samples		(2) Privatized Firms		(3) Non-Privatized Firms	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Priv_D	0.0023*	1.62				
Export_R	0.0059*	1.47	-0.0052	-0.64	0.0101	1.15
(Export_R)^2	-0.0088**	-1.90	0.0121	0.75	-0.0139*	-1.28
FDI_R	0.0069***	7.01	0.0069***	4.85	0.0077***	5.59
(FDI_R)^2	-0.0030***	-8.60	-0.0036***	-6.54	-0.0028***	-6.26
Ln(Patent)	0.0037***	24.30	0.0037***	16.68	0.0039***	18.43
RD_ExpR	-0.0978***	-4.27	-0.0860***	-2.68	-0.1056***	-3.15
Gov_Sh	0.0032*	1.62	0.0183	1.08	0.0040**	2.11
Market_Sh	0.0098***	4.24	0.0128***	3.57	0.0086***	2.92
HHI	0.0342***	8.10	0.0418***	6.95	0.0251***	4.14
Turnover	0.0584***	51.15	0.0670***	38.29	0.0517***	34.13
MFG_D	-0.0475***	-30.25	-0.0513***	-23.75	-0.0414***	-17.77
Inventory_R	-0.0027	-0.65	-0.0048	-0.84	0.0018	0.29
Tang_R	-0.0023	-0.72	-0.0009	-0.22	0.0004	0.06
Debt_R	-0.0329***	-16.70	-0.0328***	-12.28	-0.0345***	-11.26
Exchang_R	0.0030***	4.96	0.0027***	3.21	0.0034***	3.88
Ln(Asset)	0.0024***	5.15	0.0041***	6.34	0.0003	0.46
Constant	0.8493***	70.10	0.8144***	50.23	0.8896***	45.46
Obs. (Firms)	10,950 (2,221)		6,479 (1,458)		4,471 (881)	
R^2 Within	0.3643		0.3634		0.3894	
R^2 Between	0.4906		0.4702		0.5135	
R^2 Overall	0.4701		0.4550		0.5030	
F test	293.70***		178.58***		142.44***	
LM test	6,485.49***		2,891.20***		3,127.93***	
Hausman test	283.02***		379.01***		73.86***	
VIF test	1.06~1.65		1.01~1.45		1.06~1.65	

Notes: 1. Based on model specification tests such as Lagrange multiplier test (LM test) and Hausman test, both significant at 1% level (in two tailed test), fixed effects models are selected, and their results are reported.
2. ***, ** and * denote a statistical significance at 1%, 5% and 10%, respectively.

The averages of the control variables are 1.97%, 9.66%, 15.44%, and 61.75% for R&D investment ratio (RD_ExpR), market share (Market_Sh), ownership concentration (HHI), and total asset turnover (Turnover), respectively. The averages of manufacturing firm dummy variables (MFG_D), inventory ratio (Inventory_R), tangible assets ratio (Tang_R) and debt ratio (Debt_R) are 82.54%, 13.91%, 92.00%, and 41.56%, respectively. Finally, the average of firm size or total assets in a thousand yuan (Ln(Asset)) expressed in the natural log is about 21.99.

2. Correlation Analyses

Table 4 presents the Pearson correlation coefficient table showing the correlations between the variables used in this study. The correlations between variables are mostly significant at the 1% level. In such cases, multicollinearity problems should be diagnosed using the variance inflation factor (VIF) tests and must be taken care of, accordingly and properly.

3. Mean Comparison Tests

Table 5 presents the statistical differences in group means of major variables, separated into the privatized and non-privatized firm groups.

4. Regression Analyses

In this section, the effects of privatization on Chinese firms' efficiency and managerial performance (ROA) are analyzed using panel analysis models, and their results are reported. This study presents the results of analysis of the fixed effect models (FEMs), instead of the ordinary least squares models and the random effects models (REMs), using the empirical test analysis model defined earlier. To test the significance of time-series effects across years shown in the test models, we performed a Lagrange multiplier tests (LM tests). Through Hausman tests, all statistically significant, FEMs are selected better fitted ones over REMs.

4.1. Effects of Privatization, Exports, FDI and Innovation Competence on Efficiency

In this section, concerning H1–H4, the effects of the privatization process, exports, FDI, and innovation competence on the firm's efficiency index (DEA) in China are analyzed using FEMs and the results are reported in Table 6. The entire sample firms are divided into privatized and non-privatized firms. The F test results are all significant at the 1% level and the adjusted r-squared values are 0.4906, 0.4702, and 0.5135, respectively. Additionally, the variance inflation factor (VIF) values are insignificant, within a range of 1.00–1.50 for each group, much smaller than the general rejection level of 10.

In the case of the dummy variable Priv_D, which is an explanatory variable, the beta coefficient value is 0.0023, a statistically significant positive (+) value at the 10% level. This supports H1 as it shows that the privatization process has an improvement effect on corporate efficiency. The same conclusion can be confirmed with the previous studies (Majumdar, 1998; Martín & Roman, 2001; Tiemann & Schreyögg, 2012). The squared export ratio (Export_R^2) coefficient is negative, and thus, exports have inverse U-shaped effects on corporate efficiency. This means that as exports increase, the efficiency of firms rises first, and beyond a certain level, it declines, supporting H2. FDI (FDI_R) shows similar results of inverse U-shaped effects on efficiency.

Additionally, the number of patents held (Ln (Patent)) shows a statistically significant positive (+) effect at the 1% level in all firms, privatized and non-privatized firms on firm efficiency (DEA). These results support H4. Regarding the control variables, market share, the concentration of ownership (HHI), total asset turnover (Turnover), and exchange rate (Exchang_R) all have a significant positive (+) effect on corporate efficiency (DEA) at the 1% level. The dummy variable (MFG_D) and the debt ratio (Debt_R) are found to have a negative (-) effect on corporate efficiency.

Table 7. Long-term Effects of Privatization, Exports, FDI and Innovation Competence on Efficiency

Variable DEA	(1) Same Year (t+0)		(2) 1 Year Later (t+1)		(3) 2 Years Later (t+2)		(4) 3 Years Later (t+3)		(5) 4Years Later (t+4)		(6) 5 Years Later (t+5)	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Priv_D	0.0023*	1.62	0.0006	0.34	-0.0052***	-2.75	-0.0051**	-2.28	-0.0034	-1.19	0.0038	0.93
Export_R	0.0059*	1.47	0.0070**	2.18	0.0043	1.23	0.0059	1.00	-0.0019	-0.29	0.0014	0.19
$(Export\_R)^2$	-0.0088**	-1.90	0.0092**	1.66	-0.0029	-0.29	0.0280*	1.29	-0.0171	-0.67	-0.0150	-0.54
FDI_R	0.0069***	7.01	-0.0009**	-1.81	-0.0013***	-2.66	-0.0014***	-2.72	-0.0002	-0.36	0.0006	0.86
$(FDI\_R)^2$	-0.0030***	-8.60	-0.0013***	-4.07	-0.0006**	-2.11	0.0007**	1.88	0.0009**	2.10	0.0003	0.57
Ln(Patent)	0.0037***	24.30	-0.0016***	-8.91	-0.0005***	-2.38	-0.0004**	-2.07	-0.0002	-0.72	-0.0002	-0.69
RD_ExpR	-0.0978***	-4.27	-0.0053	-0.21	-0.0020	-0.07	0.0111	0.34	0.0060	0.15	0.0725*	1.48
Gov_Sh	0.0032*	1.62	-0.0004	-0.17	0.0004	0.18	-0.0008	-0.28	0.0006	0.18	0.0001	0.01
Market_Sh	0.0098***	4.24	0.0132***	4.98	0.0137***	4.68	0.0135***	3.78	0.0144***	3.16	0.0240***	4.22
HHI	0.0342***	8.10	0.0294***	6.31	0.0256***	5.09	0.0212***	3.59	0.0187***	2.51	0.0114	1.19
Turnover	0.0584***	51.15	0.0580***	46.98	0.0568***	43.55	0.0563***	37.32	0.0575***	30.01	0.0538***	21.73
MFG_D	-0.0475***	-30.25	-0.0459***	-24.97	-0.0458***	-22.78	-0.0448***	-20.00	-0.0443***	-16.32	-0.0448***	-13.03
Inventory_R	-0.0027	-0.65	-0.0038	-0.81	-0.0048	-0.96	-0.0036	-0.61	-0.0074	-1.06	-0.0101	-1.08
Tang_R	-0.0023	-0.72	-0.0003	-0.09	0.0008	0.23	-0.0007	-0.16	-0.0018	-0.35	-0.0060	-0.93
Debt_R	-0.0329***	-16.70	-0.0330***	-15.04	-0.0340***	-14.29	-0.0329***	-12.13	-0.0349***	-10.54	-0.0394***	-9.78
Exchang_R	0.0030***	4.96	0.0025***	3.8	0.0011*	1.46	0.0010	1.23	-0.0003	-0.30	0.0003	0.23
Ln(Asset)	0.0024***	5.15	0.0055***	10.21	0.0053***	9.07	0.0063***	9.06	0.0069***	8.00	0.0057***	5.27
Constant	0.8493***	70.10	0.8013***	59.53	0.8152***	56.45	0.7930***	47.05	0.7869***	37.75	0.8134***	31.41
Obs. (Firms)	10,950 (2,221)		9,936 (2,148)		9,150 (2,093)		7,438 (1,882)		5,774 (1,740)		4,255 (1,634)	
R^2 Within	0.3643		0.3192		0.3027		0.2923		0.2744		0.2461	
R^2 Between	0.4906		0.4539		0.4464		0.4407		0.4608		0.4698	
R^2 Overall	0.4701		0.4214		0.4095		0.4070		0.4257		0.4396	
F test	293.7***		242.95***		203.76***		152.54***		101.31***		56.71***	
LM test	6,485.49***		5202.68***		4,502.8***		3,336.58***		2,220.06***		1,471.96***	
Hausman test	283.02***		403.58***		257.34***		239.01***		107.93***		60.47***	
VIF test	1.06~1.65		1.09~1.73		1.04~1.77		1.01~1,77		1.01~1.75		1.02~1.67	

Notes: 1. Based on model specification tests such as Lagrange multiplier test (LM test) and Hausman test, both significant at 1% level (in two tailed test), fixed effects models are selected, and their results are reported.
2. ***, ** and * denote a statistical significance at 1%, 5% and 10%, respectively.

The long-term effects on corporate efficiency are diagnosed and shown in Table 7. The model's fitness is actually the same as the previous regressions; therefore, further explanations are skipped. The dummy variable (Priv_D) of the privatized firm has a significant positive (+) effect on corporate efficiency (DEA), significant at the level of 10%, for the year, with negative (-) effects after 2 years. The export ratio (Export_R) shows inverse U-shaped effects on corporate efficiency, at the significance level of 10% and 5%, respectively, for the year and one year later.

FDI (FDI_R) also has inverse U-shaped effects on corporate efficiency (DEA) in the year, but U-shaped effects from 1 year to 3 years later, all significant at the 1% level. The number of patents held (Ln(Patent)) shows a significant positive (+) effect at the 1% level only for the current year, and a significant negative (-) effect on corporate efficiency (DEA) continued from 1 year to 3 years later. The results are against the related research hypotheses.

4.2. Effects of Privatization, Exports, FDI and Innovation Competence on Profitability

Concerning H5–H8, we analyzed the effects of the privatization process, exports, FDI, and innovation competence on the firm's profitability (ROA) in China using FEMs and the results are reported in Table 8.

As before, the entire sample firms are divided into two groups: privatized and non-privatized firms. The F test results are all significant at the 1% level and the adjusted r-squared values between firms are 0.5332, 0.4875, and 0.5578, respectively. Additionally, the VIF values are also insignificant, much smaller than the general rejection level of 10.

The beta coefficient value of the dummy variable (Priv_D) for privatized firms is 0.0148 and statistically significant at the 1% level, indicating that the profitability of privatized firms in ROA is about 1.5%p higher than non-privatized firms. This result also supports H5, consistent with that of La Porta et al. (1999).

Exports have U-shaped effects on corporate profitability because the squared export ratio (Export_R^2) coefficient is negative (-), significant at the 1% level in all firms and non-privatized firms. This means that as exports increase, firms' profitability declines first, and beyond a certain level, it rises for all firms and non-privatized firms only in the tests, but not for privatized firms only. We cannot conclude that the effects for privatized firms are positive. FDI_R shows similar results of U-shaped effects on corporate profitability. This contradicts H6 all the firms and non-privatized firms only. The effects of FDIs are negative for the privatized firms, clearly contradicting H6. Additionally, corporate efficiency (DEA) has a significant positive (+) effect on firms' profitability (ROA) at the 1% level in the entire group and subgroups.

The coefficients of manufacturing firm dummy (MFG_D) show positive (+) effects, statistically significant at the 1% level in all firms and non-privatized firms, on the profitability (ROA) of firms. Additionally, the concentration of ownership (HHI) is found to have a significant positive (+) effect at the 1% level on the profitability (ROA) of firms in privatized firms. However, the total asset turnover ratio (Turnover) and debt ratio (Debt_R) are found to have a statistically significant negative (-) effect at the 1% level in all groups on the firm's profitability (ROA).

The long-term effects on corporate profitability are diagnosed, and the results are shown in Table 9. The model's fitness is actually the same as the previous regressions; thus, further explanations are skipped. The dummy variable (Priv_D) of the privatized firm has a significant positive (+) effect on corporate profitability (ROA), significant at the level of 1% and 5%, respectively, for the year and the subsequent year. The corporate efficiency of privatized SOEs improves their profitability for 5 years after privatization, including the year, all significant at the level of 1%.

The coefficient of the squared export ratio (Export_R^2) is positive (+), significant at the 1% for all firms for the year and one year later, exports have U-shaped effects on corporate profitability (ROA). FDI_R also has U-shaped

effects on corporate profitability (ROA) significant at 5% 10%, and 5% levels in the year, 2 years, and 5 years, respectively. The number of patents held (Ln(Patent)) shows a significant positive (+) effect at the 1% level only for the current year, and a significant negative (-) effect on corporate profitability (ROA) continued from 1 year to 3 years later. This result is contrary to research H8a for the long-term effects, while supporting H8 for the short-term effects.

Table 8. Effects of Privatization, Exports, FDI and Innovation Competence on Profitability

Variable ROA	(1) Full Samples		(2) Privatized Firms		(3) Non-Privatized Firms	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Priv_D	0.0148***	4.69				
Export_R	-0.0643***	-7.14	-0.0158	-0.93	-0.0699***	-3.17
$(Export\_R)^2$	0.0917***	8.73	0.0133	0.39	0.0564**	2.06
FDI_R	-0.0059***	-2.66	-0.0039*	-1.31	-0.0039	-1.12
$(FDI\_R)^2$	0.0017**	2.13	-0.0001	-0.08	0.0019**	1.67
Ln(Patent)	-0.0061***	-17.11	-0.0055***	-11.74	-0.0067***	-12.24
RD_ExpR	-0.0194	-0.37	0.0007	0.01	-0.0896	-1.06
DEA	1.4037***	57.95	1.3796***	46.58	1.4108***	33.55
Gov_Sh	0.0021	0.48	0.0296	0.84	0.0007	0.14
(Skipped)	Skipped for Simplicity					
Constant	-1.3568***	-39.61	-1.2873***	-30.89	-1.4157***	-22.91
Obs. (Firms)	10,950 (2,221)		6,479 (1,458)		4,471 (881)	
R^2 Within	0.3754		0.3935		0.3540	
R^2 Between	0.5332		0.4875		0.5578	
R^2 Overall	0.4947		0.4910		0.4886	
F test	290.8***		190.99***		115.2***	
LM test	894.46***		571.52***		314.96***	
Hausman test	275.15***		136.78***		97.78***	
VIF test	1.06~1.95		1.01~1.91		1.03~2.12	

Notes: 1. Based on model specification tests such as Lagrange multiplier test (LM test) and Hausman test, both significant at 1% level (in two tailed test), fixed effects models are selected, and their results are reported.
2. ***, ** and * denote a statistical significance at 1%, 5% and 10%, respectively.

Table 9. Long-term Effects of Privatization, Exports, FDI and Innovation Competence on Profitability

Variable ROA	(1) Same Year (t+0)		(2) 1 Year Later (t+1)		(3) 2 Years Later (t+2)		(4) 3 Years Later (t+3)		(5) 4Years Later (t+4)		(6) 5 Years Later (t+5)	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Priv_D	0.0148***	4.69	0.0079**	2.17	0.0042	1.04	-0.0056	-1.13	0.0044	0.67	0.0035	0.38
Export_R	-0.0643***	-7.14	-0.0016	-0.23	0.0172**	2.28	0.0148	1.14	-0.0166	-1.09	-0.0134	-0.82
$(Export\_R)^2$	0.0917**	8.73	-0.0030	-0.14	-0.0268*	-1.28	0.0119	0.25	0.0400	0.69	0.0471	0.76
FDI_R	-0.0059***	-2.66	-0.0001	-0.12	-0.0014*	-1.29	-0.0010	-0.89	-0.0026**	-1.77	-0.0006	-0.39
$(FDI\_R)^2$	0.0017**	2.13	0.0005	0.68	-0.0004*	-1.59	0.0002	0.21	0.0010	1.00	0.0025***	2.36
Ln(Patent)	-0.0061***	-17.11	0.0001	0.18	-0.0012***	-2.94	-0.0020***	-4.24	-0.0007	-1.16	-0.0005	-0.70
RD_ExpR	-0.0194	-0.37	-0.0907*	-1.62	-0.0785*	-1.33	-0.1471***	-2.06	-0.2123***	-2.37	-0.1999**	-1.81
DEA	1.4037***	57.95	1.2952***	52.32	1.2842***	50.27	1.2737***	42.97	1.2151***	33.90	1.1930***	26.99
Gov_Sh	0.0021	0.48	0.0010	0.20	0.0007	0.13	0.0013	0.21	-0.0027	-0.34	-0.0065	-0.69
(Skipped)												
Constant	-1.3568***	-39.61	-1.1941***	-33.68	-1.1998***	-32.16	-1.1927***	-27.11	-1.2113***	-21.97	-1.1663***	-17.00
Obs. (Firms)	10,950 (2,221)		9,936 (2,148)		9,150 (2,093)		7,438 (1,882)		5,774 (1,740)		4,255 (1,634)	
R^2 Within	0.3754		0.3558		0.3617		0.3370		0.3086		0.3099	
R^2 Between	0.5332		0.5296		0.5548		0.5101		0.5398		0.4910	
R^2 Overall	0.4947		0.4927		0.4977		0.4756		0.4634		0.4533	
F test	290.8***		268.26***		249.33***		176.03***		112.11***		73.12***	
LM test	894.46***		822.85***		657.89***		405.47***		216.3***		171.36***	
Hausman test	275.15***		205.62***		156.38***		97.47***		114.61***		88.43***	
VIF test	1.06~1.95		1.10~1.85		1.04~1.84		1.01~1.84		1.01~1.85		1.02~1.86	

Notes: 1. Based on model specification tests such as Lagrange multiplier test (LM test) and Hausman test, both significant at 1% level (in two tailed test), fixed effects models are selected, and their results are reported.
2. ***, ** and * denote a statistical significance at 1%, 5% and 10%, respectively.

4.3. Relationships among Innovation Competence, Efficiency, Exports and Profitability

In this section, the effects of the number of patents (Ln(Patent)), firm efficiency (DEA), export ratio (Export_R), and return on total assets (ROA) are regressed on each other, using the simultaneous equations model (SEM) based on the previous analyses.

From the table, we can verify the conclusions in the earlier sections. With many dependent variables at the same time in consideration and mutual effects on each other, we have more and clear effects of privatization on those of our concern by using simultaneous equations models (SEMs). We take the conclusions in this section as the final and robust ones.

First, the privatization (Priv_D) of SOEs in China improves their innovation competence, measured in the number of patents, overall corporate efficiency, exporting capability and profitability (though the last one, statistically not significant only in SEMs). The innovation competence of firms, measured in the number of patents (Ln(Patent)), has positive effects on their corporate efficiency and exporting capability, but negative effects on their profitability (all statistically significant).

Table 10. Relationships among Innovation Competence, Efficiency, Exports and Profitability

Variables	(1) Ln(Patent)		(2) DEA		(3) Export_R		(4) ROA	
	Coefficients	z-stats	Coefficients	z-stats	Coefficients	z-stats	Coefficients	z-stats
Priv_D	0.397***	4.35	0.001 ***	2.37	0.239 ***	3.00	0.002	0.61
Ln(Patent)			0.001 **	1.90	1.130 ***	2.50	-0.032***	-3.09
DEA	16.800***	2.98			-0.714	-0.98	1.482***	9.98
Export_R	-19.398***	-3.04	0.065 ***	3.53			1.629***	13.86
$(Export\_R)^2$	14.608***	54.80	-0.047 ***	-3.21			-1.248***	-14.08
ROA	-25.234***	-3.15	0.224 ***	17.40	-37.276 ***	-3.46		
FDI_R	1.204***	17.24	0.005 ***	3.90	-0.245	-1.26	-0.070***	-17.24
$(FDI\_R)^2$	-0.312***	-10.11	-0.002 ***	-5.56	0.026	0.46	0.018***	11.94
RD_ExpR	29.348***	10.37	-0.110 ***	-6.93	-9.560	-1.09	0.760***	3.83
Gov_Sh	-0.122	-0.71	0.000	0.07	-0.256	-1.13	0.023***	2.44
(Skipped)								
Constant	-29.132***	-14.41	0.849 ***	108.19	-1.342	-0.45	-1.285***	-21.93
Obs (Firms)	10,950 (2,061)							
Rho	41,980.35***							

Notes: 1. The test results from simultaneous equations models (SEMs) are reported.
2. ***, ** and * are statistically significant at the level of 1%, 5% and 10% (one-side tests), respectively.

The corporate efficiency (DEA) of firms has positive effects on their innovation competence (Ln(Patent)) and profitability (ROA), but negative effects on their exports (though not statistically significant in SEMs). Additionally, the R&D expenditures (RD_ExpR) have negative (-) effects on their efficiency (DEA) and exports, but positive (+) effects on their innovation competence (Ln(Patent)) and return on assets (ROA).

The export ratio (Export_R) has inverse U-shaped effects both on their efficiency (DEA) and return on assets (ROA), but U-shaped effects on their innovation competence (Ln(Patent)). Similarly, overseas direct investment (FDI_R) has inverse U-shaped effects both on their innovation competence (Ln(Patent)) and efficiency (DEA), but U-shaped effect on their exports (though not statistically significant) and return on assets (ROA). We skip the explanations for the other variables for simplicity.

V. Conclusion

This study investigates the short-term and long-term effects of exports, FDI, and innovation competence on the efficiency and profitability of privatized firms in China. A merged dataset from RESSET and CSMAR databases, including 10,950 observations (year-firms), is used for those firms listed on the Shanghai and Shenzhen Stock Exchanges for 9 years from 2009 to 2017. Using the DEA index measured by CCR methodology, this study investigated the effects of privatization on corporate output, such as innovation competence, measured in the number of patents, the overall corporate efficiency, and exports of firms. In addition, to control for the interactive endogeneity effect, we used SEMs (simultaneous equations models). Our findings are summarized as follows.

First, the privatization of SOEs in China improves their innovation competence, measured in the number of patents, overall corporate efficiency, and firms' exports.

Second, the innovation competence of firms improves their corporate efficiency and exports, but it aggravates their profitability. Moreover, the R&D expenditures improve their innovation competence and ROA, but they aggravate their efficiency and exports.

Third, the corporate efficiency of privatized SOEs improves their profitability for 5 years after privatization, including the year.

Fourth, exports have inverse U-shaped effects on efficiency and ROA, but U-shaped effects on their innovation competence.

Fifth, overseas foreign investments have inverse U-shaped effects on innovation competence and efficiency, but a U-shaped effect on ROA, whereas their effects on exports are not significant.

Sixth, the positive effects of privatization on corporate profitability and such U-shaped effects of exports on corporate profitability last for one year after privatization, whereas the U-shaped effects of FDI last for 3 years.

Our findings regarding privatization on corporate efficiency and performance are mostly consistent with prior studies. However, we also report U-shaped effects, not inverse U-shaped, effects of exports and FDIs on corporate innovation, which means that exports affect positively corporate innovation activities to some level, and then negatively. This study further reports U-shaped effects, not inverse U-shaped, effects of FDIs on corporate profitability, which means that exports affect positively firms' ROA to some level, and then aggravate their profitability.

The results in general imply that globalization improves Chinese firms' productivity, efficiency, and/or performance up to some level and for a limited time. The improved efficiency improves firms' profitability at least for 5 years. Therefore, the primary goal of privatization of SOEs must be the improvements in efficiency, technological efficiency, human resource management, and business operation, not the privatization itself.

Based on our test results, we can conclude that the empirical tests focusing both on short-term effects may not persist for a long time and linear effects are not pertinent ways to diagnose their effects. Therefore, we need to develop various ways to measure the efficiency of privatized SOEs to enforce their long-term growth in size and values.

This study needs improvements in some aspects. First, in needs to extend its sample period including recent years especially with the period of Covid 19, or some periods in economic peril. Second, it further needs to incorporate the heterogeneous traits in privatization of SOEs such as industry types, regions, requirements for public services after privatization, etc. Finally, even though maybe not the last, it further needs a linkage to a theoretical model to explain better the results of empirical tests, rather than simply reporting them as findings.

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How Does Financial Technology Drive Enterprise Innovation in China?*

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ABSTRACT

Purpose – As a new product of the traditional financial empowerment form through digital technology, financial technology (Fintech) allows a new financial service model and brings changes to enterprises. This study aims to find the channels through which Fintech affects enterprise innovation in China from the perspective of financial management.

Design/Methodology/Approach – This study constructs an econometric model using the data of Chinese A-share listed companies from 2011 to 2019 to examine the influence of Fintech development on enterprise innovation and its transmission mechanism.

Findings – The empirical results show that the development of Fintech does indeed have a driving effect on enterprise innovation. Fintech promotes enterprise innovation by alleviating financial constraints, reducing the enterprise financial expense rate, and increasing the stability of the enterprise against the backdrop of the high-quality development of China's economy.

Research Implications – This study implies that actively promoting the development of the Fintech industry can promote the innovative development of enterprises; thus, policy and technical support are indispensable for promoting the development of Fintech. Also, the government should improve the regulatory system of Fintech to prevent financial risk.

Keywords: enterprise innovation, enterprise stability, financing constraints, financial expenses, financial technology

JEL Classifications: O16, O32, O38

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I. Introduction

Today, technological progress has become the primary factor driving economic growth in two ways: First, by using the way of technological progress, through the penetration of the three factors of productivity. Second, by forming an independent industry on a high-tech basis (Balatsky & Yurevich, 2020).

Currently, China is at a critical juncture of shifting its economic growth rate, as well as the transformation and upgrading of its industrial structure. China's development impetus has become more sustainable after shifting from factor-driven to innovation-driven growth, due to aninnovation-driven development strategy (Zhou et al., 2020).

Thus, driving enterprise innovation is an important issue in China. Looking at the historical development trajectory of global enterprises, such trajectories are tangibly linked to strong financial support during the period of growth. Grennan and Michaely (2021) found that stock market development could effectively contribute to corporate innovation output by alleviating external financing constraints, while the expansion of the banking sector and its marketization have a more limited role in promoting corporate innovation. However, it must be noted that there are many imperfections in China's financial system, the direct financing scale is relatively small, and disadvantages such as high inefficiency and costs in the indirect financing market, coupled with an imperfect supervision and legal system, has hindered the financing of many innovative enterprises for an extended period (Chen & Yoon, 2021).

Financial technology (Fintech), a technology-driven financial innovation (Brummer & Yadav, 2019), is an important driving force of financial supply side structural reform. Fintech refers to the use of artificial intelligence, big data, cloud computing, and other new transformative, technologically driven, innovative financial products, business models, and business processes, and has become a research hotspot for scholars both domestically and abroad (Lee & Shin, 2018; Leong & Sung, 2018; Schueffel, 2016). The rise in Fintech has gradually reorganized the existing financial ecosystem. In 2019, the People's Bank of China issued the Development Plan (Fintech) (2019-2021), which clearly put forward the guiding ideology, development goals, and key tasks of Fintech work, and put Fintech in an extremely important position in future financial development planning. Whether digital finance-characterized by sharing, convenience, low cost, and a low threshold can drive enterprise technological innovation through precision user portraits, fine risk pricing, and intensive business processes (Demertzis et al., 2018) is a practical problem worth exploring. The existing literature discusses how to support enterprise technological innovation from the perspective of financial development, policy support, and human capital (Aghion & Howitt, 2017; Li et al., 2020; Seyoum, Wu, & Yang, 2015). Considering the brief period of Fintech development, more literature focuses on how Fintech affects the growth rate of total factor productivity (Yao et al., 2021), promotes entrepreneurship (Balsmeier & Woerter, 2019), and affects financial demand (Grennan & Michaely, 2021), amongst other considerations.

The above results provide strong theoretical support and methods for exploring a series of issues caused by "Fintech-enterprise innovation", but they lack a complete analytical framework and empirical conclusions on Fintech issues in enterprise technology innovation. Given the scale of China's Fintech development and its leading position in the world's technology practice, an in-depth study of this issue has strong practical value and significance from an interdisciplinary research perspective, under the general trend of the rapid development of big data and artificial intelligence.

Differing from previous research, the novel contributions of this study are as follows. First, it focuses on verifying the relationship between Fintech and enterprise technological innovation, and focuses on judging whether Fintech can promote innovation at different levels of enterprises. Second, it draws on the mediating effect model of Baron and Kenny (1986) and Zhao

et al. (2010): that is, the specific transmission mechanisms of Fintech affecting technological innovation, to prove the differentiated mechanism paths, such as financial constraints, financial cost rate, and enterprise financial risk. The above identification test aims to clarify the specific transmission mechanism of Fintech affecting technological innovation.

II. Theoretical Background and Hypotheses

Fintech can provide diversified financing methods for enterprises, solve financing difficulties and expensive financing problems by broadening financing channels, accelerate capital flow, and provide effective financial support for enterprises to achieve technological upgrading (Cristina & Luis, 2021). Moreover, it can enhance the risk tolerance of an enterprise, make it more effective in high-risk and high-yield projects, and improve enterprise investment efficiency (Morales, 2003). Finance is a core component of the micro-subject technological innovation environment, and an effective financial supply directly impacts the development of technological innovation activities (Wamda & Payfort, 2017). In essence, Fintech, with the help of big data, cloud computing, blockchain, and artificial intelligence, improves the high-risk premium and high operating costs due to information asymmetry (Haddad & Hornuf, 2019; Rega, 2017), and provides stable technical support for the expanding the scope of financial services and accessibility (Guo et al., 2020). Compared with early "Internet finance" research hot spots, Fintech has more breadth and depth; be it with regard to digital payment, network lending, or other specific forms, it has greatly reduced the financial market search and risk identification cost, changed the linkages of value delivery in business models, expanded new business spaces, and provided opportunities for enterprise technology innovation. Based on the above analysis, this study proposes the following hypothesis.

H1: Fintech can effectively promote enterprise innovation activities.

The theoretical level of depicting the transmission path of Fintech in promoting enterprise innovation is reflected primarily in the two aspects of supply and demand.

On the supply side, Fintech effectively consolidates financial resources at all levels in the market, resulting in a more effective supply (Arner et al., 2017; Iman, 2018). Traditional financial markets pay high costs to absorb investors with the characteristics of "many, small, and scattered". With the support of technologies such as artificial intelligence, big data, the Internet, distributed technology, and blockchain, Fintech can handle massive amounts of data, resulting in greater cost and risk reductions (Anagnostopoulos, 2018; Gomber et al., 2018). Thus, Fintech's low costs and low risks make it possible for long-tail groups to break through the restrictive threshold of financial services. This not only reduces the cost of financial institutions but also reduces corporate debt financing costs.

Conversely, Fuster et al. (2019) used US housing credit data, and after controlling for a range of factors that could affect the mortgage approval process, found that Fintech had increased the speed of loan approval by nearly 20%, and that this rapid approval did not increase the risk of default. Xiang et al. (2021) analyzed the small loan data of Ant Financial and found that it reduced the traditional bank loan review and issuance time from several months to three seconds. This loan review process, based on big data and artificial intelligence methods, also reduces human intervention and reduces the rent-seeking space in the loan approval process, thus reducing financing costs. With the support of financial technology, digital finance can provide richer financing channels at lower prices, which can effectively solve the financial constraints or difficulties and encourage more stable financial markets, and contribute to an increase in technological innovation (Chowdhurya & Maung, 2012; Leong & Sung, 2018). Thus, it can provide a solid foundation for strengthening enterprise technological innovations. Thus, the assumptions below were mad.

H2: Fintech can facilitate enterprise innovation by alleviating enterprise financial constraints.

H3: Fintech can promote enterprise innovation by reducing enterprise financial expense ratio.

H4: Fintech can promote enterprise innovation by improving the financial stability of enterprises.

III. Research and Design

1. Data

This study uses A-share enterprises listed in Shanghai and Shenzhen as research subjects, and constructs a panel dataset from 2011–2019, based on the starting year (2011) of the digital finance index and the year of CNDRS patent data cutoff for matching. Among these, the financial and patent data of enterprises come from the China Stock Market & Accounting Research Database (CSMAR), Chinese Research Data Services (CNDRS), and Wind databases, while the digital financial index of the Fintech agent variable is from the Digital Financial Inclusive Financial Index of Peking University. To ensure the reliability of the research data using the previous data processing methods, this study conducts the following data processing stipulations.

(1) It excluded financial and real estate enterprises.

(2) Enterprises listed in special treatment (ST) and delisted during the period were excluded.

(3) It excluded enterprises that had initial public offerings (IPO) during the sample period.

(4) To limit the impact of outlier fluctuation, we winsorized the variables in the data (excluding virtual variables).

(5) Samples with missing values were excluded. To reduce the interference of heterovariance, we used continuous variables.

2. Definition of the Variables

2.1. Explained Variable

Most previous studies held that enterprise research and development (R&D) was defined as technological innovation ability, but in reality, actual technological innovation activities have high-risk characteristics. Therefore, the use of these indicators to measure enterprise technology innovation ability has the potential to overstate an enterprise's innovation capability. At the same time, due to the disclosure system, the disclosure of R&D in Chinese non-financial listed companies was not comprehensive, resulting in incomplete datasets.

The number of enterprise patents were divided into three grades: (1) Patent, or the total number of patent applications; (2) Pati, which is the number of invention patent applications to characterize the core technology innovation ability of enterprises; and (3) Patud, the number of low-end patent applications of enterprises, with the sum of utility model patents and design patents as the proxy variable. The patent output variable group Pat indicates the degree of enterprise innovation, including Patent, Pati, and Patud, dealing with natural logarithmic processing due to the large difference in the degree of innovation among enterprises (Brava et al., 2018; Nguyen et al., 2021; Zhang et al., 2021; Zhou et al., 2019).

2.2. Explanatory Variable

The core explanatory variable was Fintech. At present, the measurement of the Chinese Fintech development level mainly adopted two methods: one based on Chen et al. (2018) using "text mining" through statistics and financial technology-related keywords in news or search engine release retrieval times, resulting in a synthetic construction of a financial technology index, but this method is limited to analyzing the national level of the development of financial technology, as it cannot be decompiled to the provincial level. The other is the Digital Financial Inclusive Finance Index compiled by the Internet

Financial Research Center of Peking University, which is based on data provided by Ant Financial to measure the degree of digital financial development at the provincial and urban levels (Hong Kong, Macao, Taiwan without China) (Guo et al., 2020). Measured using the three dimensions of coverage, breadth, use depth, and the digital degree of Internet financial services, this index will measure the development level of financial technology, which can cross provincial levels. This research draws on the variable design of Yang and Zhang (2020) and Liu et al. (2021) to use the degree of digital financial development (DIF) as a proxy variable for Fintech. The DIF index of provincial level is used in the core empirical part of the paper.

2.3. Mediation Variable

To further verify the transmission mechanism of the promoting role of Fintech on enterprise innovation, this study selects the following mediating variables from the perspective of alleviating financial constraints and reducing enterprise financial risk.

2.3.1. Financing Constraint Index (SA-index)

Previous literature noted that the representative measures of financing constraints were the KZ index (Kaplan & Zingales, 1997; Lamont et al, 2001), WW index (Whited & Wu, 2006), and SA index (Hadlock & Pierce, 2009), which contain many endogenous financial variables such as cash flow and leverage. To avoid an endogenous interference, Hadlock and Pierce (2010) divided enterprise financing constraints types in the enterprise financial report according to the KZ method, and they only constructed the SA index using two variables, enterprise size and a strong exogenous index. The SA index contains only the results of two relatively exogenous variables, the enterprise asset scale and business hours, and is consistent with the WW index and the cash flow sensitivity coefficient (Chen & Yoon, 2021; Hadlock & Pierce, 2010). Therefore, Hadlock and Pierce (2010) applied the following formula, SA-Index=-0.737*Size+0.043Size-0.04Age, with Size encompassing total enterprise assets and Age being the entire lifespan of the enterprise. Since the index calculated by this indicator is negative, the smaller the SA value, or the larger the absolute value, the more pronounced the financing constraints faced by enterprises.

2.3.2. Financial Expense Rate (FE)

The intensity of financial expenses is measured by the proportion of enterprise financial expenses in operating income, and this index can reflect expenses required by the enterprise to collect funds on the side.

2.3.2. Financial Risk (LnEMS)

In measuring corporate financial risk, Altman (2005) listed a total of 22 variables that may affect the financial situation in terms of liquidity, profitability, leverage, and solvency, and finally obtained the Z-score model, including five variables to measure the corporate financial situation of the enterprise. The model is recognized worldwide as a measure of corporate financial risk. The original Z-score model was used only by manufacturing companies to rate financial status, but in 1996, Altman further expanded the Z-value model and proposed the Emerging Market Score Model (EMS), a risk-scoring model primarily for emerging market companies, with specific grading ranges. The specific formula is EMScore = 6.56X 1+3.26X 2+6.72X 3+1.05X 4 + 3.25, where X1 is working capital/total assets, X2 is retained income/ total assets, X3 is operating income/total assets, and X4 is the book value/total liability of equity.

The financial risk rating standard is set by the equivalence of the U.S. debt rating when Z exceeds 5.85. The financial position is in the gray area when Z is between 5.85 – 4.15, and a company is in the crisis area at 1.75 – 4.15, and the financial position is less than 1.75. The EMS model has been widely cited in risk ratings in emerging markets after proposal by Altman, which confirmed that the model has been successfully applied in emerging market countries. China is a representative

emerging market. Makosa et al. (2021) and Guo et al. (2021) applied this model to the financial risk early warning research of Chinese listed companies and verified that this model provides a suitable early warning of financial risk. Therefore, this study uses the EMS model to measure the financial risk of listed companies.

2.4. Control Variables

According to the existing literature, this study adds a series of variables that can affect enterprise innovation (Hasan et al. 2020; Jin et al., 2021; Paradkar Knight, & Hansen, 2015). Variables include enterprise year of establishment (Age), asset debt rate (Lev), equity concentration (SD), largest shareholder concentration, total assets (Size), net profit growth rate (PG), and capital intensive (CD). Because of the variation in the level of technological innovation of enterprises between different industries, the industry effect (industry) is introduced in this article. The listed companies are divided into 19 large categories of 90 industry design virtual variables according to the Guidelines on Industry Classification of Listed Companies (Revised in 2012) (Chang et al., 2015; Li et al., 2020). If the enterprise belongs to this industry, the value is 1; otherwise, it is 0. As the macro environment and policies change, the level of technological innovation may vary greatly year-on-year. Therefore, we introduce the time effect (year) for setting the virtual variable, taking the value of 1 if the enterprise is in that year; otherwise, it is 0.

Table 1. Variable Name and Definition

	Variable Symbol	Variable Name	Variable definition
Explained Variables	Lnpatent	Total Enterprise Patents	Ln (total number of patents filed in the year + 1)
	Lnpati	Material Innovation Capacity	Ln (number of invention patents for the year + 1)
	Lnpatud	Non-Substantial Innovation Capacity	Ln (utility model patents + design patents + 1)
Explanatory Variables	DIF	Digital Financial Index	Digital Finance Inclusive Finance Index of Beijing University
Mediation Variable	FE	Financial Expense Rate	Financial expenses / operating income
	SA	Financing Constraints	SA-Index=-0.737*Size+0.043Size ^{2} -0.04Age
	LnEMS	Financial Risk	Enterprise Risk is Measured with the Altman (1995)'s EMS Model
Control Variables	Sales growth	Enterprise Growth, (%)	Current main business revenue / previous main business income-1
	Age	Establishment Year	(Study year-Established year) + 1
	Lev	Asset-Liability Ratio	Total liabilities / total assets
	SD	Equity Concentration Degree	Shareratio of largest shareholder
	Size	Total Assets and Scale	Natural number of logarithms of the total assets disclosed in the financial statements (millions)
	PG	Net Profit Growth Rate	(Current net profit-previous net profit) / previous net profit * 100%
	CD	Capital Density	The ratio of total assets to operating income

3. Research Model

3.1. Benchmark Model

To analyze the influence of Fintech on enterprise technological innovation, according to the theoretical analysis and research hypothesis of Li and Wang (2021), Makosa et al. (2021), as well as this paper, the following panel measurement model is set:

$$LnPat_{it} = a_0 + a_1 DIF + \sum Contral_{it} + \mu_{it} + \gamma_{it} + \varepsilon_{it}$$

In regression equation (1), the subscripts i and t represent the enterprise individual and period, respectively. The explained variable is the technological innovation capability of the enterprise, and the number of patent applications of the enterprise is taken as the proxy variable (Lnpatent, Lnpati, Lnpatud). The core explanatory variable is the provincial level DIF, to avoid endogenous and reverse causality and consider the lagging effect of earnings on innovation. This research delayed the allocation of financial asset incentives (DIF-1). Control represents a range of control variables that affect enterprise innovation. These successively include Corporate Year of Establishment (Age), Asset-Debt Rat (Lev), Equity Concentration (CD), Largest Shareholder Concentration, Total Assets (Size), Net Profit Growth (PG), and Capital Intensive (CD). In addition, to alleviate the impact of individual heterogeneity and period characteristics on enterprise innovation activities (Chen et al., 2018; Hasan et al., 2020), the industry fixed effect is represented by μi and period fixed effect by γt to eliminate the time-changing macroeconomic environment. ε is the model random error term, and is the model stochastic error term.

3.2. Mediation Mechanism Model

To further fully depict the transmission influence mechanism between the two, we should consider both technological innovation and the development of Fintech. Thus, this study selects the financing constraint (SA-index) of enterprises, financial expense rate (FE), and enterprise financial risk (LnEMS) as the mediating conduction variables. The following recursive equation is set to test the mediating mechanism of relevant variables to clarify the path of Fintech influencing technological innovation activities.

$$LnPat_{t+1} = \lambda_0 + cDIF_{-1} + \sum Contral_{it} + \mu_{it} + \gamma_{it} + \varepsilon_{it}$$

$$Mediatorit = \lambda_0 + aDIF_{-1} + \sum Contral_{it} + \mu_{it} + \gamma_{it} + \varepsilon_{it} + \tau_{it}$$

$$LnPat_{it} = \lambda_0 + c'DIF_{-1} + bMediatorit + \mu_{it} + \gamma_{it} + \omega_{it}$$

Panel data can be analyzed by a joint regression model, a fixed effect model, and a random effect model. The F verification results showed that the fixed-effect model was more efficient than the joint regression model. The Lagrange multiplier test results showed that the random effect model was more efficient than the joint regression model. At the same time, the Hausman verification result rejected the null hypothesis, showing that the fixed-effect model was superior. Therefore, in this study, regression analysis is conducted through a fixed effect model and the research results are interpreted.

Statistical significance of regression coefficients was reported using standard errors adjusted by the cluster standard error estimation method to control the correlation problem between heteroscedasticity and error terms of panel data.

IV. Results

1. Descriptive Statistics

Table 2 reports the mean, median, standard difference, minimum, and maximum values of the variables included in the analysis, and confirms

that there are no outliers or major violations of the regression hypothesis. The difference in innovation output between listed enterprises and the average is lower than the median, and it reflects the low innovation output of enterprises to a certain extent. The average DIF of Fintech is 237.2, and the standard difference of 90.75, which is explained by the development levels of Fintech in different provinces. The average FE is 0.014, and the median is 0.008, which indicates that the financial expense rate of most enterprises is above the average. The average LnEMS of enterprise financial risk is 2.407, the median is 2.453, the minimum is 1.198, and the maximum is 2.291, which reflects the positive financial situation of most enterprises. The mean SA-index of -3.796, with a minimum of -4.301 and maximum of -3.282, indicates the prevalence of financing constraints in listed companies.

Table 2. Descriptive Statistics

Variable	N	Mean	p50	SD	min	max
Lnpatent	22548	2.358	2.485	1.687	0	6.035
Lnpati	22548	1.652	1.609	1.453	0	5.204
Lnpatud	22548	1.820	1.792	1.603	0	5.472
DIF	22548	237.200	248.000	90.750	29.74	357.400
FE	22548	0.014	0.008	0.030	-0.045	0.127
LnEMS	22548	2.409	2.453	0.389	1.198	2.921
SA-index	22548	-3.796	-3.796	0.236	-4.301	-3.283
Size	22548	8.258	8.087	1.220	6.267	11.510
CD	22548	2.302	1.865	1.591	0.504	8.458
Lev	22548	0.408	0.398	0.201	0.066	0.833
SD	22548	34.750	32.980	14.560	10.490	69.160
PG	22548	-0.130	0.016	2.602	-11.270	8.801
Sales growth	22548	0.168	0.087	0.644	-0.903	3.303
Age	22548	17.750	18.000	5.445	7.000	30.000

The Pearson correlation coefficient table of Table 3 is the main variable, and the table data shows that the correlation coefficient of the independent variable financial technology (DIF) and Enterprise Innovation Index (Lnpatent, Lnpati, Lnpatud) are 0.109, 0.141 and 0.055, respectively. Thus, the previous hypotheses can be preliminarily verified.

Table 3. Correlation Matrix

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Lnpatent	1													
2	Lnpati	0.897***	1												
3	Lnpatud	0.919***	0.715***	1											
4	DIF	0.109***	0.141***	0.055***	1										
5	FE	-0.064***	-0.061***	-0.038***	-0.025***	1									
6	LnEMS	-0.019***	-0.024***	-0.048***	-0.009	-0.706***	1								
7	SA-index	0.065***	0.040***	0.074***	-0.314***	-0.124***	0.138***	1							
8	Size	0.318***	0.340***	0.309***	0.110***	0.309***	-0.353***	-0.112***	1						
9	CD	-0.149***	-0.124***	-0.138***	0.011	0.324***	-0.260***	-0.002	-0.009	1					
10	Lev	0.126***	0.128***	0.157***	-0.042***	0.538***	-0.642***	-0.139***	0.530***	-0.140 ***	1				
11	SD	0.008	-0.012*	0.040***	-0.070***	-0.041***	0.042***	0.135***	0.184***	-0.083 ***	0.049***	1			
12	PG	0.047***	0.045***	0.044***	-0.011	-0.109***	0.090***	0.015**	0.067***	-0.067 ***	-0.073***	0.048 ***	1		
13	Sales growth	0.071***	0.073***	0.071***	0.033***	-0.004	-0.035***	-0.036***	0.159***	-0.104 ***	0.118***	0.023 ***	0.260***	1	
14	Age	-0.043***	-0.012*	-0.046***	0.328***	0.127***	-0.130***	-0.924***	0.171***	0.013 **	0.156***	-0.102 ***	-0.019***	0.016**	1

Note: N=22548, ***p<0.01, **p<0.05, *p<0.1.

Table 4. Impact of Fintech on Firm Innovation: Fixed Effects Regression

	Model 1					
Variable	Lnpatent	Lnpati	Lnpatud	Lnpatent	Lnpati	Lnpatud
DIF-1	0.003***	0.003***	0.001***	0.002***	0.002***	0.001
	(6.11)	(6.86)	(3.16)	(4.35)	(5.66)	(1.30)
Size				0.674***	0.614***	0.570***
				(69.64)	(70.16)	(61.40)
CD				-0.119***	-0.086***	-0.111***
				(-18.25)	(-14.56)	(-17.73)
Lev				-0.378***	-0.340***	-0.160***
				(-6.51)	(-6.47)	(-2.87)
SD				-0.002***	-0.003***	-0.000
				(-3.06)	(-4.23)	(-0.21)
PG				0.008**	0.006	0.008**
				(2.20)	(1.64)	(2.17)
Sales growth				-0.079	-0.053***	-0.066***
				(-3.72)	(-2.77)	(-3.27)
Age				-0.011***	-0.007***	-0.009***
				(-5.80)	(-4.10)	(-4.66)
Constant	1.846***	1.134***	1.589***	-2.849***	-3.267***	-2.500***
	(19.45)	(13.24)	(17.84)	(-24.23)	(-30.73)	(-22.16)
Year FX	yes	yes	yes	yes	yes	yes
Industry FX	yes	yes	yes	yes	yes	yes
N	19, 243	19, 243	19, 243	19, 243	19, 243	19, 243
R-squared	0.292	0.230	0.312	0.467	0.418	0.458
Ad R-squared	0.289	0.226	0.309	0.464	0.416	0.456

Note: t-statistics in parentheses, ***p<0.01, **p<0.05, *p<0.1.

2. Regression Analysis Results

2.1. Financial and Corporate Innovation

According to the Hausman test results, P=0.000 is less than 0.05, and solidly adopts the fixed effect model regression, which follows the progressive regression processing idea. First, the univariate regression results are considered, while the fixed effects of year and industry are controlled. Secondly, relevant control variable sets were further included to test whether the empirical results were robust and reliable. Table 4 shows the results of examining the role between Fintech and enterprise innovation activities through Model 1. First, the test did not incorporate the relevant control variables to control for year and industry fixed effects. The results show that the regression coefficient of Fintech (DIF-1) is significantly positive in all three dimensions of enterprise innovation, but Fintech (DIF-1) is significantly lower than the previous two. This indicates that the development of Fintech significantly promotes enterprise innovation, but the impact on enterprise non-substantive patent innovation level is slightly weaker than substantive innovation. Second, after adding the relevant control variables, it can be seen that the return coefficient of Fintech (DIF-1) on the enterprise total patent innovation level (Lnpatent) and substantive patent innovation level (Lnpati) was positive, and both passed the 1% significance test, indicating that the development of Fintech improves substantive technological innovation ability, but has no significant impact on the enterprise non-substantive patent innovation level (Lnpatud). This means that through the development of Fintech, the core creativity of enterprises has improved, supporting H1. This study argues that (1) unlike the traditional financial model, the deep integration of financial technology and computer technology compensates for the shortcomings of traditional finance, provides more rich and diversified financing tools from the perspective of supply, and can promote more financial resources excluded from the formal financial system to provide financial support for the real economy and technical innovation departments. (2) Fintech frees financial activities from spatiotemporal restrictions. Through the application and dissemination of the Internet, it greatly promotes cross-regional and cross-industry information exchange, enhances research, development, and innovation cooperation between different regions, and realizes resource optimization allocation (Sokol, 2017). This effectively boosts the technological progress and patent output of enterprises. (3) Fintech integrates blockchain, cloud computing, artificial intelligence, and other Internet technologies to collect and classify non-standardized big data information, analyze, and make decisions, which can effectively alleviate information asymmetry within enterprises, between enterprises, and between enterprises and financial institutions. Under the support of Fintech, enterprises have improved their abilities to integrate and analyze information and can help enterprises judge the direction of innovation, market potential, and other aspects to improve the effectiveness of innovation related decision-making. Under the characteristics of profit-seeking, enterprises will focus on enhancing the competitiveness of core innovation toconcentrate resources on such high yield innovation activities, which will not play a significant role in non-substantive innovations with low economic potential (such as utility model patents and design patents).

2.2. Mechanism Identification and Inspection of Fintech for Promoting Enterprise Innovation

It is necessary to further study the specific channel mechanism of Fintech affecting enterprise technological innovation. This study selects financing constraints, financial expense rates, and financial risk for verification. Describing the specific channel mechanism of digital finance affecting enterprise technological innovation activities, recursive equations (2) through (4) are set up for the identification test.

2.2.1. Financing Constraints

Table 5. Inspection of the Impact of Fintech on Enterprise Innovation: Financing Constraints

	MODEL2	MODEL3	MODEL4	MODEL2	MODEL4	MODEL2	MODEL4
Variable	Lnpatent	SA_index	Lnpatent	Lnpati	Lnpati	Lnpatud	Lnpatud
DIF-1	0.0016***	0.0002***	0.0015***	0.0019***	0.0018***	0.0005	0.0003
	(4.35)	(7.23)	(4.00)	(5.66)	(5.23)	(1.30)	(0.854)
SA_index			0.6988***		0.7722***		0.8520***
			(6.71)		(8.20)		(8.530)
Size	0.6742***	0.0127***	0.6653***	0.6141***	0.6043***	0.5703***	0.5595***
	(69.64)	(18.99)	(68.16)	(70.16)	(68.52)	(61.40)	(59.783)
CD	-0.1190***	0.0010**	-0.1197***	-0.0858***	-0.0866***	-0.1109***	-0.1117***
	(-18.25)	(2.16)	(-18.37)	(-14.56)	(-14.71)	(-17.73)	(-17.891)
Lev	-0.3782***	-0.0256***	-0.3603***	-0.3400***	-0.3203***	-0.1602***	-0.1384**
	(-6.51)	(-6.35)	(-6.20)	(-6.47)	(-6.10)	(-2.87)	(-2.485)
SD	-0.0021***	0.0003***	-0.0023***	-0.0026***	-0.0028***	-0.0001	-0.0004
	(-3.06)	(7.44)	(-3.42)	(-4.23)	(-4.67)	(-0.21)	(-0.666)
PG	0.0082**	-0.0008***	0.0087**	0.0055	0.0061*	0.0077**	0.0084**
	(2.20)	(-2.98)	(2.35)	(1.64)	(1.82)	(2.17)	(2.358)
Sales growth	-0.0787***	-0.0052***	-0.0750***	-0.0530***	-0.0489**	-0.0663***	-0.0619***
	(-3.72)	(-3.57)	(-3.55)	(-2.77)	(-2.56)	(-3.27)	(-3.054)
Age	-0.0110***	-0.0395***	0.0166***	-0.0071***	0.023****	-0.0085***	0.0252***
	(-5.80)	(-299.70)	(3.66)	(-4.10)	(5.72)	(-4.66)	(5.786)
Constant	-2.8490***	-3.2494	-0.5784	-3.2666***	-0.7576**	-2.4999***	0.2685
	(-24.23)	(-398.86)	(-1.61)	(-30.73)	(-2.34)	(-22.16)	(0.782)
Year FX	yes	yes	yes	yes	yes	yes	yes
Industry FX	yes	yes	yes	yes	yes	yes	yes
N	19, 243	19, 243	19, 243	19, 243	19, 243	19, 243	19, 243
R-squared	0.467	0.861	0.468	0.418	0.420	0.458	0.461
Ad R-squared	0.464	0.860	0.465	0.416	0.418	0.456	0.458

Note: t-statistics in parentheses, ***p<0.01, **p<0.05, *p<0.1.

The development of Fintech has effectively alleviated the widespread phenomenon of financial exclusion and can provide financial support for more enterprises outside traditional finance. To avoid endogenous problems, this study selects the SA index as the agent variable of financing constraints. Table 5 reports the mediation results of testing financing constraints using models (2) through (4). In Table 5, the regression coefficient of Fintech (DIF-1) on financing constraints (SA-index) as tested by model (3) is 0.0002, and passes the 1% significance test, indicating that Fintech can effectively alleviate corporate financing constraints. Further, the regression results of model (4) show that the coefficient of financial constraint (SA-index) on total firm innovation (Lnpatent) is 0.6988, the coefficient of Fintech (DIF-1) on total firm innovation (Lnpatent) is 0.0015, and both pass the 1% significance test, indicating that there is a partial mediating effect of financial constraint in these firms overall, with a partial mediating effect on the overall innovation of Fintech firms. Meanwhile, according to model (4), the regression coefficient of the financing constraint (SA-index) on firm substantive innovation (Lnpati) is 0.7722, and the regression coefficient of financial technology (DIF-1) on firm substantive innovation (Lnpati) is 0.0018, and both pass the 1% significance test, indicating that there is a partial mediating effect of financial constraints in Fintech-driven firm substantive innovation. That is, Fintech can promote enterprise innovation, especially the substantive innovation of enterprises, by easing financing constraints. Thus, this supports H2.

2.2.2. Financial Expense Rate

Table 6 reports the results of using models (2) to (4) to test the mediating role of the financial expense ratio in Fintech-driven enterprise innovation. According to Table 6, with a regression test based on model (3), the coefficient of Fintech (DIF-1) on the enterprise expense rate (FE) is negative and passes the 1% significance test, indicating that Fintech has a significant inhibitory effect on the enterprise financial expense rate. Through the regression of model (4), the coefficient of the financial expense rate (FE) is -2.5477 and passes the 1% significance test, indicating that the higher the enterprise financial expense rate, the more unfavorable it is to enterprise innovation activities. Meanwhile, the coefficient of Fintech (DIF-1) and enterprise total innovation (Lnpatent) is 0.0015 and passed the 1% significance test.

Further, model (4)'s financial expense rate (FE) for the regression coefficient of enterprise substantial innovation (Lnpati) is -3.2663 and passed the 1% significance test, meaning the higher the enterprise financial expense rate, the less conducive it is to the increase of substantial innovation activities of the enterprise. Meanwhile, the coefficient of Fintech (DIF-1) and enterprise substantive innovation (Lnpati) was 0.0019 and passed the 1% significance test. This shows that the partial mediating effect wherein Fintech can promote enterprise innovation by reducing the corporate financial expense rate supports H3. At the same time, the test results show that the financial expense rate was more significant in the substantive innovation of Fintech-driven enterprises and had no significant impact on non-substantive innovation.

2.2.3. Financial Risk

Table 7 reports the effect of testing the mediating role of enterprise financial risk (LnEMS) in Fintech-driven enterprise innovation in models (2) to (4). As seen in Table 7, according to the regression test of Model (3), the Fintech coefficient (DIF-1) for financial risks (LnEMS) is 0.0002 and passes the 1% significance test, indicating that Fintech can enhance corporate financial stability and reduce financial risk. According to model (4), the coefficient of financial risk (LnEMS) for the enterprise total innovation level (Lnpatent) is 0.0906 and passes the 1% significance test, indicating that the higher the financial stability of the enterprise, the more it is conducive to the development of enterprise innovation activities. Meanwhile, the coefficient of Fintech and enterprise total innovation is 0.0017 and passes the 1% significance test. Further, model (4) is used to conduct regression analysis on financial risks (LnEMS) and substantive innovation (Lnpati). The

Table 6. Inspection of the Impact of Fintech on Enterprise Innovation: Financial Expense Rate

	MODEL2	MODEL3	MODEL4	MODEL2	MODEL4	MODEL2	MODEL4
Variable	Lnpatent	FE	Lnpatent	Lnpati	Lnpati	Lnpatud	Lnpatud
DIF-1	0.0016***	-0.0000***	0.0015***	0.0019***	0.0019***	0.0004	0.0004
	(4.217)	(-3.287)	(4.088)	(5.643)	(5.464)	(1.158)	(1.047)
FE			-2.5477***		-3.2663***		-2.0693***
			(-5.501)		(-7.794)		(-4.657)
Size	0.6772***	-0.0002	0.6765***	0.6176**	0.6168***	0.5730***	0.5725***
	(68.703)	(-1.553)	(68.690)	(69.184)	(69.201)	(60.613)	(60.590)
CD	-0.1223***	0.0070***	-0.1046***	-0.0886***	-0.0658***	-0.1140***	-0.0996***
	(-17.742)	(64.485)	(-13.738)	(-14.189)	(-9.556)	(-17.239)	(-13.637)
Lev	-0.3716***	0.0866***	-0.1509**	-0.3387***	-0.0557	-0.1525***	0.0268
	(-6.178)	(91.777)	(-2.088)	(-6.217)	(-0.851)	(-2.643)	(0.387)
SD	-0.0021***	-0.0001***	-0.0024***	-0.0026***	-0.0030***	-0.0002	-0.0005
	(-3.126)	(-11.593)	(-3.580)	(-4.219)	(-4.865)	(-0.381)	(-0.772)
PG	0.0076**	-0.0004***	0.0065	0.0050	0.0036	0.0073*	0.0064*
	(1.919)	(-7.047)	(1.636)	(1.384)	(0.986)	(1.913)	(1.673)
Sales growth	-0.0824***	-0.0012***	-0.0855***	-0.0554***	-0.0594***	-0.0704***	-0.0729***
	(-3.780)	(-3.552)	(-3.924)	(-2.806)	(-3.011)	(-3.366)	(-3.487)
Age	-0.0109***	-0.0000	-0.0110***	-0.0070***	-0.0071***	-0.0086***	-0.0087***
	(-5.704)	(-0.987)	(-5.748)	(-4.049)	(-4.111)	(-4.688)	(-4.724)
Constant	-2.8530***	-0.0265***	-2.9205***	-3.2875***	-3.3740***	-2.4974***	-2.5522***
	(-24.007)	(-14.191)	(-24.464)	(-30.545)	(-31.231)	(-21.909)	(-22.284)
Year FX	yes	yes	yes	yes	yes	yes	Yes
Industry FX	yes	yes	yes	yes	yes	yes	Yes
N	19, 243	19, 243	19, 243	19, 243	19, 243	19, 243	19, 243
R-squared	0.467	0.542	0.468	0.417	0.419	0.460	0.461
Ad R-squared	0.464	0.540	0.465	0.415	0.417	0.457	0.458

Note: t-statistics in parentheses, ***p<0.01, **p<0.05, *p<0.1.

Table 7. Inspection of the Impact of Fintech on Enterprise Innovation: Financial Risk

	MODEL2	MODEL3	MODEL4	MODEL2	MODEL4	MODEL2	MODEL4
Variable	Lnpatent	LnEMS	Lnpatent	Lnpati	Lnpati	Lnpatud	Lnpatud
DIF-1	0.0017***	0.0002 ***	0.0017***	0.0020***	0.0020***	0.0005	0.0005
	(4.443)	(3.558)	(4.391)	(5.815)	(5.723)	(1.308)	(1.293)
LnEMS			0.0906****		0.1485***		0.0249
			(1.976)		(3.586)		(0.567)
Size	0.6742***	0.0233 ***	0.6721***	0.6140***	0.6106***	0.5703***	0.5697 ***
	(69.635)	(15.245)	(69.005)	(70.161)	(69.369)	(61.399)	(60.967)
CD	-0.1189***	-0.1089 ***	-0.1090***	-0.0857***	-0.0695***	-0.1109***	-0.1082 ***
	(-18.231)	(-105.924)	(-13.278)	(-14.537)	(-9.368)	(-17.722)	(-13.728)
Lev	-0.3771***	-1.4996 ***	-0.2413***	-0.3385***	-0.1158	-0.1600***	-0.1227
	(-6.487)	(-163.672)	(-2.680)	(-6.442)	(-1.423)	(-2.870)	(-1.420)
SD	-0.0021***	0.0013 ***	-0.0022***	-0.0026***	-0.0028***	-0.0001	-0.0002
	(-3.061)	(11.925)	(-3.219)	(-4.234)	(-4.528)	(-0.208)	(-0.256)
PG	0.0082**	0.0032 ***	0.0079**	0.0055	0.0050	0.0077**	0.0077 **
	(2.198)	(5.500)	(2.118)	(1.640)	(1.497)	(2.171)	(2.146)
Sales growth	-0.0786***	0.0010	-0.0787***	-0.0529***	-0.0530***	-0.0663***	-0.0663 ***
	(-3.717)	(0.296)	(-3.721)	(-2.766)	(-2.774)	(-3.268)	(-3.269)
Age	-0.0110***	0.0003	-0.0111***	-0.0070***	-0.0071***	-0.0085***	-0.0085 ***
	(-5.791)	(1.011)	(-5.806)	(-4.093)	(-4.120)	(-4.660)	(-4.664)
Constant	-2.8635***	2.9770 ***	-3.1332***	-3.2868***	-3.7290***	-2.5027***	-2.5769 ***
	(-24.114)	(159.053)	(-17.321)	(-30.621)	(-22.811)	(-21.968)	(-14.847)
Year FX	yes	yes	yes	yes	yes	yes	yes
Industry FX	yes	yes	yes	yes	yes	yes	yes
N	19, 243	19, 243	19, 243	19, 243	19, 243	19, 243	19, 243
R-squared	0.467	0.747	0.467	0.418	0.419	0.458	0.458
Ad R-squared	0.464	0.746	0.464	0.416	0.416	0.456	0.456

Note: t-statistics in parentheses, ***p<0.01, **p<0.05, *p<0.1.

Table 8. Robustness Test Results

	First Stage	Second Stage		
	(1)	(2)	(3)	(4)
Variable	DIF-1	Lnpatent	Lnpati	Lnpatud
DIFb-2	0.151***			
	(5.23)			
DIF-1		0.027*	0.026*	0.017
		(1.65)	(1.78)	(1.03)
Size	-0.033	0.473***	0.426***	0.399**
	(-0.23)	(17.17)	(17.66)	(14.92)
CD	0.010	-0.002	-0.001	-0.002
	(1.16)	(-1.55)	(-1.21)	(-1.47)
Lev	1.018**	-0.209**	-0.084	-0.097
	(2.19)	(-2.32)	(-1.10)	(-1.09)
SD	-0.013	-0.000	-0.001	0.002
	(-1.51)	(-0.01)	(-0.71)	(1.24)
PG	0.000	0.000**	0.000	0.000**
	(1.72)	(2.51)	(1.31)	(2.34)
Sales growth	0.007	-0.001	0.001	-0.001
	0.78)	(-0.66)	(0.41)	(-0.61)
Age	27.812**	-1.806***	-1.273***	-1.779***
	(26.00)	(-3.26)	(-2.62)	(-3.20)
Year FX	yes	yes	yes	yes
Industry FX	yes	yes	yes	yes
Obs	15638	15638	15638	15638
R-squared		0.180	0.116	0.230
Kleibergen-Paap rk LM statistic		22.862 (Chi-sq (1) P-val =0.0000)		
Cragg-Donald F statistic		150.438		
Kleibergen-Paap rk Wald F statistic		27.335		
10% maximal IV size		16.380		

Note: t-statistics in parentheses, ***p<0.01, **p<0.05, *p<0.1.

coefficient is 0.1485 and passes the 1% significance test, and demonstrates that the lower the financial risk rate, the more favorable the increase in substantial innovation. The coefficient of Fintech (DIF-1) and innovation (Lnpati) was 0.0020 and passed the 1% significance test. It indicates that there is a partial mediating effect, meaning Fintech can promote enterprise innovation by reducing enterprise risks and enhancing the financial stability of enterprises, which supports H3. At the same time, the test results show that the financial risk was more significant in Fintech-driven enterprise substantive innovation and had no significant impact on the non-substantive innovation of enterprises.

3. Robustness Tests

To avoid reverse causality issues, we used a one-period lag of Fintech as the dependent variable for the fixed effects regression, but further endogeneity testing of the model is necessary to make the findings more reliable. In this paper, the two-stage least square method (2SLS) was used to regression with the Fintech coverage Breadth index (DIFb) as an instrumental variable. As a dimension reduction indicator of the Fintech index, the breadth of Fintech coverage is a provincial variable, which is mainly reflected by the number of electronic accounts (such as Internet payment accounts and the number of bank accounts bound to them). The enterprise innovation patent is an individual variable, which is exogenous to the breadth of enterprise innovation Fintech coverage. At the same time, the Fintech coverage breadth is also correlated with the Fintech index to a certain extent after the lag stage treatment, and the second lag variable has occurred, which is unrelated to the current disturbance term, which can meet the requirements of the instrumental variable for correlation and exogeneity.

Table 8 reports the results of the two-stage least square regression. The results show that at the 10% significance level, the coefficients of DIF-1 on overall firm innovation performance and substantive firm innovation are both significantly positive, and the regression coefficients increase, indicating that Fintech development has a significant promotional effect on firm innovation performance. The regression coefficient on non-substantive innovation of firms was not significant, meaning the promotion effect on the substantive innovation of firms was stronger than that of non-substantive innovation, and the regression results after adding instrumental variables are generally consistent with the results of the benchmark regression. Further, this demonstrates the reliability of the study results. The Kleibergen-Paap rk LM statistic for the instrumental variables tested in Table 8 is 22.862, corresponding to a p-value of 0, indicating that the instrumental variables are identifiable. The Cragg-Donald Wald F statistic of 150.438 is much larger than Stock-Yogo weak ID test critical values at the 10% level with a judgement value of 16.38; therefore, there is no weak instrumental variable issue.

V. Conclusions and Recommendations

1. Conclusions

The development of Fintech has caused profound changes in the traditional financial industry. This new financial business service model has had a significant impact on the high-quality development of China's economy. Fintech augments traditional financial services with emerging technologies such as big data, cloud computing, and mobile Internet. It effectively promotes the technological innovation of enterprises by broadening financing channels, lowering the threshold of financial services, reducing information asymmetry, and reducing financing costs. This study focuses on Chinese A-share non-financial listed companies from 2011-2019, studying the influence of Fintech on enterprise innovation activities. The empirical results show that the development of Fintech can promote an increase in enterprise technological innovation, especially on enterprise substantive

innovation, supporting H1.

Further research has found that Fintech can effectively reduce financial constraints, reduce an enterprise's financial expense rate, and reduce enterprise risk to increase financial stability, thus promoting technological innovation activities and improving innovation output; therefore, H2, H3, and H4 are supported. This paper argues that (1) he development of Fintech has greatly broadened the scope of financial services, effectively reducing information asymmetry between banks and enterprises through a combination of big data and Internet technology, thus reducing financing costs and effectively alleviating the financing constraints of enterprises. If financing constraints are alleviated, enterprises have increased cash flow to support innovation activities, thereby promoting the improvement of substantial innovation output. (2) The financial expense rate reflects the level of financial expenditure incurred in financial operations and the flow of the financial capital chain. Since high financial expenditure leads to an overall increase in operating costs, the development of Fintech can encourage enterprises to effectively control financial expenditures by adjusting financing channels, accurately aiming at matching financing tools, and improving the internal capital structure of the enterprise. This enables an increase in available funds to promote the innovative power of enterprises. (3) The reduction of enterprise financial risk and the increase in financial stability are important drivers of innovation. Innovation activities typically have high risk, long cycles, and high uncertainty characteristics. According to agency theory, enterprise operators are more inclined to pursue more stable operations and high-yield investments, and the development of financial technology can not only reduce financial costs but also reduce financial risk through information technology, which greatly promotes the ability to evaluate information. In doing so, innovation is promoted through the establishment of more informed and stable management practices.

2. Policy Implications

Based on the previous empirical research conclusions and practical problems facing economic development, this study presents the following policy implications.

(1) It is necessary to actively promote the development of the Fintech industry to promote the innovative development of enterprises. China is in an important period of transformation from factor-driven to innovation-driven growth. Fintech has played an important role in promoting it, so promoting the development of Fintech can provide an impetus for enterprise innovation. Policy and technical support are indispensable for promoting the development of Fintech. Full support through innovation, research and development, talent training, technical safety, and other channels can effectively drive the healthy development of the Fintech industry. First, investment in research and development should be increased in information technology to provide good conditions for Fintech innovation and encourage the development of the Fintech industry. We should make full use of the state's ability to introduce Fintech development plans, increase capital investment, lay a good foundation for information technology, and actively promote the continuous innovation and improvement of high-end core technologies such as big data, blockchain, and artificial intelligence. Increasing the supply of Fintech products and applications, solving problems in Fintech by efficiently identifying enterprise information, reducing the limitations of traditional financial businesses, and broadening the financing channels of enterprises will ultimately promote effective technological innovation. Second, to strengthen the training of Fintech talents, special attention should be paid to strengthening knowledge on blockchain technology, big data analysis, and other professional knowledge to ensure that Fintech has the support of skilled individuals to promote enterprise technological innovation. Finally, in view of the increasing complexity and concealment of financial risks, at the technical level, the safe construction of blockchain, artificial intelligence, and other new technology infrastructures in the Fintech industry should be strengthened, and a risk early warning mechanism should ensure the safety of the entire Fintech industry.

(2) It is also vital to improve the regulatory system for Fintech. A sound economic and institutional environment can not only promote its development but also the continuous technological innovation of enterprises. However, while actively promoting the development of Fintech, financial regulators should pay attention to preventing systemic risks possibly brought about by Fintech innovation, and strengthen compliance and risk management in the process of financial innovation. Regulators should make full use of big data, blockchain, and artificial intelligence, improve the upgrade supervision system, develop real-time data integration systems and regulatory report automation systems to evaluate the authenticity of data more accurately, and more effectively supervise Fintech participants to improve the quality and efficiency of supervision. Further, Chinese regulators should strengthen cross-national and interregional communication and exchanges, strengthen information sharing with other countries and regions, jointly explore optimal Fintech supervision policies, and ensure the healthy and orderly development of Fintech.

3. Limitations

This study selected the enterprise financial constraint index, financial cost rate, and financial risk as intermediary variables for the transmission mechanism analysis. Financial regulatory policy, capital development level, and regional science and technology development were not included in the study, so the model may deviate from reality. Future research should expand on this study and aim to account for more of the limitations to further improve the accuracy and usability of results.

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Digital Trade Negotiation in Korea-China-Japan FTA: Minimax Strategy in the Process of Making Consensus

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ABSTRACT

Purpose – The purpose of this paper is to apply the minimax procedures of the negotiation model to digital trade negotiation in the KCJ FTA to predict possible negotiation outcomes, as well as sensitive issues, for each country.

Design/Methodology/Approach – Based on the negotiation model of the minimax procedures, this paper first derives top preferences for each country in negotiating the KCJ FTA. It then conducts a sectional analysis of issues and derives possible negotiation outcomes in terms of both majority voting (MV) outcomes and minimax outcomes (*FBn)*. It finally predicts sensitive issues in the voting process and outcome rankings for each section of issues.

Findings – For the first section of issues, the minimax outcome will prevail, while the MV outcome will be the first in ranking for the last section of issues. In terms of sensitivity during the negotiation process for voting, China is predicted to be the most reluctant to agree on binding rules on non-discrimination. As Japan is not as sensitive as the other two countries in each issue of digital trade agreement, both Korea and China are predicted to be the most hesitative in agreeing on binding rules on source code.

Research Implications – Under the minimax procedures, negotiation positions as well as the dynamics of the voting process for each issue can be systematically predicted ex ante. The negotiation outcomes derived from the model can be viewed as win-win that would not produce any left-out countries, since each country minimizes the deviation from the initial top preference to the agreed deal.

Keywords: digital trade, digital trade negotiation, KCJ FTA, minimax strategy, voting process
JEL Classifications: F13, F51, F53

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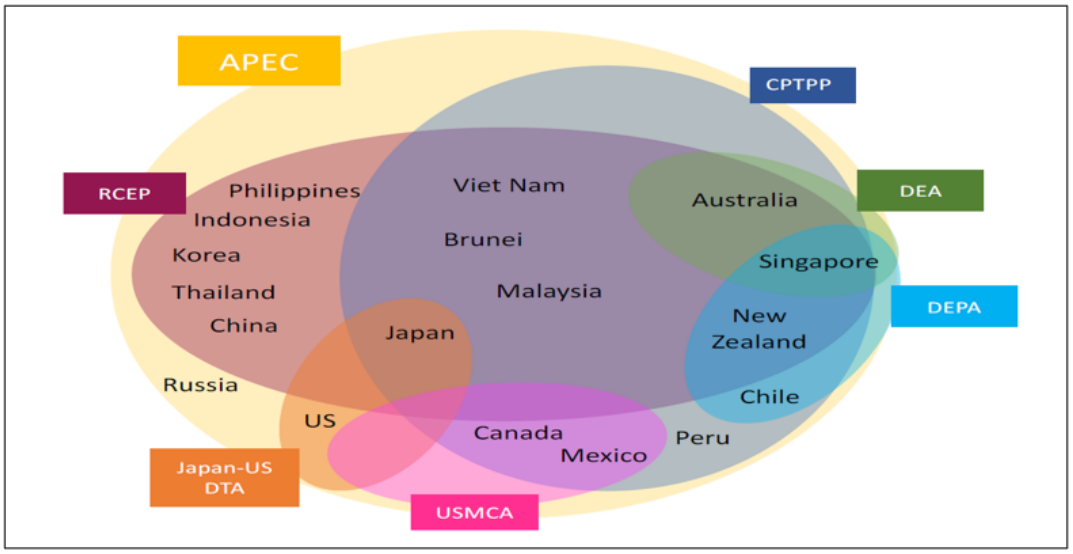
I. Introduction

Since 2013, China, Japan, and Korea, the three major countries in Northeast Asia, are still in the process of FTA negotiation toward the Korea-China-Japan Free Trade Agreement (KCJ FTA). Aiming at a higher level of liberalization than the already ratified Reginal Comprehensive Economic Partnership (RCEP), the three are actively debating trilateral trade liberalization issues, including market opening for goods and services, investment, rules of origin, customs clearance, competition, and e-commerce. As the RCEP already adopted an independent e-commerce chapter to introduce new rules, such as the cross-border transfer of information by electronic means and locations of computing facilities, KCJ FTA negotiation also covers issues such as expanding electronic payments, liberalizing data distribution, and simplifying electronic certificate signing procedures like public certificates. The topic of digital trade, no longer under the name of e-commerce, is one of the toughest issues for the KCJ FTA as the three differ in negotiation positions and interests. (WTO, 2021) Although the three are eager to have common digital trade rules to expand their overseas market as well as to enhance the competitiveness of digital firms, they differ in negotiation goals and positions as their participation in digital trade rule making differs (Fig. 1). For example, China focuses more on regulations on traditional e-commerce since it is the largest exporter in ASEAN the e-commerce market. At the same time, China has put forward data protectionism by setting up a "Great Firewall" that prevents firms from trying to use local data. With a wait-and-see attitude, Japan intends to propose the liberalization level of FTAs it has signed so far. Japan signed a digital trade agreement with the US in October 2019, which is the highest level of openness in relation to digital commerce, including the liberalization of cross-border data transfers as well as a ban on server localization. Korea is interested in facilitating e-commerce trade, especially in content and intellectual property trade or short-term cooperative activities, while it needs to find a focal point between the purpose of the KCJ FTA targeting digital trade liberalization and the proper level of domestic data regulations (Casalini

Fig. 1. The Overlapping Web of Digital Trade Rules in the Asia-Pacific



& González, 2018). As ongoing discussions at the WTO on specific e-commerce issues that include data flows and trust have been slow, these issues are increasingly being addressed in regional trade agreements (Honey, 2021). As the three countries in the KCJ FTA are keen to establish new and efficient digital trade rules which will promote global competitiveness, it is the right time to check how negotiation outcomes can be born at provisional level, which concerns different issues.

There is literature on digital trade agreements with a textual of provisional approach. In other worlds, the unit of analysis is at the provision level rather than at the trade agreement level. (Monteiro & Teh, 2017) Countries usually vote separately on each provision of a trade agreement, and the parties to an agreement that wants to propose or initiate any kind of provision must consider how these provisions will be viewed at the time of consensus. One writes the American history of free trade agreement provisions governing e-commerce, and then suggests that e-commerce issues must be addressed by US trade policy (Bieron & Ahmed, 2012). Another argues that as e-commerce chapters have become more common and more detailed, their legal enforceability, such as the relationship between e-commerce chapters and dispute settlement, has also risen (Froese, 2019). Some also deal with the e-commerce case of the TPP and present its rule-making history achievements with regard to the classification of e-commerce rules (Hamanaka, 2019). Moreover, there is a case study on e-commerce in South Korean FTAs which analyzed in terms of policy priorities and provisional inconsistencies using a framer-follower approach (Kim, 2019). One paper includes a detailed mapping and coding of all preferential trade agreements and provides an overview of the evolution of digital trade provisions, using The TAPED (Trade Agreements Provisions on Electronic-Commerce and Data) dataset, but it only highlighes some emerging trends and lacks analysis of the negotiation aspects of digital trade agreements. (Burri & Polanco, 2020) Lastly, there is research on rule initiator conditions at the time of introduction of digital trade related provisions in PTAs that explain the extent of diffusion and adopters' exact calculus for accepting these commitments (Elsig & Klotz, 2021). However, none of these provisional studies on e-commerce provide an ex ante prediction of negotiation outcomes as well as sensitive issues in the process of voting. By applying minimax procedures of the negotiation model into the digital trade negotiation of the KCJ FTA, this paper attempts to predict possible negotiation outcomes as well as sensitive issues for each country in the process of negotiation (Brams et al., 2007). Under this framework, we can predict negotiation positions and the dynamics of each participating country before any type of trade negotiation begins or ends. This model is useful since it gives answers to whether the proposing country will receive sufficient support as the theoretically best sets of negotiation outcomes can be calculated. In Section Two, this paper begins applying this framework to the KCJ to find top preferences for each country. Section Three conducts a sectional analysis of issues based on the minimax procedures and derives possible negotiation outcomes, including both majority voting (MV) outcomes and minimax outcomes. Section Four finally predicts sensitive issues and outcome rankings in each section of issues.

II. Theoretical Background and Conceptual Framework

This paper adopts a concept of "a minimax procedure for negotiating multilateral treaties" to analyze the KCJ FTA (Brams et al., 2007). This is a procedure that creates a compromise as close as possible to the preferences of each party involved. It introduces a concept called "a minimax outcome" in which "the maximum distace of the compromise from the position of any state is minimal". Since countries vote separately on each provision of a trade agreement, a provision is included in the treaty if a simple or qualified majority supports it, or otherwise it is excluded. This literature focuses on "aggregating votes", where the votes for and against every provision

are aggregated, influencing how the agreement provisions are pakaged. A state's "top preference" or ideal point exists where each state supports or votes for a speific vector. Below a state's top preference, its preference for other vectors depends on their distance from the ideal as each states ranks vetors based on proximity to the ideal point. In the framework, it is assumed that all positions of states, given by vectors of 1s and 0s, are possible, and preferences by vectors of 1s and 0s, where "1" indicates approval and "0" indicates the disapproval of each proposed provision of a treaty. In this paper analyzing the KCJ FTA, all the three countries' preferences by vectors of 1s and 0s, where "1" indicates approval of a provision with obligation and a "0" indicates the disapproval, are noted. Previous literature already analyzed this compared to 'softer' provisions, 'harder', and legally enforceable provisions diffused substantially more, and provision initiators are taking a bolder approach by formulating highly legalized terms to provide strong signals for overall ambition (Elsig & Klotz, 2021). It does not explain what can be possible negotiation outcomes in "aggregated" terms concerning ex ante pros and cons for the binding provisions for each issue. Like the origital model, this paper suggests careful assumptions in order to apply the model to the case of digital trade agreement in the KCJ FTA.

1. Model Assumptions

First, major issues from articles in an FTA e-commerce chapter are to be classified in Table 1. There are three major sections, including 'Business and Trade Facilitation (I)', 'Business and Consumer Trust', and 'Business and Trade Facilitation (II)'. The provisions of an e-commerce chapter are to remove trade barriers and counter discriminatory action while providing governments with flexibility. Second, the "top preference" for each country can be induced as a country's position on each issue in an FTA e-commerce chapter and can be derived from the country's negotiation outcomes in previous FTAs, especially those with active rule makers for digital trade, such as the US, EU, China, Australia, and Singapore. In this regard, for all three countries concerning FTAs with an e-commerce chapter signed and ratified since 2010, this paper only includes those provisions agreed to in regional FTAs such as the CPTPP and RCEP, as well as bilateral FTAs with each other or with the US and EU. Besides, in terms of including an e-commerce chapter, Korea has ratified or signed 13 FTAs, Japan has nine, and China has four. Moreover, for the purpose of research, this paper will ignore the qualitative differences between the target FTAs since the interest of this experiment lies in what negotiation outcomes related to binding provisions can be derived at the provision level, and the exact calculus for accepting these commitments that can be predicted. Third, if one country approves the inclusion of an article which concerns obligation, the number '1' is appointed, and if not, '0' is appointed. It is assumed that countries prefer 0 instead of 1 since articles with obligation increase regulation compliance costs within each country. Compliance with e-commerce obligations means that they can be a constraint on regulatory choices when implementing domestic digital industry policies. In the case of developing countries that lack digital infrastructure and lack related personnel, implementing mandatory e-commerce provisions can be burdensome as significant compliance costs will be incurred (Lee & Kang, 2021).

2. Top Preferences for Korea

Korea has 13 FTAs with an e-commerce chapter, either enforced or signed. Enforced in March of 2006, the Korea-Singapore FTA has four articles in Chapter 14 and one article in Chapter 18, two of which concern obligation, and one concerns cooperation. Tentatively enforced in July of 2011 and finally in December of 2012, the Korea-EU FTA has two articles in Chapter 7, two of which concern obligation, and one concerns cooperation. Enforced in March of 2012, the Korea-US FTA has nine articles in Chapter 15, four of which concern obligation, and five concern cooperation. Enforced in December of 2014, the Korea-Australia FTA has ten articles in Chapter 15, four of which

Table 1. Article Classification of an FTA E-commerce Chapter

Section	Number	Article or Issue
1. Business and Trade Facilitation (I)	1-1	No customs duties
	1-2-1	Non-discrimination (NT)
	1-2-2	Non-discrimination (MFN)
	1-3	Electronic authentication & signature
	1-4	Paperless trading
2. Business and Consumer Trust	2-1	Online consumer protection
	2-2	Personal information protection
	2-3	Unsolicited commercial economic messages
	2-4	Domestic regulatory framework
	2-5	Transparency
	2-6	Cyber security
3. Business and Trade Facilitation (II)	3-1	Cross-border transfer of information by electronic means
	3-2	Location of computing facilities
	3-3	Source code
	3-4	Access to and use of the internet for electronic commerce
	3-5	Internet interconnection charge sharing
	3-6	Liability of intermediary service providers
	3-7	Cooperation (# of cooperative activities)

concern obligation, and three concern cooperation. Enforced in December of 2015, the China-Korea FTA has nine articles in Chapter 13, three of which concern obligation, and two concern cooperation. Signed in November of 2020, the RCEP has 18 articles in Chapter 12, ten of which concern obligation, and two concern cooperation. Table 2 shows Korea's FTAs with an e-commerce chapter with articles or provisions with obligations (Os), those with cooperation (Cs), and those with no articles (n/a). The maximum degree and extent of the Korean liberalization of e-commerce and digital trade compliance with the RCEP has four binding provisions. In terms of ranking among the first section of articles, 1-1 is first, followed by 1-3. 1-2 is third and fourth, and 1-4 is the least attractive issue for Korea. For the second section of articles, 2-2 is first, followed by 2-1. 2-4 is third, and 2-3 is fourth. 2-6 is the least interesting issue to Korea. For the third section, 3-7 is first, followed by 3-1 and 3-2. Regarding the topical ranking of Korea, the first section ranks first, the second one second, and the third one last. In conclusion, for the first section of articles in Business and Trade Facilitation (I), with four issues involved, Korea has an aggregate vote number of "1110". For the second section of articles in Business and Consumer trust, with six issues involved, Korea has an aggregate vote number of "111110". For the third section of articles in Business and Trade

Table 2. Korea's OC Table of E-commerce Chapters

FTAs (Ratification date)	Facilitation of E-commerce					Conducive Environment for E-commerce						Facilitation of Cross-Border E-commerce						
	1-1	1-2-1	1-2-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	3-7
K-Singapore (06.03) Chp.14.1-4 & 18.3	O	O	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C (4)
K-EU (11.07)(15.12) Chp.7.6.48-49	O	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C	O (6)
K-US (12.03) Chp.15.1-9	O	O	O	O	C	C	C	n/a	n/a	n/a	n/a	C	n/a	n/a	C	n/a	n/a	n/a
K-Australia (14.12) Chp.15.1-10	O	n/a	n/a	C	C	O	O	C	O	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K-China (15.12) Chp.13.1-9	O	n/a	n/a	O	C	n/a	O	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C (4)
RCEP (22.02) Chp.12.1-18	O	n/a	n/a	O	C	O	O	O	O	O	C	O	O	n/a	n/a	n/a	n/a	O (5)
O (Number of Os)	6	2	1	3	0	2	3	1	2	1	0	1	1	0	0	0	0	2
C (Number of Cs)	0	0	0	1	4	1	1	1	0	0	1	1	0	0	1	0	0	2
Top preferences	**1**	**1**		**1**	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**
Sectoral Ranking (13)	1	3	4	2	5	2	1	4	3	5	6	2	3	6	4	6	6	1
Topical Ranking			1					2							3			

Notes: 1. For research purposes under this paper's framework, the two articles on non-discrimination, including National Treatment (1-2-1) and Most-favored Nation (1-2-2), are integrated and counted as one (1-2).
2. For the K-EU FTA and K-UK FTA concerning 2-1 and 2-2, n/a is assigned because those are included in 3-7, cooperation. C is assigned to 3-6 because it was stipulated in Chapter 10. Intellectual Property of the two FTAs.
3. Cooperative activities concerning unsolicited message (2-3) is mentioned in 3-7 instead of 2-3, except for K-Australia and the RCEP. (RCEP, 2020)
4. For 3-1 of the K-Canada FTA, n/a is assigned because it was mentioned in 3-7, cooperation.
5. For 4-2 of the RCEP, O is assigned because it is possible to apply Chapter 19 (Dispute Settlement) if the review is completed according to Art.12.17.3.
6. The top preference for 2-5 is zero (0) instead of one (1) because the ranking is 5th with less significance in the section for Korea, even though it has one FTA with a provision which concerns obligation.

Source: Author's analysis from Ko (2020, pp. 235-236).

Facilitation (II), with seven issues involved, Korea has an aggregate vote number of "1100001".

3. Top Preference for Japan

Japan has nine FTAs with an e-commerce chapter, either enforced or signed. Enforced in February of 2002, the Japan-Singapore EPA has five articles in Chapter 5, none of which concern obligation, and one concerns cooperation. Enforced in January of 2015, the Japan-Australia EPA has ten articles in Chapter 13, seven of which concern obligation, and two concern cooperation. Enforced in January of 2019, the CPTPP has 18 articles in Chapter 14, 11 of which concern obligation, and five concern cooperation. Enforced in February of 2019, the Japan-EU EPA has 12 articles in Chapter 8, six of which concern obligation, and two concern cooperation. Enforced in January of 2020, the Japan-US DTA has 22 articles in the Agreement, 12 of which concern obligation, and one concerns cooperation. Signed in November of 2020, the RCEP has 18 articles in Chapter 12, ten of which concern obligation, and two concern cooperation. Table 3 shows Japan's FTAs with e-commerce chapters that have articles or provisions with obligations (Os), those with cooperation (Cs), or those without articles (n/a). In terms of ranking among the first section of articles, both 1-1 and 1-3 are first, followed by 1-2-1 and 1-2-2. 1-4 is the least attractive issue to Japan. For the second section of articles, 2-4 is first, followed by 2-3. 2-2 is third and 2-1 is fourth. 2-6 is the last issue of significance for Japan. For the third section, 3-1, 3-2, and 3-3 are first, followed by 3-7. In summary, for the first section of articles, Japan has an aggregate vote number of "1110". For the second, Japan has an aggregate vote number of "111110". For the third, Japan has an aggregate vote number of "1110001".

4. Top Preferences for China

China has four FTAs with an e-commerce chapter, either enforced or signed. Enforced in December of 2015, the China-Korea FTA has nine articles in chapter 13, three of which concern obligation, and two concern cooperation. Enforced in December of 2015, the China-Australia FTA has 11 articles in Chapter 12, seven of which concern obligation, and one concerns cooperation. Enforced in October of 2019, the China-Singapore updated FTA has 11 articles in Chapter 15, six of which concern obligation, and two concern cooperation. Signed in November of 2020, the RCEP has 18 articles in Chapter 12, ten of which concern obligation, and two concern cooperation. Table 4 shows China's FTAs with e-commerce chapters that have articles or provisions with obligations (Os), those with cooperation (Cs), or without articles (n/a). The maximum degree and extent of the Chinese liberalization of e-commerce and digital trade comply with the RCEP with four binding provisions. In terms of ranking among the first section of articles, both 1-1 and 1-3 are first, followed by 1-4. For the second section of articles, 2-2 is first, followed by 2-1, 2-4, and 2-5. 2-6 is the issue of least significance for China. For the third section, 3-1, 3-2, and 3-3 are first, followed by 3-7. Regarding the topical ranking of China, the first section ranks first, the second one second, and the third one the last, just like Korea. In sum, for the first section of articles, China has an aggregate vote number of "1011". For the second, China has an aggregate vote number of "111110". For the third, China has an aggregate vote number of "1100001".

III. Analysis of Negotiation Outcomes[1]

This section presents possible negotiation outcomes under a minimax strategy. From analyses in the previous section, the top preferences for Korea, Japan, and China in negotiation for the KCJ FTA are summarized in Table 5. For the first section of articles in Business and Trade

1. Author can share actual game outcomes for this section of paper if requested via email (bomingo@catholic.ac.kr)

Table 3. Japan's OC Table of E-commerce Chapters

FTAs (Ratification date)	Facilitation of E-commerce					Conducive Environment for E-commerce						Facilitation of Cross-Border E-commerce						
	1-1	1-2-1	1-2-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	3-7
J-Singapore (02.11) Chp.5.40-44	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C (2)
J-Australia (15.01) Chp.13.1-10	O	O	O	O	C	C	O	n/a	O	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	O (5)
CPTPP (19.01) Chp.14.1-18	O	O	O	O	C	O	O	O	O	n/a	C	O	O	O	C	C	n/a	C (5)
J-EU (19.02) (20.9) Chp.8.70-81	O	n/a	n/a	O	n/a	C	n/a	O	O	n/a	n/a	O	n/a	O	n/a	n/a	n/a	C (8)
J-US (20.01) DTA Art.1-22	O	O	O	O	n/a	O	O	O	O	n/a	C	O	O	O	n/a	n/a	O	n/a
RCEP (22.02) Chp.12.1-18	O	n/a	n/a	O	C	O	O	O	O	O	C	O	O	n/a	n/a	n/a	n/a	O (5)
O (Number of Os)	5	3	3	5	0	3	4	4	5	1	0	4	3	3	0	0	1	3
C (Number of Cs)	0	0	0	0	3	2	0	0	0	0	3	0	0	0	1	1	0	5
Top preferences	**1**	**1**		**1**	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**1**
Sectoral Ranking	1	3	3	1	5	4	2	2	1	5	6	1	2	2	6	6	5	4

Note: The top preference for 2-5 is zero (0) instead of one (1) because the ranking is 5th with less significance in the section for Japan, even though it has one FTA with a provision which concerns obligation. This applies to 3-6 as well.

Facilitation (I), with four issues involved, Korea and Japan have the same aggregate vote number of "1110", while China has "1011". For the second section of articles in Business and Consumer trust, with six issues involved, all three countries have the same aggregate vote number of "111110". For the third section of articles in Business and Trade Facilitation (II), with seven issues involved, Korea and China have the same aggregate vote number of "1100001", while Japan has "1110001".

Table 4. China's OC Table of E-commerce Chapters

FTAs (Ratification date)	Facilitation of E-commerce					Conducive Environment for E-commerce						Facilitation of Cross-Border E-commerce						
	1-1	1-2-1	1-2-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	3-7
C-Korea (15.12) Chp.13.1-9	O	n/a	n/a	O	C	n/a	O	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		C(4)
C-Australia (15.12) Chp.12.1-11	O	n/a	n/a	O	O	O	O	n/a	O	O	n/a	n/a	n/a	n/a	n/a	n/a		C(3)
C-Singapore (19.10) Chp.15.1-11	O	n/a	n/a	O	C	O	O	n/a	O	O	n/a	n/a	n/a	n/a	n/a	n/a		C(5)
RCEP (22.02) Chp.12.1-18	O	n/a	n/a	O	C	O	O	O	O	O	C	O	O	n/a	n/a	n/a	n/a	O(5)
O (Number of Os)	4	0	0	4	1	3	4	1	3	3	0	1	1	0	0	0	0	3
C (Number of Cs)	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	3
Top preferences	1	0		1	1	1	1	1	1	1	0	1	1	0	0	0	0	1
Sectoral Ranking	1	4	4	1	3	2	1	5	2	2	6	2	2	4	4	4	4	1

1. Business and Trade Facilitation (I)

For the first section of articles in Business and Trade Facilitation (I), with four issues involved in Tables 6, 7, and 8, Korea and Japan have the same aggregate vote number of "1110", while China has "1011". Under minimax procedures, there exists one *MV* outcome and two *FBn,* or the minimax outcomes for the first section of articles. The *MV* outcome for the first section of articles is '1110', which is identical to both Korea and Japan, meaning no position change for the two countries in the KCJ FTA. For China with '1011' as its top preference, it's position on 'non-discrimination (1-2)' should be changed from no to yes to fit '1110'. The possibility of a Chinese position change on 'non-discrimination (1-2)' is not too high since the RCEP did not include articles related to this issue. FB_1 and FB_2, or the minimax outcomes for the first section of articles, are '1111' and '1010'. In the case of '1111', the positions of both Korea and Japan on 'paperless trading (1-4)' should be changed from rejection to acceptance to fit '1111', while the positions of China on not only 'paperless trading (1-4)' but also 'non-discrimination (1-2)' should be changed from no to yes. It will be difficult for China to reject both issues, given its strong insistence on digital sovereignty (Gao, 2020). In the case of '1010', the positions of the three countries will not be changed at all as China can easily say no to 'paperless trading (1-4)', and the other two are also indifferent to 'non-discrimination (1-2)'. Nonetheless, Korea and Japan will be more reluctant to reject 'non-discrimination (1-2)' than China's no to 'paperless trading (1-4)' since both countries want to expand their digital-related markets abroad by signing FTAs with the inclusion of MFN or NT as safeguards. In case of the RCEP as well as the most advanced cases of e-commerce chapters in the world, the aggregate vote number is '1010', which is the same as FB_2 under minimax procedures.

Table 5. Top Preferences of Korea, Japan, and China for the KCJ FTA

Section	Country	Top Preference
Business and Trade Facilitation (I)	Korea	1110
	Japan	
	China	1011
Business and Consumer Trust	Korea	111110
	Japan	
	China	
Business and Trade Facilitation (II)	Korea	1100001
	China	
	Japan	1110001

Table 6. Top Preferences for Korea and Japan for the First Section

Top Preference	d=0	d=1	d=2	d=3	d=4
1110	1110	1111 1100 1010 0110	1101 1000 1011 0010 0111 0100	1001 0000 0011 0101	0001
Total	1	4	6	4	1
	$_4C_0$	$_4C_1$	$_4C_2$	$_4C_3$	$_4C_4$

Table 7. Top Preferences for China for the First Section

Top Preference	d=0	d=1	d=2	d=3	d=4
1011	1011	1010 1001 1111 0011	1000 1101 0111 0010 1110 0001	1100 0101 0000 0110	0100
Total	1	4	6	4	1
	$_4C_0$	$_4C_1$	$_4C_2$	$_4C_3$	$_4C_4$

Table 8. Minimax Outcomes for the KCJ for the First Section

Combination	d=0	d≤1	d≤2	d≤3	d≤4
1. 0000				3	3
2. 1000			3	3	3
3. 0100			2	2	3
4. 0010			3	3	3
5. 0001			1	1	3
6. 1100		2	2	3	3
7. 1010		3	3	3	3
8. 1001		1	1	3	3
9. 0110		2	2	3	3
10. 0101				3	3
11. 0011		1	1	3	3
12. 1110	2	2	3	3	3
13. 1101			3	3	3
14. 1011	1	1	3	3	3
15. 0111			3	3	3
16. 1111		3	3	3	3
Total	3	15	33	45	48
	n	$({}_4C_0+{}_4C_1)n$	$({}_4C_0+{}_4C_1+{}_4C_2)n$	$({}_4C_0+{}_4C_1+{}_4C_2+{}_4C_3)n$	$2^k * n$

2. Business and Consumer Trust and Business and Trade Facilitation (II)

For the second section of articles in Business and Consumer trust, as shown in Table 9, all three countries have the same aggregate vote number of "111110", which is an MV outcome as well as minimax outcome for the second section of articles at '110110'. In the case of '110110', the position of the three countries with '111110' as their top preference can be difficult to change from allowing binding provisions for 'unsolicited commercial economic messages (2-3)' to removing this obligation since they have put emphasis on 'unsolicited commercial economic messages (2-3)' in previous FTAs. In case of the RCEP as well as the most advanced cases of e-commerce chapters in the world, the aggregate vote number is '111110', which is the same as an MV outcome as well as minimax outcomes under minimax procedures. For the third section of articles in Business and Trade Facilitation (II) with seven issues involved, Korea and China have the same aggregate vote number of "1100001", while Japan has "1110001". The MV outcome for the third section of articles is '1100001', which is also a minimax outcome. Korea and China, with their top preference of '11000001', have not changed in position, while the possibility for Japan to make 'source code (3-3)' non-binding is low because Japan has already admitted the issue to be mandatory in previous FTAs. In the case of the RCEP, the aggregate vote number is '1100001', which is the same as MV under minimax procedures

Table 9. Top Preference for China for the Second Section

Top Preference	d=0	d=1	d=2	d=3	d=4	d=5	d=6
111110				111001			
				110101			
				110011			
			111101	110000	110001		
			111011	101101	101001		
			111000	101011	100101		
			110111	101000	100011		
		111111	110100	100111	100000	100001	
		111100	110010	100100	011001	010001	
		111010	101111	100010	010101	001001	
	111110	110110	101100	011101	010011	000101	000001
		101110	101010	011011	010000	000011	
		011110	100110	011000	001101	000000	
			011111	010111	001011		
			011100	010100	001000		
			011010	010010	000111		
			010110	001111	000100		
			001110	001100	000010		
				001010			
				000110			
Total	1	6	15	20	15	6	1
	${}_6C_0$	${}_6C_1$	${}_6C_2$	${}_6C_3$	${}_6C_4$	${}_6C_5$	${}_6C_6$

IV. Analysis of Sensitive Issues

1. Business and Trade Facilitation (I)

This section deals with sensitive issues and outcome rankings. For the first section of issues, there are two sensitive issues, including 1-2 (Non-discrimination) and 1-4 (Paperless Trading), when attempting to agree to provisions with obligation (Table 10). In the process of voting during any negotiation, sensitive issues arise when possible negotiation outcome pushes participating countries' top preferences from "0" to "1", which forces them to agree to accept binding provisions. For 1-2 (Non-discrimination), while it is not difficult for Korea and Japan to agree binding rules on non-discrimination, China will be reluctant to accept this as it considers the scope of digital trade as mere e-commerce, which is narrower than the other two countries. For 1-4 (Paperless Trading), not only Korea and Japan but also China is willing to accept this agreement as China has already submitted to the WTO a sole proposal on the inclusion of provisions of electronic invoice and electronic payment essential for promoting e-commerce (Lee & Kang, 2021). In sum, in terms of negotiation outcome ranking, first is FB_2 outcome (1010), which is same as the outcome of the RCEP, followed by MV outcome (1110) and FB_1 outcome (1111), consecutively.

Table 10. Negotiation Outcomes and Sensitive Issues for the First Section

Country	Top Preference	MV Outcome	FBn Outcomes		Sensitive Issues
			FB_1	FB_2	
Korea Japan	1110	1110			n/a
	1110		1111		1-4(Paperless Trading) (0 → 1)
	1110			1010	1-2(Non-discrimination) (1 → 0)
China	1011	1110			1-2(Non-discrimination) (0 → 1) 1-4(Paperless Trading) (1 → 0)
	1011		1111		1-2(Non-discrimination) (0 → 1)
	1011			1010	1-4(Paperless Trading) (1 → 0)

Table 11. Negotiation Outcomes and Sensitive Issues for the Third Section

Country	Top Preference	MV Outcome	FBn Outcomes		Sensitive Issues
			FB_1	FB_2	
Korea China	1100001	1100001			n/a
	1100001		1100001		n/a
	1100001			1110001	3-3(Source code) (0 → 1)
Japan	1110001	1100001			3-3(Source code) (1 → 0)
	1110001		1100001		3-3(Source code) (1 → 0)
	1110001			1110001	n/a

2. Business and Trade Facilitation (II)

For the third section of issues, there is only one sensitive issue, 3-3 (Source code), as shown in Table 11. For 3-3 (Source code), China is particularly very sensitive to agreeing to provisions with obligation since China has more strict data regulation, which limits the free flow of data within its territory (Lee, 2019). In terms of negotiation outcome ranking, the first is the MV outcome (1100001), followed by the FB_1 outcome (1100001), which is same as the negotiation outcome of the RCEP (1100001). The FB_2 outcome (1110001) is the last preferred negotiation outcome among the three.

V. Implications and Conclusion

There are two implications from this negotiation model. First, it is realistic to assume that any country participating in trade negotiation attempts to minimize changes in its current 'optimal' position to a compromise as the model assumes. The minimax negotiation strategy, which is also discussed in game theory, refers to the tendency of negotiation participants to minimize 'worst possible losses faced by participating in negotiations'. Applying this logic to the FTA trade negotiation process, participating countries must bear losses because of the negotiations; that is, the 'additional market opening' to be accepted by the agreed negotiation, and there is a tendency to minimize this as much as possible. In fact, the 'additional market opening' is the biggest loss a country must bear because the status quo level of liberalization a country has concerning a specific FTA issue, such as digital trade, is optimal, which does not need to be further changed. In other words, each FTA participating country recognizes the outcomes of the previously concluded FTA negotiations as optimal. In the negotiation process, a country tends to have a strategy to minimize additional opening from its current status quo on a specific FTA negotiation topic. Applying this to the Korea-China-Japan FTA digital negotiation, the acceptance of the "mandatory regulations" agreed to in FTAs is the "maximum distance of the commerce" related to each article. Maximum minimization can be interpreted as establishing a negotiation strategy as to make each provision not become a mandatory regulation in the process of agreement, having fewer obligations in terms of this paper's concept. Second, this model suggests that negotiation outcomes calculated according to the model were derived in respect to the negotiating interests of all possible participants. It is very useful in that it is possible to predict in advance what level of agreement can be made based on reciprocal (win-win) negotiation, which is often pursued in any FTA negotiation. Whether each clause in the agreement is currently negotiated starting with an optimal position derived from the contents of each country's previous trade agreement is "acceptable to mandatory regulations" is not very difficult to predict. Moreover, sensitive issues within the agreements can also be predicted in advance. For example, applying this model to the KCJ FTA, Korea's bargaining power for each issue can be identified, and its alternatives can be specifically prepared as the overall negotiation strategy can be structured and systematically implemented.

This paper aims to apply the logic and mechanisms of the minimax procedures of the negotiation model to the ongoing KCJ FTA negotiations on electronic commerce. Under the minimax procedures of the negotiation model, negotiation outcomes of digital trade in the KCJ FTA for each section of issues can be predicted ex ante. For the first section of four issues, business and trade facilitation (I), the FB_2outcome will prevail as it is the least burdensome to agree to from each country's top preference. For the third section of the seven issues, business and trade facilitation (II), the MV outcome will prevail. In terms of sensitivity in the voting process, China is predicted to be the most reluctant to agree to binding rules on non-discrimination. As Japan is not as sensitive as the other two countries for each issue, both Korea and China are predicted to be the most hesitant in agreeing to binding rules on source code. Under the framework, it is possible to predict the negotiation positions and dynamics

of each participating country before negotiation begins or ends. Furthermore, we can infer the negotiation positions and dynamics of each participating country when reviewing negotiation outcomes after conclusion. Most of all, inferred negotiation outcomes can be viewed as win-win that would not produce any left-out countries since each country minimizes the deviation from the initial top preference to the agreed deal. To understand why digital trade negotiations of the three countries differ in their respective regulations, positions, and policy commitments, in-depth research on each country's history of domestic regulations and policy, as well as a study on the dynamics of trade stakeholders, must be done (Elms, 2021; Zhang, 2019). Moreover, factors affecting the positions of each country in digital trade negotiation, including size of the domestic market (land, population, market demand, economic level, etc.), technological or industrial competitiveness, trade openness and FTA experience, and the level of security laws and systems or level of protecting domestic market can be also analyzed in future studies. In addition, using the same framework, further comparative research in regulatory trade negotiations such as labor, environment, or investment are also possible. New rules for digital trade in Northeast Asia should consider consumers, small-and-medium-sized firms, and trade partners in developing countries (Ko, 2021).

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A Study on the Market Integration of Agricultural Product Wholesale Markets in Korea: A Focused Relation Analysis of Prices in Agricultural Product Wholesale Market*

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ABSTRACT

Purpose – In this study, we investigate the market integration function of agricultural product wholesale markets by analyzing the price determination power of individual markets that play a pivotal role in the distribution of agricultural products in Korea, and the relationship between prices among these markets.
Design/Methodology/Approach – We analyzed nine central wholesale markets that play a key role in 32 agricultural product wholesale markets in Korea using the daily price data of six major items. For the analysis, the stability of time series data was reviewed through the Unit Root test, and the ability to determine their own prices was checked through variance decomposition, forecast error variance decomposition.
Findings – The results show that the prices in the Garak Agricultural Product Wholesale Market, which accounts for 33.6% of all trade volume in all 32 agricultural products wholesale markets, have a remarkable impact on the prices in major central wholesale markets; thus, these markets, except for the Garak Market, lack their own price determination power for most items.
Research Implications – Agricultural product wholesale markets in Korea are achieving market integration due to the relatively small land area, a trade method focusing on auctions in wholesale markets, and the real-time sharing of agricultural trade information owing to advancements in information and communication technology. Therefore, this study's results are distinct from those of previous studies claiming that distance affects market integration.

Keywords: agribusiness, food distribution, global agro-industrial complex, market integration, wholesale market
JEL Classifications: D40, L11, Q13

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I. Introduction

Many studies have investigated the integration of markets that traditionally handle identical items, but are separated in terms of geography. Barrett (1996) stated that the integration of spatially separated markets is a key variable in determining market scope. The integration of spatially separated markets is determined by satisfying the "law of one price", which states that "identical commodities (i.e., commodities with the same physical properties, date, and location) will trade at the same price" (Rauh, 2001). Various markets depict market integration; however, agricultural product public wholesale markets (hereinafter referred to as "wholesale markets"[1] are especially suitable for analysis as new prices for various items in these markets are discovered every day. In addition, as of 2019, 59.0% of agricultural products in Korea were distributed through wholesale markets, indicating the pivotal role of wholesale markets in the distribution of agricultural products.

One of the main purposes for establishing a wholesale market for trading agricultural products is reasonable price determination. Generally, in individual wholesale markets, the price of each item is determined based on daily supply and demand. If wholesale markets are integrated, however, they may lack the ability to determine their own prices, and individual wholesale markets may have a high price relationship. Accordingly, this study investigates the market integration of wholesale markets in Korea by analyzing price relations among individual wholesale markets that are spatially separated based on the daily price data of the main items traded in wholesale markets.

To date, the analysis of market integration of wholesale markets has not been a key topic of research in Korea. Major studies in Korea related to wholesale markets or prices of agricultural products in the country have focused on investigating price relationships among wholesale markets or stages of distribution, as well as the effects of price transmission. Previous studies related to market integration in other countries approached the consumption site centered on and analyzed items with relatively little price volatility according to supply and demand (Engal & Roders, 1996; Parsley & Wei, 2001). In this study, market integration was studied for the first time in public wholesale markets classified as institutional markets. In addition, it is differentiated from previous studies by analyzing the producer-centered analysis based on the auction price. And, it is meaningful that the analysis was conducted on only agricultural products that are greatly affected by supply and demand.

Accordingly, to verify price relationships among wholesale markets in Korea, as well as their price determination power, we investigate the market integration of wholesale markets that are spatially separated through forecast error variance decomposition (FEVD). To this end, out of the 32 wholesale markets in Korea, we chose nine central wholesale markets (Ministry of Government Legislation, 2020)[2] as the subject of analysis, selecting the three common vegetable types and three fruit types with high trade volume. Daily price data from January 2015 to December 2019 were used in the analysis, and the price variables used were actual prices rather than the price indices.

II. Literature Review and Operation of the Agricultural Wholesale Market in Korea

1. Literature Review

Previous studies have claimed that the speed at which prices in a single market are adjusted by an

1. These are wholesale markets, established with the government budget, where agricultural products can be traded.
2. Central wholesale market" means an agricultural and fishery products wholesale market that becomes the wholesale center in the relevant jurisdiction and neighboring areas among the agricultural and fishery products wholesale markets established in a Special Metropolitan City, Metropolitan City, Special Self-Governing City or Special Self-Governing Province.

external shock is related to the distance between markets. Engel and Rogers (1996) analyzed consumer prices among 23 cities in North America using the consumer price index (CPI) of 14 products from 1978 to 1994 and discovered that the distance between cities affected price volatility. Fackler and Goodwin (2001) investigated the integration of agricultural product markets and concluded that the distance between markets was a factor that affected the speed of the shock to agricultural product prices. Parsley and Wei (2001) investigated price relationships using quarterly data of 27 products simultaneously traded in 96 regions of the United States and Japan from 1976 to 1997. They discovered that the stability of domestic prices was lower than the relative volatility of international prices. Gardner and Brooks (1994) studied the market integration of six agricultural products and processed agricultural products in 14 cities in Russia, and discovered that price differences were affected by the distance between regions, and similar prices were formed when markets were located in the same zone, not far from each other.

Goodwin et al. (1999) investigated the connectedness of four food items traded in five cities in Russia based on price information from 1993 to 1994, and found that markets of cities located in the same or neighboring provinces tended to be integrated. Goletti et al. (1995) investigated the integration of rice markets in 64 regions of Bangladesh and concluded that shorter distances between regions tended to result in market integration.

Iregui and Otero (2011) used CPI data for 54 foods in 13 cities in Colombia and discovered that cities closer together with similar populations and economic characteristics were more likely to show market integration. A 2012 study by the same authors analyzed price adjustment speed depending on market distance based on weekly price data for 18 agricultural product wholesale markets in Colombia and found that a greater distance between markets resulted in slow price adjustment (Iregui & Otero, 2012). Moreover, by analyzing the integration of spatially separated markets using CPI data for 153 consumer goods in 13 cities in Colombia, it was found that the market integration of fresh foods occurred more frequently compared with other goods (Iregui & Otero, 2017).

Hamulczuk et al. (2019) investigated the prices of canola used in biodiesel, and confirmed that markets in the European Union and Ukraine were directly and indirectly integrated, concluding that the canola prices in the two markets are in a long-run equilibrium. In other words, there were cases in which markets were integrated based on government policies.

Vinh et al. (2020) explored market integration in the Middle East and Africa through the retail prices of 135 goods and services in 23 countries, and determined that, owing to China's growing influence, market integration was increasing in the two regions. This implies that market integration is possible through investment from other countries as well.

Therefore, previous studies have shown that market integration is highly correlated with the distance between markets, and markets can be integrated by economic policies as well as investment and support from other countries. In addition, previous studies have analyzed market integration centered on the cousumer market by using variable such as consumer price or CPI. And it was found that there have been many previous studies on industrial products and agricultural processed products that are not sensitive to price changes according to supply and demand. In this study, the anlysis was focused on the acution and bidding prices of agricultural products. In other words, from the perspective of the producers who supplied agricultural products, it is differentiated from previous studies in that the analysus was focused on only agricultural products that are greatly affected by supply and demand.

2. Operation of the Agricultural Wholesale Market in Korea

To protect the rights and interests of the producers and consumers of agricultural products, Korea has established and operates wholesale markets based on the Act on Distribution and Price Stabilization of Agricultural and Fishery

Products. Wholesale markets established based on this law must have fairness and transparency in the commerce of agricultural products, and thus the Korean government has stipulated guidelines[3] regarding the operation and management of various wholesale markets.

As of 2019, 59.0% of agricultural products traded in Korea went through wholesale markets (Korea Agro-Fisheries Trade, 2020a). In other words, at least 50% of agricultural products produced in Korea were traded through wholesale markets, which play a key role in connecting producers with consumers. Wholesale markets in Korea generally have a system in which wholesale market corporations[4] collect goods purchased through an auction (Korea Agro-Fisheries Trade, 2020b)[5] by intermediary wholesalers[6], after which they are distributed to retailers. Moreover, one of the main purposes for establishing a wholesale market is to determine prices based on quality standards and the supply–demand of each product, for which auctions are commonly used.

As of 2019, there were a total of 32 wholesale markets operating in Korea. Those serving as a wholesale hub in an area and neighboring areas are referred to as "central wholesale markets". Korea has nine such markets. The remaining 23 are local wholesale markets (Ministry of Government Legislation, 2020)[7]. One of the main features of the Korean wholesale market is that trade volume is concentrated in one out of the 32 wholesale markets. Of the total trade volume of agricultural product wholesale markets in 2019, 6,944,863 plus 2,331,383 (domestic + imported) tons were traded in the Garak Wholesale Market in Seoul, accounting for 33.6% of total trade volume. Following Garak Wholesale Market is the Gangseo Wholesale Market in Seoul, which has a total trade volume of 9.2% (639,159 tons) (Korea Agro-Fisheries Trade, 2020b). In other words, trade volume is concentrated in a single wholesale market in Korea, which is why many studies indicated that the prices in the Garak Wholesale Market have a critical impact on the pricing of wholesale markets in Korea (Chae, 2018; Kim & Kim, 2014; Yoon & Yang, 2009). If prices in Garak Wholesale Market, which has the highest trade volume, affect the pricing of all wholesale markets, it can be assumed that these spatially separated wholesale markets are ultimately integrated. Accordingly, this study investigates whether the markets are integrated based on the results of price relationships among wholesale markets through FEVD using a vector autoregression (VAR) model.

III. Empirical Analysis

1. Data

1.1. Analysis Target Items and Wholesale Markets

Six items were selected for this study: three vegetables and three fruits with the highest trade volumes among agricultural products sold in Korea. As of 2019, the trade volume of each selected item accounted for 37.3% of total trade volume in wholesale markets (Korea Agro-Fisheries Trade, 2020b).

3. Crucial details about transactions in Korea's wholesale markets, such as transaction methods for agricultural products, roles of distributors, and restrictions in wholesale markets are stated clearly in the Act on Distribution and Price Stabilization of Agricultural and Fishery Products.
4. Among distributors for wholesale markets in Korea, wholesale market corporations gather agricultural products at the wholesale market, performing tasks such as determining the prices of agricultural products from producers through "auctions" in the wholesale market.
5. Transactions in Korean wholesale markets are divided into "auction" and "trade at a fixed price or free trade", and as of 2019, 77.06% of all agricultural product trade volume of in wholesale markets were traded through auctions.
6. Intermediary wholesalers are distributors that purchase agricultural products from wholesale market corporations and distribute these to retailers.
7. "Local wholesale market" refers to an agricultural and fishery product wholesale market other than the central wholesale market.

Table 1. Wholesale Market Trade Volume of Items Selected for Analysis (2019)

	Vegetables			Fruits			Others Others	Total Total
	Onions	Radishes	Chinese Cabbages	Apples	Mandarins	Pears		
Volume (Ton)	683,557	613,873	583,270	327,908	274,600	110,589	4,351,066	6,944,863
Share in Total (%)	(9.8)	(8.8)	(8.4)	(4.7)	(4.0)	(1.6)	(62.7)	(100.0)

Source: Korea Agro-Fisheries Trade Corporation (2020b).

Wholesale markets analyzed in this study include Garak Wholesale Market, which has the highest trade volume market among all wholesale markets in Korea, as well as eight other wholesale markets classified as central wholesale markets according to the Act on Distribution and Price Stabilization of Agricultural and Fishery Products. Only central wholesale markets were analyzed in this study as the trade volume is concentrated in central wholesale markets owing to the nature of Korean produce markets, and the prices in local wholesale markets are affected to a certain extent by neighboring central wholesale markets, which makes it difficult to derive clear analysis results. As shown in Table 2, 62.2% of the total trade volume was traded in nine central wholesale markets out of the 32 wholesale markets, proving that these central markets represent all 32 wholesale markets in Korea in terms of the distribution of agricultural products.

Table 2. Trade Volume of Wholesale Markets Selected for Analysis (2019)

(Unit: 1,000 tons, %)

	Garak	Daegu	Umgung	Ojung	Gakhwa	Samsan	Guwal	No-en	Ulsan	Others (23)	Total
Volume	2,331	565	389	233	230	177	163	153	76	2,627	6,944
Total Share	(33.6)	(8.1)	(5.6)	(3.4)	(3.3)	(2.6)	(2.3)	(2.2)	(1.1)	(37.8)	(100.0)

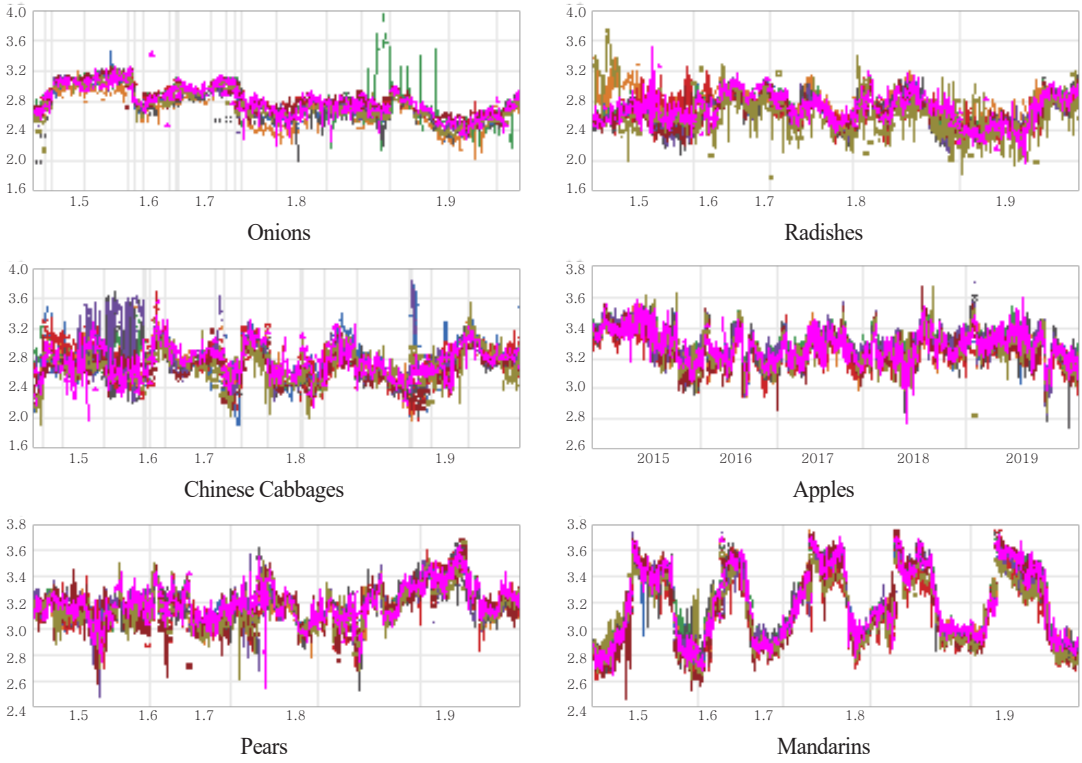
Source: Korea Agro-Fisheries Trade Corporation (2020b).

The average daily price data for each item in the wholesale markets from January 2015 to December 2019 available in the "Source Data on Daily Auction Prices in Wholesale Markets Nationwide" provided by the Ministry of Agriculture, Food, and Rural Affairs Public Data Portal were used to analyze the market integration of wholesale markets in Korea (Ministry of Agriculture, Food and Rural, 2020). For the price data unit, the price of each package weight[8] was converted to "KRW per kg". The analyzed data were converted into logarithms to secure the linear relationship of the data.

8. As prices vary by packaging unit (vehicle, box size), the figures were thus converted into kilograms for analysis.

The observation days for each item were as follows: onions, 544 days; radishes, 858 days; Chinese cabbages, 659 days; apples, 1,215 days; mandarins, 1,026 days; and pears, 969 days. The number of observed days differed depending on the traded item as trading days vary by item, even though the annual average trading days for wholesale markets is 305 days. The changes in the prices of each item in the wholesale markets during the analysis period are shown in Fig. 1.

Fig. 1. Changes in the Average Price of Each Item in Central Wholesale Markets



Source: Ministry of Agriculture, Food and Rural (2020).

1.2. Forecast Error Variance Decomposition (FEVD)

In this study, the Unit Root Test (ADF) was first performed to confirm the normality of the price data. Afterwards, for items with nonstationary, the long-run equilibrium relationship was examined through the 'Johansen Co-integration Test'. Finally, based on the VAR model (VECM), we tried to examine the price determination power of individual wholesale market through the analysis of Forecast Error Variance Decomposition.

Forecast Error Variance Decomposition analysis is an analysis method that measures the relative contribution of variables to each other's variability (Hamilton, 1994). The variance of one

of the variables in the model is decomposed for each variable to indicate how much it is explained by the other variables.

In the VAR model, the forecast error of the t-period is as shown in (1), and the mean square error (MES) of the forecast at the ┌ time is as shown in (2).

$$\epsilon_{t+s} = Y_{t+s} - \hat{Y}_{t+s} = \epsilon_{t+s} + \Psi_1 \epsilon_{t+s-1} + \Psi_2 \epsilon_{t+s-2} + \ldots + \Psi_{s-1} \epsilon_{t+1} \quad (1)$$

$$\begin{aligned} MSE(\hat{Y}_{t+s}) &= MSE(\epsilon_{t,s}) \\ &= E[(Y_{t+s} - \hat{Y}_{Y+s})(Y_{t+s} - \hat{Y}_{Y+s})'] \\ &= \Omega + \Psi_1 \Omega \Psi'_1 + \Psi_2 \Omega \Psi'_2 \\ &\quad + \ldots + \Psi_{s-1} \Omega \Psi'_{s-1} \end{aligned} \quad (2)$$

In order to calculate the proportion of the shock appearing in the j variable in the forecast error of the predicted value $\hat{Y}i$, $t+s$ of the s-climate for the variable Y, the ϵt is expressed as an orthogonalization error ut is as shown in (3).

$$\begin{aligned} \Omega = E(\epsilon_t \epsilon'_t) &= a_1 a'_1 \cdot Var(u_{1t}) + a_2 a'_2 \cdot Var(u_{2t}) \\ &\quad + \ldots + a_n a'_n \cdot Var(u_{nt}) \\ MSE(\hat{Y}_{t+s}) &= \sum_{j=1}^{n} Var(u_{jt})[a_j a'_j + \Psi_1 a_j a'_j \Psi'_1 \\ &\quad + \Psi_2 a_j a'_j \Psi'_2 + \ldots + \Psi_{s-1} a_j a'_j \Psi'_{s-1}] \end{aligned} \quad (3)$$

Based on the above process, variance decomposition measures how much the j orthogonal error (u_t) of $Var(u_{jt})[a_j a'_j + \Psi_1 a_j a'_j \Psi'_1 + \Psi_2 a_j a'_j \Psi'_2 + \ldots + + \Psi_{s-1} a_j a'_j \Psi'_{s-1}]$ contributes to the mean square error (MES) of the forecast error after s period.

Table 3. Results of Unit Root Test for Each Item

	Onions	Radishes	Chinese Cabbages	Apples	Pears	Mandarins
Garak	-2.597 *	-2.942 **	-3.258 **	-5.378 ***	-4.054 ***	-2.871 **
Daegu	-2.084	-4.742 ***	-5.052 ***	-5.803 ***	-4.273 ***	-2.869 **
Umgung	-2.143	-5.433 ***	-4.836 ***	-6.600 ***	-5.036 ***	-2.887 **
Ojung	-2.330	-3.152 **	-7.061 ***	-7.416 ***	-5.009 ***	-3.200 **
Gakhwa	-2.788 *	-4.203 ***	-3.878 ***	-6.434 ***	-3.690 ***	-3.133 **
Samsan	-2.520	-3.880 ***	-4.044 ***	-5.989 ***	-5.398 ***	-2.747 *
Guwal	-2.413	-4.950 ***	-4.118 ***	-5.982 ***	-5.288 ***	-2.968 **
No-en	-2.554	-3.202 **	-4.066 ***	-6.287 ***	-5.116 ***	-3.052 **
Ulsan	-2.825	-3.174 **	-4.951 ***	-6.400 ***	-6.244 ***	-3.345 **

Note: 1. The values are t-test values.
2. ***p<0.01, **p<0.05 and *p<0.10.

A Johansen co-integration test was conducted to verify the existence of cointegration vectors among variables (wholesale markets) for the prices of onions that showed an abnormal time series with a unit root. The results indicated a total of nine cointegration vectors among variables for the time series data of the prices of onions. Accordingly, this study applied the vector error correction model (VECM) for onions and the VAR model for five other items (radishes, Chinese cabbages, apples, pears, and mandarins) to conduct FEVD.

Table 4. Johansen Co-integration Test Results of Onions with a Unit Root

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value
None *	0.192	510.900***	197.37
At most 1 *	0.156	395.860***	159.53
At most 2 *	0.139	304.270***	125.62
At most 3 *	0.111	223.440***	95.754
At most 4 *	0.084	159.690***	69.819
At most 5 *	0.078	112.520***	47.856
At most 6 *	0.068	68.741***	29.797
At most 7 *	0.047	30.476***	15.495
At most 8 *	0.008	4.326***	3.8415

Note: ***p<0.01, **p<0.05 and *p<0.10.

3. Results of Price Relationship Analysis between Wholesale Markets

Based on analysis of the price relationship among wholesale markets through FEVD[9] in Korea in the past, if the explanatory power of prices in the wholesale market after 30 days is less than 50%, a wholesale market has insufficient price determination power of its own (Kim & Kim, 2014; Yoon, 2008). Accordingly, we investigated the price determination power of each wholesale market based on the criteria of previous studies, and also investigated the market integration of wholesale markets in Korea by analyzing the relationship between prices in the Garak Wholesale Market and eight other central wholesale markets.

First, we analyzed the price determination power of each wholesale market in the relationship among the through FEVD. Overall, the results showed that most wholesale markets had at least 50% explanatory power for onions (among the

9. The same appropriate time lag was selected from AIC and SIC, and if not the same, it was decided based on SIC.

vegetables) after 30 days, thereby showing their own pricing power to a certain extent. However, six wholesale markets (except for Garak Wholesale Market, Eomgung Wholesale Market, and Gakhwa Wholesale Market for radishes) and four wholesale markets (except for Garak Wholesale Market, Daegu Wholesale Market, Eomgung Wholesale Market, Ojung Wholesale Market, and Ulsan Wholesale Market for Chinese cabbages) had less than 50% explanatory power for prices after 30 days, indicating that, even though they are central wholesale markets, they failed to have their own pricing power.

As for the three types of fruit, eight central wholesale markets (except for Garak Wholesale Market) showed poor price determination power with less than 50% explanatory power after 30 days.

Table 5. Results of Price Determination Power Analysis of Central Wholesale Markets

		Garak	Daegu	Eomgung	Ojung	Gakhwa	Samsan	Guwal	No-en	Ulsan
Onions (lag 2)	1	100.00	89.49	90.62	82.33	93.82	85.08	98.26	92.71	95.75
	15	94.29	58.10	42.84	46.98	82.98	60.17	94.62	85.41	83.71
	30	94.22	56.15	38.24	44.67	82.31	58.70	94.58	84.94	82.58
Radishes (lag 1)	1	100.00	89.52	98.44	69.48	92.56	65.92	91.31	61.04	90.91
	15	88.97	23.76	79.22	28.91	67.63	18.65	54.34	18.91	47.16
	30	84.97	18.90	74.39	25.71	61.70	14.69	47.65	16.11	38.83
Chinese Cabbages (lag 1)	1	100.00	99.28	96.80	97.80	93.94	86.56	93.03	94.95	91.12
	15	86.65	74.76	68.44	74.33	50.65	39.27	53.90	55.26	58.88
	30	83.89	68.05	63.41	69.05	44.08	33.56	45.78	48.66	53.13
Apples (lag 1)	1	100.00	86.13	85.55	91.98	85.22	85.16	82.84	84.90	92.81
	15	79.17	43.40	37.51	46.51	40.72	30.05	33.60	39.67	47.58
	30	75.39	35.60	29.90	38.71	34.80	23.33	26.83	32.90	38.85
Pears (lag 1)	1	100.00	92.10	92.45	97.28	93.50	95.41	94.30	92.11	96.17
	15	72.39	42.68	45.97	47.54	42.71	49.91	42.34	44.40	56.29
	30	67.46	33.81	36.82	36.84	34.95	39.42	31.77	33.84	44.03
Mandarins (lag 1)	1	100.00	83.69	89.02	75.23	73.79	77.40	74.33	73.91	74.42
	15	72.51	34.51	39.62	25.25	15.77	23.96	20.03	25.27	17.63
	30	62.64	29.19	30.94	16.62	9.44	17.50	12.50	17.43	11.18

Studies in Korea have consistently proven that prices in the Garak Wholesale Market, which has the largest trade volume, have a significant impact on other wholesale markets. For empirical analysis, this study investigated the impact of prices in the Garak Wholesale Market on eight wholesale markets based on the FEVD results.

The results showed that, of the three types of vegetables, the prices of radishes and Chinese cabbages in Garak Wholesale Market affect prices in each central wholesale market to a certain extent. The price of radishes in the market after 30 days explained the prices in each central wholesale market by a minimum of 11.83% to a maximum of 65.95%, while those of Chinese cabbages explained prices by a minimum of 6.27% to a maximum of 20%.

As for fruits, prices in Garak Wholesale Market after 30 days explained the prices in all central wholesale markets with a high percentage. Apples were explained by a minimum of 34.33% to a maximum of 47.28%, pears by a minimum of 31.22% to a maximum of 43.65%, and mandarins by a minimum of 37.79% to a maximum of 48.96%.

Table 6. Effects of Prices in Garak Wholesale Market on Prices in Central Wholesale Markets

		Garak	Daegu	Eomgung	Ojung	Gakhwa	Samsan	Guwal	No-en	Ulsan
Onions	1	100.0	10.51	7.94	15.23	4.12	11.34	1.19	2.98	0.66
	15	94.29	25.38	38.17	41.81	13.12	33.09	2.94	5.68	4.38
	30	94.22	26.43	41.22	43.87	13.85	34.52	3.12	6.00	4.75
Radishes	1	100.00	10.48	1.29	28.40	6.48	30.07	8.03	24.70	6.07
	15	88.97	64.51	8.83	55.75	24.15	65.03	36.01	53.08	40.11
	30	84.97	65.77	11.83	58.05	28.70	65.95	40.29	55.74	45.45
Chinese Cabbages	1	100.00	0.72	0.14	0.65	5.48	12.77	2.41	1.03	0.31
	15	86.65	6.16	2.95	20.92	32.88	44.52	15.34	17.62	10.19
	30	83.89	10.65	6.27	24.91	38.09	48.20	20.91	23.38	14.43
Apples	1	100.00	13.86	8.42	6.43	6.75	8.24	7.01	6.35	2.86
	15	79.17	41.27	38.07	34.80	35.96	42.81	39.98	36.01	27.74
	30	75.39	46.24	43.39	39.85	41.82	47.28	44.84	41.27	34.33
Pears	1	100.00	7.90	6.21	1.86	4.50	3.76	3.37	1.83	1.77
	15	72.39	38.14	33.45	29.42	36.58	28.53	29.04	30.75	24.25
	30	67.46	43.65	39.18	35.67	42.27	34.46	35.77	36.79	31.22
Mandarins	1	100.0	16.30	6.48	16.95	17.68	12.31	15.22	18.10	13.20
	15	72.51	43.06	33.23	41.48	49.48	41.38	40.11	48.46	41.05
	30	62.64	44.78	37.79	43.93	48.96	43.79	42.79	48.53	43.73

VI. Conclusion

In this study, we investigated the market integration of geographically separated wholesale markets through FEVD based on the VAR model (or VECM) with six items from nine agricultural product wholesale markets in Korea.

The results of the analysis show that the price determination power for fruit in each central wholesale market, except for Garak Wholesale Market, is remarkably insignificant compared to vegetables. Moreover, examining the impact of prices for each item in Garak Wholesale Market on central wholesale markets revealed that fruit prices in the market maintained at least 30% explanatory power over many wholesale markets, except for Garak Wholesale Market, even after 30 days. This indicates that the prices determined in the Garak market continued to affect central wholesale markets. Further, some central wholesale markets had their own price determination power over vegetables, but not over fruit. Since there are insufficient facilities to store, process, and distribute vegetables after growing, they are distributed to wholesale markets without a separate handling process (Korea Rural Economics Institute, 2015)[10]. In other words, vegetable producers have limitations in adjusting shipments of agricultural products through storage depending on price fluctuations, thereby being forced to ship even when prices are unfavorable.

Thus, prices are determined according to supply and demand each day in individual wholesale markets, which gives these markets their own price determination power for vegetables, to a certain extent. Conversely, for fruit, most individual farmers have their own low-temperature storage facilities, or there are large-scale low-temperature storehouses at the community level, which enables producers to adjust shipment volume depending on price changes. In other words, since short-term shipments can be adjusted based on market price data depending on the price fluctuations at Garak Wholesale Market, wholesale markets other than Garak lack price determination power. Moreover, prices in other wholesale markets are affected by Garak Wholesale Market because trade volume in the latter accounts for 33.6% of all trade volume across the 32 wholesale markets in Korea. In addition, since it is located in the capital of Seoul, other wholesale markets symbolically acknowledge agricultural product prices at Garak, and thus it has a great impact on the pricing of the other 31 wholesale markets. Previous studies also discovered that prices in Garak Wholesale Market affected prices of other wholesale markets located in the same region (Kim & Kim, 2014; Yoon & Yang, 2009). And although it varies by item and market, the prices in the 31 wholesale markets are affected by the prices in the Garak wholesale market, which has the highest trade volume (Chae, 2018).

According to studies on market integration in Russia and Colombia by Fackler and Goodwin (2001), Gardner and Brooks (1994), Goletti et al. (1995), Goodwin et al. (1999), and Iregui and Otero (2011, 2012, 2017), distance between markets is a key variable in price adjustment, which is somewhat different from the results of this study. Since the landmasses of Russia, Colombia, and the United States analyzed in previous studies are larger than that of Korea, distance has an absolute impact in the previous studies due to shipping expenses, whereas the relatively small land area in Korea results in an insignificant impact from distance.

Despite the spatial distance between wholesale markets[11], this phenomenon is caused by a trade volume that is excessively concentrated in Garak Wholesale Market, as well as the effect of real-

10. The low-temperature storage facilities for onions, which are the easiest to store among the vegetables examined in this study, are obsolete, with 82% established before the 2000s
11. The “Guwol Wholesale Market” is closest to the Garak (44.1km), and “Eomgung Wholesale Market” is farthest (380.2km) (based on the Naver Map traffic information).

time trade information sharing systems such as electronic auctions[12]. In Korea, electronic auctions were gradually adopted in the 32 wholesale markets in the 2000s, laying the foundation for the generation of transaction information. Based on continuous research and development, a system was established to provide real-time trade information on agricultural products, including prices. Furthermore, real-time information is disclosed on the website of the Korea Agro-Fisheries & Food Trade Corporation (at.agromarket.kr) under the Ministry of Agriculture, Food, and Rural Affairs in Korea, and summaries and infographics are available to the public. Trade data collected each day are currently built into a database and shared through the Korean Ministry of Agriculture, Food, and Rural Affairs Public Data Portal (data.mafra.go.kr). With this system, a total of 34,572,464 cases of real-time trade information on 253 agricultural products in 32 wholesale markets were generated and accumulated as of 2019, with a daily average of 112,248 cases, adding up to a massive database.

Furthermore, as the first country to commercialize 5G services, Korea's internet and mobile internet speeds are extremely high, and the smartphone uptake rate in 2019 was 93.2%, enabling anyone to check agricultural product wholesale prices on a mobile device, regardless of time and location. Even though auction time varies by wholesale market, the establishment of a real-time price data sharing system causes prices in the Garak Wholesale Market, where the trade volume is concentrated, to affect prices in other wholesale markets. Moreover, with the increased information access of shippers, buyers, distributors, and producers, after shipping products to wholesale markets other than Garak, price comparisons between Garak and other markets can be made in real time. Thus, suppliers can demand a price increase or ship products to Garak, which keeps other central wholesale markets from ignoring the pricing influence of the Garak Wholesale Market.

In other words, wholesale markets in Korea are geographically separated, but remain integrated because of the unique distribution system in which transactions are made by auction supplemented with increased information access. Further, vegetables with relatively lower shelf lives tend to show a lower level of market integration compared to fruit.

Through this study, it is meaningful that the characteristics of agricultural products trading methods in the wholesale market, geographical conditions, and the development of information and communication were derived as factors affecting the integration of agricultural products market. In addition, it is significant that the level of market integration differs according to the characteristics of vegetables and fruits among agricultural products.

Considering the above, there are active discussions in Korea on the actual restructuring of wholesale markets to reestablish the roles and functions of local wholesale markets as well as some central wholesale markets that fail to perform the main function of wholesale markets with insufficient competitiveness. Further, it might be advisable to transform some of the 32 wholesale markets to perform other roles, such as distribution centers.

In this study, there is a limit in terms of the diversity of variables in that market integration was analyzed through the Forecast Error Variance Decomposition based on only the price information of the wholesale market. Therefore, in the future, related studies should be analyzed using various variables such as price information and GIS data between wholesale markets.

12. An "electronic auction" is held by displaying product information on the display board in the auction house, after which a bidder uses a bidding machine to present his/her desired price, and the auctioneer accepts the highest bidder.

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MNE Subsidiary Managers' International Work Experience and Advice Networks: The Moderating Role of Cultural Distance

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ABSTRACT

Purpose – To perform effectively in the context of the dual embeddedness of MNE subsidiaries, subsidiary managers need to build and use wide advice networks across headquarters and their host countries. Informed by social learning theory, we explore how a subsidiary manager's prior international work experience contributes to building advice networks and how cultural distance between the manager's home and the prior working country moderates the relationship between international experience and the advice networks there
Design/Methodology/Approach – The study is based on a survey of 187 subsidiary managers that report directly to subsidiary heads, in 43 subsidiaries of 12 South Korean MNEs.
Findings – We find that parent country national subsidiary managers with prior international work experience in a host country tend to have larger and stronger local advice networks in the country, whereas host country national subsidiary managers' prior international work experience in the multinational enterprise's home country contributes to building strong advice networks in the home country. More crucially, we find that a parent country national subsidiary manager's prior international work experience in the host country has a stronger influence on the size of local advice networks when there is higher cultural distance between the home and the host country.
Research Implications – In the management of this paper, our study identifies cultural distance as a boundary condition in the relationship between MNE subsidiary managers' international work experience and advice networks.

Keywords: advice network, cultural distance, international experience, social learning theory, South Korean multinational enterprises, subsidiary manager
JEL Classifications: F23, L20, M10

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I. Introduction

Subsidiaries of multinational enterprises (MNEs) are embedded in both their MNE networks and local business networks (Meyer et al., 2011). Given this dual embeddedness, subsidiary managers need to understand interdependencies across MNEs sub-units and external organizations (Roth, 1995) and be able to access critical information and knowledge from their local environment as well as corporate headquarters (Birkinshaw et al., 2005). However, to gather the necessary information and knowledge they require across different locations, subsidiary managers need help from relevant actors both at headquarters and in the local environment (Harvey et al., 2011a). Thus, to perform effectively in the context of the dual embeddedness of subsidiaries, they need to build and use wide advice networks - the relationships through which they share information and knowledge relevant to their work (Nebus, 2006) - across headquarters and host countries (Mäkelä & Suutari, 2009).

Advice networks have attracted attention from management scholars, as they are one of the critical social networks for managers (Zhang et al., 2009). An important determinant of success in managerial work is the capacity to access job-related advice and information (Seibert et al., 2001). As advice networks are composed of relationships through which employees share information and knowledge relevant to their work (Nebus, 2006), they give members opportunities to exchange job-related information, business insights and managerial know-how (McDonald et al., 2008).

However, subsidiary managers often lack advice networks outside their home country. For example, a parent country national (PCN) subsidiary manager, while having strong networks in the MNE home country, may lack advice networks in a host country; a host country national (HCN) subsidiary manager with local networks in the host country, might be lacking advice networks at headquarters (Sparrow et al., 2017). To compensate, MNEs sometimes provides prospective subsidiary managers with prior international work experience, perhaps at headquarters through inpatriation (Reiche et al., 2009) or prior work experience in a host country such as short-term assignments and business trip for PCNs (Caligiuri & Colakoglu, 2007). However, we could not find any studies that have examined whether and when subsidiary managers' prior international work experiences in either headquarters for HCNs, or the relevant host country for PCNs, contributes to building their advice networks in foreign locations.

To address the gap between the importance of the topic for MNEs and its lack of coverage in the literature, we explore how prior international work experiences of a subsidiary manager contribute to building advice networks in the relevant foreign country. More specifically, we examine whether a PCN subsidiary manager with prior international work experience in the host country has larger and stronger local advice networks there; whether an HCN subsidiary manager with prior international work experience in the MNE home country develops larger and stronger advice networks at headquarters; and whether cultural distance - the extent to which the culture of a country is novel or different from another country (Shenkar, 2001) - between a subsidiary manager's home and a prior working foreign country moderates the relationships between international experiences and advice networks.

Experiences in foreign countries often provide individuals with unique learning experiences that cannot be acquired in their home countries (Roth, 1995). International experience has mainly been considered in relation to managers' cognitive or intercultural abilities (Le & Kroll, 2017; Takeuchi et al., 2005). Foreign countries may provide stimuli that can create dissonance between an individual's cognitive schemas and the environment. This dissonance may stimulate learning that leads to the accumulation of domain-specific knowledge and general cognitive competencies (Endicott et al., 2003; Suutari & Mäkelä, 2007). In particular, work assignments in foreign countries with high cultural distance provide strong stimuli (Cuypers et al., 2015). Social learning facilitated through previous international experience with high cultural distance between countries makes it

easier for a subsidiary manager to acquire accurate information or knowledge (Lee & Sukoco, 2010; Piaskowska & Trojanowski, 2014) in order to build advice networks there.

To address our research aims, we used a sample of Korean MNEs' subsidiary managers working in various host countries. Our study makes several novel contributions to the International HRM literatures. First, our study identifies cultural distance as a boundary condition in the relationship between MNE subsidiary managers' international work experience and advice networks. We extend the literature by showing that the effect of international experience is cultural context specific, particularly when it comes to its relational outcomes.

Second, although the impacts of social networks on various individual and organizational outcomes have been explored (e.g., Taylor, 2007; Wang et al., 2014), no studies examine the antecedents to an MNE subsidiary manager's advice networks. We contribute to the literature on advice networks in MNEs by theorizing the positive role of subsidiary managers' prior international work experiences in building their advice networks in relevant foreign countries and by providing empirical evidence to support the argument. Third, while extant studies on international experience have examined its effects on managers' careers (Jokinen et al., 2008) and their cognitive and cultural capabilities (Caligiuri & Bonache, 2016; Dragoni et al., 2014; Engle & Crowne, 2014), we extend the literature on international experience by examining the effect of managers' international experiences on their relational outcomes. Fourth, while previous studies have devoted attention to the HQ or subsidiary CEO level (e.g., Carpenter et al., 2001; Le & Kroll, 2017), this study takes a more comprehensive approach by examining managers in subsidiary top management teams who report directly to the head of the subsidiary.

The paper takes the following form. We review the literature to identify the theoretical background and build on the insights there about aspects of managers' experience in order to develop hypotheses. Then we outline our methodology, and present and discuss our findings.

II. Theoretical Background and Hypotheses

1. Social Learning Theory

Social learning theory suggests that an individual's learning can be motivated when cognitive dissonance between an individual and the environment is experienced. Cognitive dissonance often occurs when an individual encounters new, meaningful, and critical experiences (Kolb, 1984) which may not be understood with their existing knowledge and beliefs (Endicott et al., 2003). When existing schema and new impressions interplay, the individuals' existing schemas change (Fee et al., 2013).

Learning occurs in two distinct processes: assimilation and accommodation (Piaget, 1955). Assimilation involves the addition to existing schemas, and accommodation involves the development of sophisticated schemas and fundamental changes in cognitive structure (Fee et al., 2013). Exposure to more frequent accommodative triggers prompts cognitive restructuring. Considerable cognitive dissonance motivates subsidiary managers to assimilate and accommodate existing schemas (Endicott et al., 2003; Le & Kroll, 2017). Such situations are most likely to occur when subsidiary managers engage in more frequent interaction with host culture nationals. A culture of the country is transmitted most directly through interactions with its people, and regular cross-cultural interaction (Fee et al., 2013)

In this study, we adopt social learning theory to explain the reason cultural distance moderates the relationship between MNE subsidiary managers' prior international work experience and advice networks. When cultural distance increases, it would be easy for a subsidiary manager with prior international work experience to access sources of knowledge and thus build new relationships in the foreign environment. Thus, we posit that subsidiary managers' prior international work experience in specific foreign countries may help them to increase their advice networks.

2. Subsidiary Managers' Prior International Work Experience and Their Advice Networks

International experience is a complex and multi-dimensional concept (Takeuchi et al., 2005; Le & Kroll, 2017). We focus on particular aspects of international experiences in relation to advice networks across borders. We focus on country-specific international experiences (Rickley, 2019; Schmid & Wurster, 2017) rather than general international experience. We aim to examine particular international experiences that contribute to building country-specific advice networks (e.g. headquarter advice networks for HCN subsidiary managers, local advice networks in particular host countries for PCN subsidiary managers). To build advice networks effectively in specific countries, it is necessary to understand cultural norms and contexts regarding social interactions in the society (Rickley, 2019). Work experiences in a specific country enables an individual to acquire such country-specific knowledge in social interactions in the country (Takeuchi et al., 2005). Hence, location-specific international experiences would be relevant to this study, as the role of international experience in building advice networks is culture specific.

With regard to advice networks, we examine two aspects: size (number of contacts) and strength (frequency of contact), considered as key aspects of individual-level networks (McDonald et al., 2008; Semrau & Werner, 2014). Size refers to the total number of different actors in the networks (Lin et al., 1985). Larger networks provide much information and access to a wider range of resources than smaller networks (Liao & Welsch, 2005). Information and advice about buyers, consumers, competitors, pricing, and promotions from a wide range of networks allows subsidiary managers to evaluate the possibility of business success (Dyer & Ross, 2008). In addition, strong ties, which refer to the closeness and interaction frequency of a relationship between individuals (Granovetter, 1973), facilitate deeper access to knowledge and generate stronger support and collaboration from relevant parties, particularly in business (Jack, 2005). We expect that both the size and the strength of advice networks would be important for MNE subsidiary managers, considering the broad scope of required knowledge and the strong support and collaboration needed from various parties across different functions and locations.

According to social learning theory, unfamiliar cultures in foreign countries provide a wide range of stimuli through social interactions (Shaw, 1990). The cognitive disequilibrium that occurs during international assignments can contribute to developing higher levels of cognitive complexity. Prior international assignments provide individuals with intense experiences that create information or knowledge of the foreign country (Kohonen, 2005). These can help the individual to understand different cultural environments by facilitating the social learning process (Lee & Sukoco, 2010; Ott & Michailova, 2018; Shannon & Begley, 2008).

More crucially, international work experience provides opportunities to learn how to interact effectively to build relevant advice networks in the future by observing others' behaviors in the specific cultural setting. During periods of international assignments, therefore, subsidiary managers can build advice networks and then utilize these in their future work (Bozkurt & Mohr, 2011; Mäkelä & Suutari, 2009). For example, mutual understanding about business partners' culture enhances the quality of interaction with them and helps avoid stereotypes about the cultural and ethical environment (Sharma, 2019).

We apply this theoretical reasoning to the cases of PCN and HCN subsidiary managers (Argote & Miron-Spektor, 2011; Chen et al., 2010; Johnson & Duxbury, 2010) and hypothesize that:

H1a: A PCN subsidiary manager's prior international work experience in a host country is positively related to the size of their advice networks with local stakeholders.

H1b: A PCN subsidiary manager's prior international work experience in a host country is positively related to the

strength of their advice networks with local stakeholders.

Similarly, HCN subsidiary managers - another important human resource for MNEs - with prior international work experience in the MNE home country may have more opportunities for direct interactions with people there and learn how to develop relationships with them, which help them to build a number of social ties with headquarter colleagues in different departments or work groups (Reiche, 2012). Through the prior international experience in headquarters, HCN subsidiary managers are assimilated into a part of the MNE (Walsh et al., 2008). The more HCN subsidiary managers actively assimilates into headquarters, the more they develop advice networks at headquarters (Harvey et al., 2011b).

They not only build advice networks in the country, that can be utilized when they undertake the role of subsidiary manager, but also gain an understanding of how to build and manage relationships there in the future. Hence, they can act as boundary spanners (Harvey et al., 2011c; Harzing et al., 2015) as their advice networks across headquarters and local parties allow them to access the critical knowledge and information they need (Reiche et al., 2009). Thus, we hypothesize:

H1c: An HCN subsidiary manager's prior international work experience in the MNE home country is positively related to the size of their advice networks at corporate headquarters.

H1d: An HCN subsidiary manager's prior international work experience in the MNE home country is positively related to the strength of their advice networks at corporate headquarters.

3. The Role of Cultural Distance in Building Advice Networks through International Experience

While the previous international work experience of subsidiary managers can contribute to building their advice networks, some may build more from their experience than others. So, we posit that the positive relationship between subsidiary managers' prior international work experience and their advice networks may be moderated by the cultural distance between their home and prior host countries (Manev & Stevenson, 2001). We particularly focus on cultural distance between subsidiary managers' home country and relevant foreign countries where they previously gained international working experiences (MNE home country for HCN subsidiary manager; the host countries for PCN subsidiary managers).

Prior international contacts provide opportunities to enrich cultural intelligence - "the ability to interact effectively with culturally different individuals" (Thomas et al., 2015, p. 1100) - by developing cross-cultural skills (Deal et al., 2001). Cultural exposure can increase open-mindedness, cultural empathy, emotional stability and flexibility (Crowne, 2013). Several studies have shown that cultural intelligence is related to individuals' relational abilities and trust with foreigners (Rockstuhl & Ng, 2008). Individuals are culturally conscious when they have opportunities to experience different cultural values and norms. A variety of international work experiences allows individuals to obtain knowledge and skills that are essential for working in different cultural environments (Shannon & Begley, 2008). For PCN subsidiary managers, the more they interact with host nationals, the more they will learn about behavioral norms and the rationale for why people behave in certain ways.

When subsidiary managers work in foreign countries, and interact and communicate with people from different cultures, they learn in specific cultural circumstances and acquire more accurate information or knowledge on the foreign country (Michailova & Ott, 2018; Piaskowska & Trojanowski, 2014). However, these environments may differ considerably from their home country and the cultural characteristics of the country might impact the effectiveness of their prior international work experience in building advice networks there. Learning theories suggest that cognitive dissonance stimulates learning,

which occur when an individual encounters new, meaningful, and critical experience (Kolb, 1984). As foreign environments may present stimuli that are new and different, they may create a sense of dissonance, which can result in individuals' learning (Endicott et al., 2003). Arguably, this learning experience would be more stimulated, when an individual has work experience in a more culturally distant location.

International experience is more likely to play a role in building advice networks, then, when the cultural distance between the home and host country is high (Kim et al., 2008), as higher cultural distance triggers a critical learning process which enables individuals to develop a more accurate understanding of their partners' cultural background, thus helping them to overcome negative reactions and misunderstandings (Rockstuhl & Ng, 2008). Therefore, prior international experience may produce larger and stronger advice networks where there is a high cultural distance between countries. Applying this reasoning to PCN subsidiary managers, we hypothesize:

H2a: A PCN subsidiary manager's prior international work experience has stronger influence on the size of their advice networks with local stakeholders when there is higher culture distance between the home and the host country.

H2b: A PCN subsidiary manager's prior international work experience has stronger influence on the strength of their advice networks with local stakeholders when there is higher culture distance between the home and the host country.

Similarly, working in headquarters, HCN subsidiary managers' learning on the expected mode of social interactions at headquarters is more likely to be facilitated when cultural distance is high between their home country and the MNE home country. HCN subsidiary managers' previous international experience in an MNE home country with high cultural distance makes them easier to adapt to the new headquarters environment through social learning (Lee & Sukoco, 2010; Piaskowska & Trojanowski, 2014). In such a case we expect that the effectiveness of prior international experience of HCNs in building advice networks at headquarters would be increased, so we hypothesize:

H2c: An HCN subsidiary manager's prior international work experience has stronger influence on the size of their advice networks with corporate headquarters when there is higher culture distance between the manager's home and the MNE home country.

H2d: An HCN subsidiary manager's prior international work experience has stronger influence on the strength of their advice networks with corporate headquarters when there is higher culture distance between the manager's home and the MNE home country.

Taken together, Fig. 1 presents the conceptual research model.

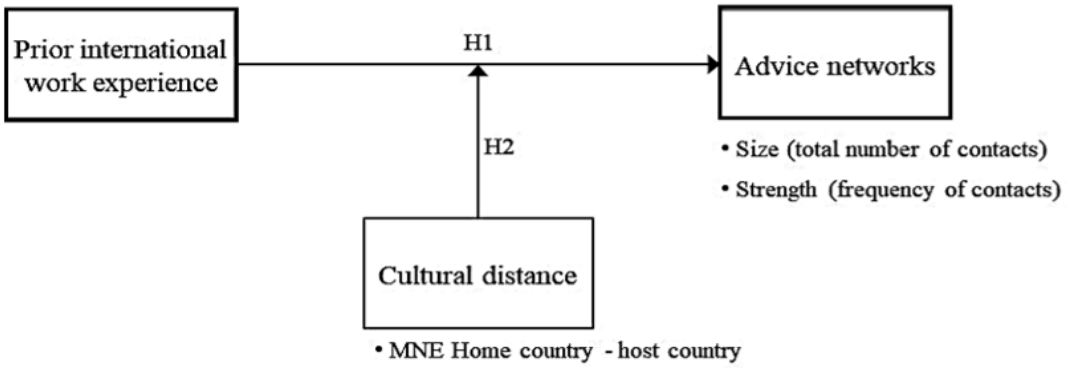
III. Method

1. Sample and Procedures

Our analysis is based on a sample of subsidiary managers of South Korean MNEs. Although South Korean MNEs show a significant presence across the globe, they are less studied than MNEs from the USA, Europe and Japan (Chung et al., 2014).

We conducted a survey with subsidiary managers who report directly to subsidiary heads, in 43 subsidiaries of 12 South Korean MNEs. We selected the companies based on (1) their international presence, (2) their leading positions in their respective industries, and (3) accessibility. Total revenues range from US$130million to US$178,217million. The total number of employees range from 282 to 392,305 with a mean

Fig. 1. The Conceptual Research Model



of 34,932. It faithfully reflects the population as representative multinational companies in South Korean MNEs.

We collected data by asking headquarters HRM managers or subsidiary HRM managers of the firms to send survey questionnaires to subsidiary managers. However, the response rate was low at 8%, mainly due to confidentiality issues. Thus, in most cases, one of the authors visited subsidiaries to distribute and collect questionnaires personally from subsidiary managers. Subsidiaries in China, Vietnam, Thailand, Singapore, Hungary, and Slovakia were visited between December 2016 and April 2017. For subsidiaries in other countries, headquarters HRM managers helped to distribute and collect questionnaires. Eventually, we collected data from 187 subsidiary managers. The respondents include 125 PCNs and 62 HCNs.

The Korean version of the questionnaire was used for PCNs and the English version for non-Korean respondents. The English questionnaire was translated into Korean and then back-translated into English by an independent translator to check the accuracy of translation and adjust it accordingly (Brislin et al., 1973; Brislin, 1976; Matsumoto & van de Vijver, 2010).

2. Measurement

The length of prior international work experience was measured i) by summing the years of prior international work experience in the host country before the current assignment for PCN subsidiary managers, and ii) by summing the years of prior international work experience in the MNE home country for HCN subsidiary managers (Le and Kroll, 2017; Schmid & Wurster, 2017).

The two dependent variables are the size and strength of advice networks. The size of advice networks is defined as the total number of contacts an individual has currently (Semrau & Werner, 2014). Subsidiary managers were asked to list contacts from whom they ask advice, including i) external parties in the host country for PCN subsidiary managers (e.g., government officers, suppliers, customers, vendors, and experts in other companies); and ii) managers at corporate headquarters for HCN subsidiary managers. The strength of advice networks was measured by interaction frequency between two individuals (Granovetter, 1973; McDonald et al., 2008). They were asked to report how often during the previous twelve months they sought advice about a subsidiary's future business strategy, the parent firm's current strategy, the effectiveness of the subsidiary's resource allocation, and managerial know-how. A five-point scale was used including the responses: (1) never, (2) less than once a month, (3) 1~3 times a month, (4) 1~3 times a week, and (5) daily.

Cultural distance (Dragoni et al., 2014; Le & Kroll, 2017) was measured following the procedure developed by Kogut and Singh (1988), using the original four cultural dimension scores (uncertainty avoidance, individualism, masculinity, and power distance) developed by Hofstede (1980). The formula is below.

$$CDjh = \sum_{i=1}^{4} \left\{ \frac{(I_{ij} - I_{ih})^2}{Vi} \right\} / 4$$

Where CDjh is the cultural distance between hth country (PCN/ HCN subsidiary manager's home country) and jth country (PCN subsidiary manager: the host country; HCN subsidiary manager: South Korea); Iij is the jth country's score on the ith cultural dimension in the Hofstede cultural dimension scale; Iih is the hth country's score on the ith cultural dimension; and Vi is the variance of the index of the ith cultural dimension.

Referring to previous research on international experience and the social networks of subsidiary managers (Dickmann et al., 2016; Jokinen et al., 2008; Suutari & Mäkelä, 2007), we included control variables such as job functions (staff, sales/ marketing, production, and research & development: dummy variables), total tenure of entire career (1 = less than 1 year, 2 = 1~5 years, 3 = 6~10 years, 4 = 11~15 years, 5 = more than 16 years), job grade (1 = manager, 2 = senior manager, 3 = director, 4 = executive), gender (male = 1, female = 0), and age (1 = below 25, 2 = 26~30, 3 = 31~35, 4 = 36~40, 5 = 41~45, 6 = 46~50, 7 = 51~55, 8 = over 56). For the parent firm characteristic, Industry was measured by creating a series of dummy codes (Kobrin, 1991), 1 = Manufacturing-Computer and electronics, 2 = Manufacturing-Machinery, 0 = Others (Metal, Information technology, Construction, Services, Finance and Insurance, Beverage).

As the data for the dependent and independent variables were obtained from the same source - subsidiary managers - there may be a concern that issues of common method variance might have inflated or deflated the strengths of the relationships among the research constructs (Podsakoff & Organ, 1986; Podsakoff et al., 2003). However, common method bias is less likely to be a concern in our study as the data is factual rather than perceptual, and there is a clear time gap between the independent variable (prior international experience) and the dependent variable (current advice networks). In addition, several procedures were followed to reduce the risk of common method bias: making explicit statements on the nature of the research project and protection of respondent anonymity (Nancarrow et al., 2001; Podsakoff et al., 2003); and placing the dependent variables apart from the independent ones in the survey questionnaire (William et al., 1989).

IV. Results

We divided the dataset into PCN and HCN subsidiary managers. Hierarchical regression analysis was conducted for each dataset. Correlation statistics from the dataset for PCN subsidiary managers, including means and standard deviations, are provided in Table 1. The mean score for prior international work experience was 1.307. They have 5.032 contact points for advice-seeking on average and contact with local parties 1~3 times a month normally.

Table 2 provides correlation statistics from the dataset for HCN subsidiary managers, including means and standard deviations. The mean score for prior international work experience was 1.846. They have 4.420 contact points for advice-seeking on average and normally have contact with managers at headquarters 1~3 times a year.

Table 3 presents the results of hierarchical regression analyses for PCN subsidiary managers' advice networks in their relevant host countries. We first entered all control variables (Model 1 and 4) before adding the independent variables.

Model 2 and 5 test the effect of prior international

Table 1. Means, Standard Deviations, and Correlations of PCNs

Variables	Mean	S. D	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Job Function (Staff)	.370	.484	1												
2. Job Function (Sales & Marketing)	.140	.353	-.313**	.100											
3. Job Function (Production)	.390	.490	-.613**	-.329**	1										
4. Tenure	4.600	.635	-.068	.007	.067	1									
5. Job Grade	2.260	.731	.088	.008	-.089	.525**	.1								
6. Gender	.990	.089	-.118	.037	.072	.085	-.091	1							
7. Age	5.340	.742	.026	-.068	.070	.534**	.619**	.042	1						
8. Industry (Computer & Electronics)	.540	.501	-.155	-.304**	.386**	-.030	-.059	-.084	-.131	1					
9. Industry (Machinery)	.410	.493	.042	.309**	-.300**	.113	.057	.075	.164	-.892*	1				
10. Length of Prior International Experience (MNE Home Country)	1.307	2.138	-.059	-.037	.128	.140	.034	.055	.212*	.039	-.103	1			
11. Cultural Distance	4.160	1.895	-.024	.111	-.115	-.014	.256**	-.078	.076	-.033	-.018	.073	1		
12. Size of Advice Network (Host Country)	5.032	3.823	.059	.020	.058	-.197*	-.110	-.117	-.115	.341**	-.319**	.208*	-.098	1	
13. Strength of Advice Network (Host Country)	3.639	1.023	-.105	-.156	.211	-.115	-.200*	-.075	-.197*	.212*	-.107	.172	-.182	.677*	1

Note: N=125, *p<0.1, **p<0.05 (2-tailed). S.D: Standard Deviation.

Table 2. Means, Standard Deviations, and Correlations of HCNs

Variables	Mean	S. D	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Job Function (Staff)	.400	.495	1												
2. Job Function (Sales & Marketing)	.060	.248	-.216	.100											
3. Job Function (Production)	.390	.491	-.653**	-.209	1										
4. Tenure	4.610	.554	.220	-.293*	-.043	1									
5. Job Grade	2.100	.783	.194	-.033	-.184	.541**	.100								
6. Gender	.760	.432	-.150	.148	-.015	.150	-.027	1							
7. Age	4.890	1.057	.245	-.160	-.041	.680**	.726**	-.061	1						
8. Industry (Computer & Electronics)	.480	.504	-.204	.008	.158	-.140	-.162	-.131	-.234	1					
9. Industry (Machinery)	.500	.504	.164	.000	-.132	.176	.125	.188	.261*	-.968**	1				
10. Length of Prior International Experience (MNE home country)	1.846	4.070	-.186	.127	.197	.163	.033	.167	.050	.086	-.073	1			
11. Cultural Distance	4.110	2.502	-.052	.073	.272**	-.038	-.119	.102	-.142	-.044	-.031	.054	1		
12. Size of Advice Network (Host Country)	4.420	3.222	-.046	.130	-.052	-.220	.198	-.279*	.024	.327**	-.384**	.215	-.148	1	
13. Strength of Advice Network (Host Country)	3.613	.944	.103	-.056	-.144	-.058	.062	-.220	.043	.094	-.139	.092	-.231	.487**	1

Note: N=62, *p<0.1, **p<0.05 (2-tailed). S.D: Standard Deviation.

work experience on advice networks with local parties in order to test Hypothesis 1a and 1b. The relationship between the prior international work experience and the size and the strength of advice networks was significant (size: $\beta = 0.205$, $p < 0.01$, strength: $\beta = 0.209$, $p < 0.05$). Adding the prior international work experiences variable to the hierarchical regression analysis increases explanatory power from 18.6% in Model 1 to 22.4% in Model 2 and from 10.7% in Model 4 to 14.7% in Model 5. The results provide support for Hypothesis 1a and 1b. Models 3 and 6 include cultural distance and the interaction term of prior international work experience and cultural distance to test the moderating effect. The positive moderating effect of cultural distance on the relationship between the prior international work experience and the size of advice networks with local parties (Model 3) was significant ($\beta=0.341$, $p<0.05$), which supports Hypothesis 2a. In addition, variance inflation factor (VIF) analysis was conducted in order to check multicollinearity in regression Model 3 in Table 3. The largest VIF in the model was 3.114 which is far lower than the usual cutoff point of 10 (Hair et al., 2006). Therefore, we concluded that no serious multicollinearity issue was involved in the analysis. However, no significant moderating effect of cultural distance was found in the relationship between prior international work experience and the strength of advice networks (Model 6), so we cannot accept Hypothesis 2b.

Table 3. Length of Prior International Experience of PCNs and Advice Networks in Host Countries

Variables	Size			Strength		
	Model1	Model2	Model3	Model4	Model5	Model6
	β(S.E)	β(S.E)	β(S.E)	β(S.E)	β(S.E)	β(S.E)
Job Function (Staff)	.319(1.166)	.312(1.143)*	.310(1.108)*	-.051(.451)	-.037(.444)	.004(.447)
Job Function (Sales & Marketing)	.319(1.343)*	.305(1.319)*	.325(1.279)**	-.137(.491)	-.135(.483)	-.097(.487)
Job Function (Production)	.265(1.184)	.248(1.162)	.195(1.133)	.139(.462)	.165(.455)	.202(.456)
Tenure	-.148(.634)	-.166(.623)	-.199(.611)	.015(.198)	-.012(.196)	-.029(.196)
Job Grade	-.062(.607)	-.024(.601)	.033(.607)	-.075(.190)	-.020(.191)	.059(.201)
Gender	-.081(3.673)	-.086(3.603)	-.096(3.492)	-.090(1.044)	-.095(1.026)	-.103(1.024)
Age	.056(.602)	-.006(.606)	-.011(.587)	-.168(.192)	-.226(.237)	-.251(.193)
Industry (Machinery)	-.334(.725)**	-.303(.718)**	-.333(.700)***	.025(.239)	.058(.047)	.064(.238)
Length of Prior International Experience (Host Country)		.205(.154)*	.002(.216)		.209(.047)*	.231(.068)
Cultural Distance			-.297(.207)**			-.177(.071)
Length of Prior International Experience X Cultural Distance			.341(.033)*			.008(.010)
R^2	.186	.224	.286	.107	.147	.172
Adjust R^2	.130	.164	.216	.028	.061	.068
F	3.323**	3.699***	4.106***	1.359	1.720	1.660

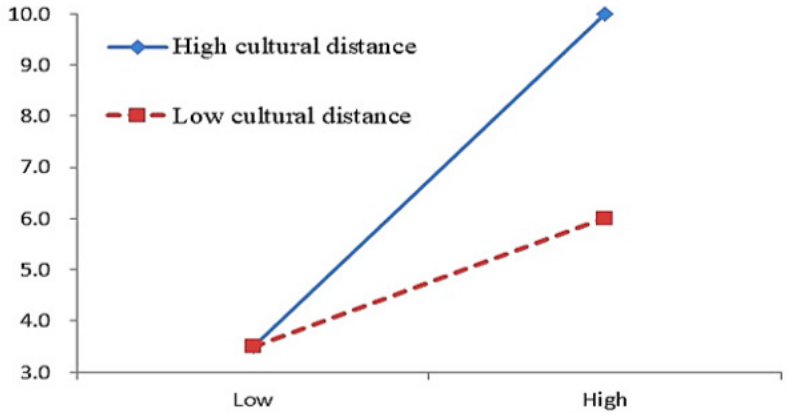
Table 4. Length of Prior International Experience of HCNs and Advice Networks at Corporate Headquarter

Variables	Size			Strength		
	Model1	Model2	Model3	Model4	Model5	Model6
	β (S.E)	β (S.E)	β (S.E)	β (S.E)	β (S.E)	β (S.E)
Job Function (Staff)	-.081(1.141)	-.087(1.079)	-.058(1.143)	-.086(.408)	-.095(.403)	-.009(.436)
Job Function (Sales & Marketing)	.033(1.745)	-.041(1.689)	.054(1.187)	-.119(.610)	-.170(.617)	-.043(.692)
Job Function (Production)	-.097(1.138)	-.175(1.093)	-.160(1.220)	-.240(.404)	.303(.408)	-.223(.454)
Tenure	-.400(.964)*	-.489(.932)**	-.458(.940)**	-.132(.343)	-.185(.343)	-.131(.352)
Job grade	.343(.697)	.347(.660)*	.417(.685)	.021(.254)	.030(.251)	.110(.262)
Gender	-.150(.912)	-.183(.867)	-.197(.874)	-.163(.333)	-.201(.334)	-.214(.334)
Age	.155(.612)	.174(.580)	.130(.597)	.124(.225)	.114(.222)	.017(.235)
Industry (Machinery)	-.368(.763)**	-.339(.725)**	-.375(.747)**	-.134(.282)	-.105(.281)	-.121(.303)
The length of prior international experience (host country)		.304(.089)**	.698(.235)*		.217(.034)	.585(.090)
Cultural distance			.033(.171)			-.081(.084)
The length of prior international experience X Cultural distance			-.457(.048)			-.423(.019)
R2	.356	.435	.459	.101	.140	.180
Adjust R2	.258	.337	.340	-.052	-.028	-.025
F	3.657**	4.440***	3.861***	.662	.831	.880

Notes: 1. N=125, *p<0.1, **p<0.05 and ***p<0.01.
2. Industry (Computer & Electronics) was excluded due to high VIF test score.

To demonstrate the contingency effects of cultural distance for PCN subsidiary managers, we present the interaction plots between the length of prior international work experience, advice networks and cultural distance at 0.5 standard deviation above (high cultural distance) and 0.5 standard deviation below (low cultural distance) the mean of cultural distance, as suggested by Aiken and West (1991). Fig. 2 indicates that, as the length of prior international work experience in host countries increases, the size of PCN subsidiary managers' advice networks with local parties increases; The relative increase in advice networks is greater for a high cultural distance as compared to a low cultural distance between PCN managers' home country and their host countries.

Fig. 2. Effect of the Length of Prior International Work Experience of PCNs and Cultural Distance on Advice Networks in the Host Country



V. Discussion and Conclusion

Overall, the results of the study contribute to our understanding of the relationship between the prior international work experience of subsidiary managers and their advice networks in relevant foreign countries. Our evidence emphasizes that PCN subsidiary managers' prior international work experience in relevant host countries is particularly effective in building their advice networks there. More importantly, PCN subsidiary managers' prior international work experience contributes to building stronger advice networks in host countries regardless of cultural distance between their home and host countries. However, the effect of prior international work experience on the size of advice networks is culture specific, as we find a positive effect mainly in the context of high cultural distance between home and host countries. This implies that one can build a number of advice networks in a foreign country by leveraging learning from prior working experience in the country, but developing relationships based on prior working experience could be particularly helpful in a culturally different host country from one's home country. Also, PCN subsidiary managers with longer prior international work experience have stronger advice networks. Building strong relationships with people in a foreign country may require deeper cultural understanding of the country.

On the other hand, HCN subsidiary managers' prior international work experience in MNE home countries affects only the size of advice networks in headquarters regardless of cultural distance between their home countries and the MNE home country. That is, even HCN subsidiary managers with working experience in the MNE home country still seem to have difficulty in building strong advice networks with headquarters managers. One possible explanation could be that while PCN subsidiary managers often have status as an HQ representative with power endowed by headquarters (Harzing et al., 2015; Reiche, 2007), and build strong local networks relatively easily using their superior position, HCN subsidiary managers may not enjoy the same level of influence on headquarters managers (Reiche & Harzing, 2015) and thus receive less support to build advice networks at HQ. This unexpected finding suggests an important implication to the inpatriation literature. Without detailed attention (but no greater resources) paid to the development of inpatriates' networking, ensuring that they meet and work with valuable people as often as possible in their time at HQ, inpatriation will continue to be

less valuable than it could be.

1. Theoretical Contributions

Our study contributes to research on international experience and advice networks in several ways. First, our findings highlight the positive role of cultural difference as a moderating condition for the effect of international experience on advice networks. There have been contrasting views on the role of cultural distance in the extant literature. Some studies argue that high cultural distance between countries may contribute to developing one's cognitive capabilities and leadership competencies (Dragoni et al., 2014), based on social learning theory (Endicott et al., 2003). As cultural distance increases, previous international experiences may help individuals understand different cultural circumstances and provide them with accurate information or knowledge on a foreign country by facilitating the social learning process (Lee & Sukoco, 2010; Michailova & Ott, 2018; Shannon & Begley, 2008).

Others claim that individuals can adjust to a new environment and build advice networks more easily when the cultural distance between their home and host countries is lower (Chen et al., 2010; Manev & Stevenson, 2001), as cultural differences may cause difficulties for individuals in adjusting to and working in a foreign country (Li et al., 2013). Although, we could not find the moderating effect of cultural distance across all cases we examined, we partially show that subsidiary managers' international experience may be effective in building advice networks particularly when there is a high level of cultural differences between their home and host countries.

Second, our study contributes to the literature on advice networks in MNEs by theorizing and examining the role of subsidiary managers' prior international work experiences in building such networks. Individual differences in experiences or abilities have been suggested as a potential antecedent to advice networks in MNEs. We show that gaining direct interaction opportunities and cultural learning in a relevant country before undertaking the subsidiary manager role has a positive effect, supporting social learning theory that emphasizes the importance of social learning in building individual-level social ties (Kostova & Roth, 2003). If managers visit foreign countries, and interact and communicate with people from different cultures, they will acquire knowledge, skills, and information through observation and conversations (Piaskowska & Trojanowski, 2014). Foreign countries with high cultural distance provide greater stimuli (Cuypers et al., 2015). The stronger the stimuli, the more intense the cognitive dissonance (Endicott et al., 2003; Le & Kroll, 2017), motivating managers to engage in the assimilation and accommodation process (Piaget, 1955).

Third, we extend the literature on international experience by showing the effect of subsidiary managers' prior international work experiences on their relational outcomes. Previous research on the impact of international experience has been concerned mainly with the impact on managers' career development (Jokinen et al., 2008) and the development of their personal capabilities such as cross-cultural competence (Caligiuri & Bonache, 2016; Engle & Crowne, 2014) and strategic thinking (Dragoni et al., 2014). These studies have examined general international experiences, rather than culture or location-specific international experiences, as contributors to such outcomes as cognitive abilities or career advancement (Georgakakis et al., 2016). We find, on the contrary, that location-specific work experience is crucial for impacting relational outcomes such as advice networks.

2. Practical Contributions

A major concern for MNEs is how to build the global network of MNEs' subunits, so they devote attention to the identification, development and retention of subsidiary managers, particularly those with experience crossing geographic and cultural boundaries, that can successfully develop advice networks in multiple cultural settings (Taylor, 2006). We are now able to contribute suggestions as to how MNEs can more effectively select and develop their potential subsidiary managers.

This study may provide valuable information

about subsidiary managers' selection, staffing, and training. Organizations seeking to recruit more cognitively complex expatriates should be interested not only in whether a potential employee has undertaken an international assignment, but also in how the individual spent time during the assignment. For instance, effective selection criteria might focus on the extent and nature of interaction an applicant has had with host culture nationals, either directly (e.g. hosting or visiting people from the host culture) or indirectly (e.g. knowledge of local communication norms). The findings may also assist organizations in refining the expatriate management processes to maximize the development benefit. In light of the current findings, for example, organizations may consider being more proactive in providing support to encourage non-work interactions with host culture nationals, or structuring work roles to enhance interactions with them. Given that expatriates frequently live in "golden expatriate ghettos" (Janssens, 1995, p. 157), which can limit interaction with people from the local culture, this could represent substantial changes for many assignments (Fee et al., 2013).

To develop subsidiary managers who can play the role of boundary spanner across MNE organizations and local external parties, MNEs need to provide prospective managers with opportunities for direct interactions with individuals in relevant countries through location specific international assignments. As our study shows, direct interaction opportunities in the MNE home country (for HCNs) or relevant host countries (for PCNs) before taking a subsidiary manager role in a focal subsidiary will help prospective subsidiary managers to create useful advice networks, as well as social learning, to add to the advice networks they already have in their home countries. This will assist in their performance of the crucial bridging role (Kostova & Roth, 2003).

Second, appropriate selection systems for international managers are important in improving performance in a subsidiary (Caligiuri et al., 2009), and thus previous international experience is an important selection criterion for MNEs. Human resource practitioners in MNEs should recruit individuals with prior work experience. Also, candidates to be PCN subsidiary managers should be given opportunities for prior work experience in the host country in order to build social contacts during international assignments (Shannon & Begley, 2008). This is indeed one of the critical reasons MNEs send managers to foreign countries (Tarique & Schuler, 2010). Companies might also consider the use of self-initiated expatriates from the headquarters country in the host country as bridge-spanners (Furusawa & Brewster, 2015).

Third, the results of the moderating effect of cultural distance suggest that an MNE may need to give priority to culturally distant locations from the MNE home country when they decide a host country for providing prior international experiences to future expatriates. It would be important to increase the effectiveness of prior international experiences to build an advice network in the assigned location, as providing prior international experiences could be a considerable investment for an MNE.

3. Limitations and Future Research

Like all research, this study has limitations. Initially, it is based on a cross-sectional design, since resources did not allow more elaborate procedures. Future longitudinal research would be useful.

In addition, our data is taken from South Korean MNEs. Whilst this is an under-researched group, further research is needed to investigate the international experience-advice networks relationship in MNEs from other nations. The use of a single country sample adds to knowledge of a comparatively under-researched country but inevitably raises concerns about generalizability (Gaur et al., 2007).

In spite of these limitations, our findings are robust. They also indicate future research avenues. Manager's individual characteristics may moderate the relationships between prior international work experience and advice networks. The relationship between the size of advice networks and subsidiary performance could be examined further as that relationship has yet to be firmly established empirically.References

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Does the Two-Child Policy Affect the Consumption Upgrade of "Two-Child Families": Based on CFPS Data from the Chinese Family Tracking Survey

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ABSTRACT

Purpose – In the context of the continued low consumption rate of Chinese residents, the increasingly aged society in China, and the decline in the birth rate, the Chinese government has gradually liberalized the fertility policy. The two-child policy has undergone policy adjustments from "only child of both parties" in 2011 to "only child of one party" in 2014, and then to the "Universal" policy in 2016, which marked the complete end of the "one-child policy" implemented since the 1970s. The purpose of this paper is to assess the effect of the "two-child birth policy" on the consumption upgrading of urban households, and to explore the mechanism of the effect.

Design/Methodology/Approach – Through the quasi-natural experiment of the "two-child policy", empirical analysis is carried out using the panel data of the China Family Tracking Survey (CFPS) database from 2012-2018. In order to improve sample selection bias and endogenous problems as much as possible, double-difference (PSM-DID) methods based on propensity score matches were adopted to construct the experimental and control groups to empirically test the impact of the second-child policy. A robustness test was carried out through methods such as parallel trend tests and sample size reduction. Further heterogeneity analysis of the policy action mechanism was conducted using the triple difference method (DDD).

Findings – (1) In general, the "two-child policy" has promoted the upgrading of household consumption levels and consumption structures. (2) Furthermore, research findings of a triple difference (DDD) model were that the effect of fertility policy between household consumption levels and consumption structure was different across target households with different levels of household wealth. That is, the higher the wealth level of the household, the more the fertility policy promoted an increase in household consumption and an upgrade of the consumption structure, but for education consumption expenditure, regardless of household wealth level, the fertility policy promoted a significant increase in household consumption expenditure and had a "crowding out effect" on other developmental hedonic consumption of the household, and the lower the wealth level, the more pronounced the crowding-out effect.

Research Implications – This paper studies the consumption of urban residents from the perspective of the characteristics of family population structure. It uses Chinese empirical data to test the applicability of relevant consumption theories in China, and provides perfect unique sample data for the academic community. By exploring the mechanism of the impact of the fertility policy on the consumption level and structure of residents, it can provide a reference for evaluating past population and economic policies. However, it provides a theoretical basis and guidance for the formulation of population and economic policies in the future, and the implementation of supporting policies for the "Three-Child Policy".

Keywords: consumption structure, consumption upgrade, two-child policy
JEL Classifications: J13, O12, P36

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I. Introduction

A family planning policy with the goal of "controlling the total population and improving the quality of the population" was implemented more than 70 years ago, which has had an important impact on population, economic, and social development. On one hand, the total fertility rate dropped rapidly from 5.81 in 1970 to 1.18 in 2010, resulting in a slowdown in population growth. By 2014, the birth rate fell to 12.08‰ before the implementation of the "only child of one party"[1] policy. On the other hand, with the decline in the number of births, the increasing life expectancy of the population, the aging of the population's age structure, and the increasing burden of old-age care, China officially became an aging society in 2000.

Whether it is the decline in the birth rate or the accelerated aging of the population, Chinese society has begun to face a labor shortage (Cai, 2010). Faced with this situation, the Chinese government has adopted a gradual liberalization of the two-child policy. The "one-child" policy implemented since the early 1980s has ended, the population has increased in the short term, and the fertility level has rebounded. Although the total number of births began to decline again after 2017, the number of births of two or more children was significantly higher than that of one child in terms of the number of children born. The effect of the "Universal" two-child policy is still emerging, and some urban families will have only children. The female family transformed into a "two-child" family to welcome the second child, and even a third child after the "three-child policy" in 2021. The proportion of child consumption in urban households occupies an important position. Therefore, the adjustment of the birth policy will inevitably have an impact on the consumption of urban residents.

China's overall consumption shows a lack of demand alongside an upgraded consumption structure. With economic growth, Chinese households have achieved rapid income growth, household consumption has increased substantially, and the consumption structure has been gradually upgraded. However, from an international comparison, China's final consumption rate is not only significantly lower than that of developed countries, it is also deficient compared with developing countries such as India and Brazil. Coupled with the slowdown in China's economic growth, China's economic development has entered a new normal, and weak domestic demand has restricted the sustainable development of society and the economy. As a result, China's lack of consumer demand coexists with the upgrading of the consumption structure. The adjustment of the fertility policy will not only have an impact on urban household consumption but also affect the level of household consumption and the upgrading of the consumption structure for Chinese families that are increasingly seeking quality of life.

Research questions are put forward. (1) The upgrading of household consumption structure represents an improvement in the quality of life of households. Then, what changes have taken place in the family consumption level and consumption structure of a target family affected by the "two-child policy" after giving birth to a second child? Is consumption upgraded or downgraded? (2) Does the effect of the fertility policy have heterogeneity in the effect of the policy due to different family characteristics? Will family wealth gaps and family social status differences lead to differences in family budget constraints, which in turn lead to differentiation in family consumption? In the face of increasing competitive pressure from education, does family education expenditure have a crowding-out effect on other developmental hedonic consumption?

The childbirth policy both brings hope to a family to have more children and promote consumption, but also increases the burden of parenting. The problem of "fewer births and aging" may become more prominent. Therefore, studying

1. The term "only child of one party" refers to a situation where one of the spouses was the only child before they were married.

the childbirth policies on the consumption level and consumption structure of urban households has important theoretical and practical significance for the sustainable development of China's economy and society.

II. Related Concepts and Advanced Research

1. Definition of Relevant Concepts

Consumption structure is the proportion of various consumption expenditures in total consumption expenditure (Li, 1984). The upgrading of consumption structure is reflected in the change in the proportional relationship of the structure of resident consumption expenditure (Shi et al., 2019), which is manifested in upgrading the microstructure and level of various types of consumption expenditure. For example, the transformation of resident consumption from subsistence to enjoyment and development, from material to service, is represented by Maslow's hierarchy of needs theory and Bourdieu's cultural capital theory. The National Bureau of Statistics of China divides household consumption into eight categories: food, clothing, living expenses, daily necessities and services, transportation and communication, education, culture and entertainment, medical care, and other supplies and services. Scholars usually classify the first four categories as resident subsistence consumption, and the latter four as development and hedonic consumption. If the proportion of the last four increases, it is regarded as an upgrade of household consumption structure (Mao & Xu, 2014). This study believes that the upgrade of urban household consumption is manifested in the improvement of household consumption level and the improvement of household consumption structure.

2. Advance Research

The implementation of the new fertility policy will affect household consumption through two paths. First is the macro path; the change in fertility behavior will first affect the age structure of the population, and then affect the labor market and capital stock (Cutler et al., 1990), and ultimately leads to the level of household consumption. The second is the micro path; the life cycle stage of the family will affect its consumption level (Modigliani & Brumberg, 1954; Modigliani & Cao, 2004). Changes in the number of children in the family directly brought about by changes in reproductive behavior will affect the family's life cycle. Resource allocation has an impact (Samuelson, 1958), thereby affecting the level and structure of household consumption. From the perspective of aggregate change, children are normal "consumption goods" (Becker & Lewis, 1973; Zhang et al., 2003). This is because the number of children born to some families increases after fertility policy adjustment and consumption expenditure on child rearing may rise accordingly. Moreover, children are also a future resource for retirement (Ehrlich & Lui, 1991), and an increase in the number of children reduces parent retirement savings as households increase current consumption. However, having children leads households to expect higher childcare expenditures in the future. According to the precautionary savings theory (Zeldes, 1989), households may also "precautionarily save" for future consumption in order to achieve future consumption goals, thus reducing current consumption (Zeldes, 1989). Therefore, whether the "two-child policy" will promote or curb household consumption is not conclusive. From the perspective of structural changes, Chinese families have always had a tradition of emphasizing education (Liu & Lu, 2008). After giving birth to a second child, parents may increase children human capital investment, which will increase family cultural and educational expenditures. In addition, as the number of children in the household increases, households may increase residential consumption or save for the purchase of a house due to the rise in the household's housing needs (Chen & Qiu, 2011; Chen & Yang, 2013). These costs related to childcare may come at the cost of reducing consumer spending in other

aspects of the household，which may reduce the family's development and enjoyment consumption. Therefore, the "two-child policy" may also cause changes in the household consumption structure.

Regarding the impact of fertility policies on household consumption, some literature finds that the one-child policy reduces household consumption (Wang, 2010; Yuan & Song, 2000; Zhou & Yin, 2011). The main explanation was the fact that the one-child policy gradually breaks the role of the traditional family that relies on the number of children to retire, thus encouraging households to accumulate (Modigliani & Cao, 2004). In addition, Chinese traditional culture has a preference for boys, and the one-child policy has exacerbated gender imbalance. Parents will increase their savings in order to enhance their son's competitiveness in the marriage market, thereby inhibiting consumption (Wang & Guo, 2011). The burden of child care as a whole plays an inverse role in the share of developmental household consumption. However, considering the stratification, it significantly contributes to the upgrading of the consumption of low-consumption-ability households, and negatively affects the developmental consumption share of medium- and high-consumption-ability households. The aging of the population significantly contributes to the upgrading of household consumption. However, looking at different consumption levels, increasing the share of health care only has a catalytic effect on the consumption upgrade of households with high spending power, while it has an inverse effect on low- and middle-income households with less elastic health care spending (Yang, 2019).

At present, there is little literature that uses family micro-data to estimate how the "two-child policy" affects the consumption level and consumption structure upgrade of the family. Regarding changes in the consumption structure of Chinese households, existing studies mainly focus on income levels, income expectations, and income distribution (Bai et al., 2015), consumption preferences and consumption habits (Shi et al., 2019), and relative prices of commodities (Tang et al., 2018) The age structure of the population has been examined (Mao & Xu, 2014), but there is no literature that focuses on the impact of the "two-child policy" on household consumption structure. Ren (2019) used the AIDS expansion model to test, and found that the birth policy has an important impact on the consumption structure of urban residents. Wang et al. (2020) studied the impact of the two-child policy on family two-child fertility and consumption, but their two-child policy was limited to the "only child of one party" two-child policy and the "Universal" two-child policy.

III. Theoretical Hypothesis

1. The Impact of the "Two-Child Policy" on Household Consumption

Based on the above analysis, the "two-child policy" will affect household consumption level and consumption structure from both macro and micro paths. A micro-family will change the number of children caused by the change in reproductive behavior, which will affect the allocation of resources in the family's life cycle. (Samuelson, 1958). However, the empirical research conclusions on the effects of the "two-child policy" and how the number of children affects household consumption are not uniform. In terms of consumption level, the number of children in the target families increased after fertility policy adjustment. On the one hand, parents will reduce retirement savings to increase current consumption to cope with the increased cost of child-rearing (Wang et al., 2020; Wang & Zhan, 2021). On the other hand, in anticipation of higher future childcare expenditures, households may also increase "precautionary savings" and reduce current consumption (Li & Xu, 2020). However, from the perspective of structural change, due to the importance of education and the change in the concept of child-rearing to elite rearing in Chinese families, even if the number of children increases, it does not replace quality with quantity. After having two children, households spend more on culture and education (Liu & Lu, 2008), which leads to a rise in developmental

household consumption. In addition, with the establishment of the target family's willingness to have a second child, the demand for housing purchases or housing space in the school district increases (Ding, 2017), and families may increase consumption of improved housing. In addition, with the rise in the number of children, families go out to travel (Liu & Liu, 2017) and eat out more frequently (Li et al., 2020), and family enjoyment consumption expenditures increase. Moreover, due to the "cohort effect", education consumption, improved housing consumption, travel consumption, and dining out consumption all bring demonstration effects to surrounding households (Song & Zou, 2021), enhancing the developmental and hedonistic consumption of the family. Therefore, the following assumptions are made:

H1: The "two-child policy" will promote family consumption.

H1a: The "two-child policy" will increase the consumption level of target families.

H1b: The "two-child policy" will affect the upgrading of the consumption structure of the target households.

2. Analysis of the Heterogeneity of the Family Wealth Gap

China's household wealth inequality is more severe than income inequality. Inflation has widened the income and wealth gaps of residents. The Gini coefficient has continued to expand with rising inflation (Tan & Li, 2017). The wealth gap is not equal to the income gap. The income gap will gradually transform into the wealth gap, and the latter is larger than the former (Zhang & Tang, 2004). With China's urban real estate reform and soaring housing prices, family housing has become an important asset for family allocation. Property ownership has become an important tool for storing and accumulating wealth (Nan et al., 2020). For those who are excluded from the housing market, alternative resources are dwindling. In the asset structure of China's middle-class wealth, the proportion of real estate allocation reached 79.5%, which is much higher than the 34.1% in the United States. Rising housing prices and housing purchase shocks have become important exogenous shocks that affect consumer budget constraints. The effect of rising house prices on household consumption is more complicated. Rising house prices may promote household consumption through the "wealth effect" of household asset appreciation (Mao et al., 2017); it may also save money for house purchases or repay house loans leading to the "liquidity restraint effect", thereby inhibiting household consumption (Yan & Zhu, 2013). It is also possible that high housing prices may lead to a "desperate consumption effect"; that is, renting households abandon house purchase plans and increase non-housing consumption (Yoshikawa & Ohtaka, 1989). Therefore, the impact of rising house prices on different groups' consumption and savings decisions (rental households, single-house households, or multi-suite households) is different.

Thus, based on the wealth effect of rising house prices, the household wealth gap will lead to differences in household consumption liquidity constraints, leading to consumption inequality. The increase in the number of children has an indirect effect on household consumption behavior. It reduces precautionary household savings, directly increasing the level of household consumption and developing the share of hedonic consumption expenditures. In these studies, some scholars have found that the asset effect from increased property values can effectively raise the overall household consumption level (Bi & Wang, 2021). Home appreciation can bring wealth accumulation to a household, and changes in the value of a home have a greater impact on household consumption than financial assets (Zhang & Cao, 2012). Other studies have shown that the number of children is significantly positively correlated with housing (Hou, M. H., 2018). As a fixed asset, housing is also an important part of family wealth. Target families with two children that have more housing or high property values may be less susceptible to mobility constraints, are more willing to have a second child, and be more willing to pay for education and growth.

With the intensification of education competition,

the family decision-making on childbirth has shifted from "raising children to prevent the elderly" based on the number of children to pursuing high-quality of children. The increase in various educational investments paid for intergenerational support (Liu & Lu, 2007) will inevitably squeeze other family resources, which will have an impact on family consumption. Long and Liang (2019) looks at the consequences of an investment in education, namely the squeeze on parental consumption by investment in education, and the real reasons why parents are afraid to spend under the pressure of investment in education. The pressure of investment in education has turned many parents into "hidden poor people". Research on the relationship between education expenditure and household consumption has shown that the education expenditure borne by households is negatively correlated with other consumption needs, especially for urban residents (Fang, 2009). The economic pressures faced by families of different income levels in the education competition are different. Education expenditures account for a low share of household income for high-income households, so an increase in education expenditure has little impact on household consumption levels. For low-income households, education expenditures account for a larger share of household income. Hence, an increase in education expenditure leads to a reduction in other household expenditures, and has an obvious crowding-out effect on other household consumption (Lin, 2020). It can be seen that family education expenditures come at the cost of lowering the consumption of other members of the family. Although the increase in education spending reflects an upgrade in consumption structure, it does not enhance the consumption structure of all members.

As the value of real estate has continued to rise in recent years, families with a large number of children may increase family consumption levels and optimize family consumption structure due to the increase in assets. However, since the level of household wealth varies greatly depending on the value of property, the effect of the "two-child policy" on the consumption level and the upgrading of consumption structure of target households can also be significantly different. In the case of increasingly fierce competition in education, the crowding-out effect of education expenditure on other consumption of target households of different wealth levels will also differ. Therefore, the following assumptions are mad.

H2a: The "two-child policy" has heterogeneous effects on the consumption levels of target families with different wealth levels.

H2b: The impact of the "two-child policy" on the upgrading of the consumption structure of target families with different wealth levels is heterogeneous.

H2c: Educational consumption expenditure has a crowding-out effect on the other consumption of target households with different wealth levels, and it has a more obvious crowding-out effect on households with lower wealth levels.

IV. Research Design

1. Sample Selection and Data Collection

The sample data of this study are from the China family panel studies (CFPS) implemented by the China Social Science Survey Center of Peking University. Since the real target families of the "two-child fertility policy" are families with one child, and there are great differences in Fertility Policies between rural families and urban families in China, so the target families are set as urban families with at least one child. Also, because this study uses the double-difference method (DID) to test the policy effect of fertility policy implementation, which needs to satisfy the parallel trend hypothesis, panel data of CFPS2012, CFPS2014, CFPS2016, and CFPS2018 are constructed. The target household types are divided into an experimental group (households having two children) and a control group (maintaining "one-child status" households).

The actual operation uses STATA 15.0 software for data processing. First, the household samples identified by the National Bureau of Statistics in cfps2012, cfps2014, cfps2016, and cfps2018 are retained. Then, the household database data of cfps2012 - cfps2018 are horizontally merged with the personal database data, and the relevant data are retained. After the variables, the four periods of data are merged longitudinally, and a panel data sample size of 26,387 is obtained. Next, based on the target family setting, only families with at least one child in the household are retained, and the portion of the household that is retained may have older families, meaning the group of families that no longer have the ability to have children, so families with a mother that is 55 years of age or older are further eliminated.

2. Variable Description

2.1. Choice of Explanatory Variables

The explanatory variables in this study are the level of household consumption and the structure of household consumption. The indicator measure of the level of total household consumption is the logarithm of household consumption expenditure (lnpce), and the alternative explanatory variables are tested using total household expenditure (lnexp). Of which, the structure of household consumption is measured as the log of household subsistence consumption expenditure (lnxf_scx) and the log of developmental hedonic consumption expenditure (lnxf_fzxl). This paper uses the eight consumption classification indicators from the National Bureau of Statistics used in the CFPS survey data and draws on the Wang et al. (2020) classification. Among the consumption expenditures, food, housing, and clothing are classified as subsistence consumption expenditures, while health care, education, and entertainment, transportation and communication, household equipment, and other goods and services are classified as development and enjoyment consumption expenditures.

2.2. Explanatory Variable Selection

In this paper, the grouping dummy variable (treati), the time dummy variable (postt), and its interaction term (DID=treati*postt) for the two-child target households are selected as explanatory variables. The group dummy variable measures the difference between two-child and one-child households, the time dummy variable measures the change between the experimental and control groups before and after the policy intervention, and the interaction term measures the impact of the "two-child birth policy" on the consumption level and consumption structure of the experimental and control groups, which are the core explanatory variables of this paper.

In addition, the explanatory variables (DDD) were used in analyzing household heterogeneity. DDD is the cross-product term with fami_characterj on top of DID. fami_characterj represents household attributes, including a high level of household wealth and high social status. Among these, household wealth is measured in terms of the logarithm of the total value of household property (lnhouseasset_gross), which accounts for the vast majority of households, drawing on the paper by Jun Wang & Zhan (2021), and the household social status variable is measured by drawing on the nature of employers in China using the CFPS Household Tracking Survey in the study by Wang et al. (2020).

When we explore the crowding-out effect of education expenditures on other developmental hedonic consumption expenditures, explanatory variables such as log education and training expenses (lnfp510), log cultural and entertainment consumption (lnfp502), and log health care expenditures (lnfp512) are important proxies for household developmental hedonic consumption.

2.3. Control Variable Selection

Given that the personal characteristics of the household head and other household-level factors affect household consumption behavior, this

Table 1. Table of Variables and Definition Descriptions

Variable Name		Variable Description
Interpreted Variable	Total Household Consumption (lnpce)	Total household consumption plus 1, then take the natural logarithm
	Survival Consumption (lnXf_scx)	Household subsistence consumption plus 1, then take the natural logarithm, subsistence consumption mainly includes food, clothing, water, electricity, heating, and property management fees, consumption of daily necessities, housing repair, and other expenses
	Developmental and Enjoyable Consumption (lnxf_fzxl)	Household developmental consumption plus 1, then take the natural logarithm, developmental consumption mainly includes household equipment and supplies, education, recreation, transportation and communication expenditures
	Total Household Expenditure (Proxy for the Explanatory Variable) (lnexp)	Total household expenditure plus 1, then take the natural logarithm
Other Interpreted Variables	Education and Training Fees (lnfp510)	Education and training fees expenditure plus 1, then take the natural logarithm
	Cultural and Entertainment Consumption (lnfp502)	Culture and entertainment consumption expenditure plus 1, then take the natural logarithm
	Health Care Expenses (lnfp512)	Health care consumer spending plus 1, then take the natural logarithm
Focus on Core Explanatory Variables (Interaction Explanatory Term)	$streat_i \times post_t$ (DID)	Target family has two children after the policy is implemented = 1; Target family maintains one child after the policy is implemented = 0
	$streat_i \times post_t \times fami\_character_j$ (DDD)	$treat_i \times post_t$ as above, $fami\_character_j$, representing household wealth level
Other Explanatory Variables	$streat_i$	Families who have two children after the implementation of the policy = 1, families who maintain the "one-child status" = 0
	$Post_t$	Time dichotomous variable, after policy implementation = 1, before policy implementation = 0
	Total house value (lnhouseasset_gross)	Add 1 to total household property value and take the logarithm
Control Variables	Square of mother's age / 100 (mmage222)	Mother's age squared /100
	Family education level (edu_max)	(Highest education of both spouses) Illiterate \ semi-literate = 0; elementary school = 1; junior high school = 2; high school \ secondary school \ vocational high school = 3; university or above = 4
	One-child gender	First child sex male = 1; sex female = 0
	Family income level (lnfincome1)	Annual household income amount plus 1, taking the natural logarithm
	Any other properties or not (fr1)	Other properties besides current home = 1; otherwise = 0
	Household Net Worth Rating (jzc_3df)	Household net worth triple quantile: lowest quantile = 1; middle quantile = 2; highest quantile = 3
	Employees in the system (tzn)	At least one spouse works within the system = 1; both spouses work outside the system = 0 (including the employer's attributes of the party and government organs, state-owned enterprises, institutions)
	Province (provcd)	Province Code

paper controls for variables such as mother's age squared/100 (mmage222), sex of the first child (c1_sex), household education level (edu_max), log of household income level (lnfincome1), presence of other properties (fr1), household net worth class (jzc_3df), and province (provcd).

3. Research Methodology and Model Setting

3.1. Double Difference (Difference-in-Difference, DID)

The double-difference method (DID) is also called the multiplicative difference method. The change of consumption level and consumption structure of families with two children mainly comes from three aspects: firstly, the "grouping effect" formed by families due to differences; secondly, the "time effect" part caused by the inertia of families over time or due to the change of economic situation; and thirdly, the "policy processing effect" part formed by the number of children in the structure of family members affected by the policy of having two children and supporting measures. The Double Difference (Difference-in-difference, DID) method can effectively isolate the "policy processing effect", which is widely used in the evaluation of the effect of policy implementation (Dong & Zhu, 2016).

The classic DID feature is that the policy intervention time is at the same time. However, the comprehensive two-child policy was officially implemented nationwide on January 1st, 2016. For each family, the decision to have a second child is not simultaneous; it is said that the birth year of the second child is not necessarily the same. Hence, this article adopts the multi-point DID (also called multi-period DID) method. At this point, DID = 1 indicates that the individual in this household had a second child in a specific year; DID = 0 indicates the year before the individual was subjected to the policy intervention, and there is no longer a uniform year of policy implementation in the multi-period DID, but each household is allowed to have its own year of policy action. The model is as follows.

$$y_{i,t}=\alpha+\beta\cdot DID_{it}+\gamma\cdot X_{i,t}+u_i+v_t+\varepsilon_{i,t} \quad (1)$$

Among these, subscript i represents the household and t represents time. yi,t is a set of explanatory variables of household i in period t, including household consumption level and consumption structure (measured by household per capita consumption, household subsistence consumption, household development, and hedonic consumption). DIDit is the dummy variable of most interest, or whether the "two-child policy" has an impact on household consumption. When an individual family has a second child in year t after the comprehensive "two-child policy", then DIDit = 1, otherwise DIDit = 0, its coefficient β is the core parameter, reflecting the consumption effect level of the policy. Xi,t represent other control variables that change over time and affect household consumption, and the coefficient γ reflects the influence of other control variables on household consumption. ui and vt represent the individual household fixed effect and the year fixed effect, respectively.

3.2. Propensity Value Matching (PSM-DID) Method

The DID method can isolate the "policy processing effect" by solving the endogenous problem through double difference, but it may not avoid the problem of sample bias, while PSM helps to deal with the problem of sample bias. Because of the differences in household attributes between households with and without two children, the direct use of the double difference model (DID) to test the impact of the "two-child birth policy" on household consumption levels and consumption structure upgrading may be somewhat biased. Therefore, this paper adopts a combined propensity score matching-based double difference (PSM-DID) approach to try to more accurately estimate the impact of the two-child policy on household consumption structure. Therefore, this paper adopts a combined propensity score matching-based double difference (PSM-DID) approach to try to estimate more accurately the association between the impact of the "two-child birth policy"

Table 2. Descriptive Statistics of Grouping

did	Variable	N	mean	sd	min	max
0 Control Group	lnexp	10,261.00	10.99	0.84	0.00	14.81
	lnxfscx	10,261.00	10.14	0.96	0.00	12.23
	lnxffzxl	10,261.00	9.77	1.14	0.00	12.42
	c1sex	10,261.00	0.53	0.50	0.00	1.00
	mmage222	10,261.00	18.55	6.27	2.89	29.16
	edumax	10,261.00	2.52	1.20	0.00	9.00
	lnfincome1	10,261.00	10.55	2.08	0.00	13.12
	fr1	10,261.00	2.07	2.28	0.00	5.00
	tzn	10,261.00	0.27	0.44	0.00	1.00
	lnfinance_asset	10,261.00	8.01	4.53	0.00	13.82
	lnhouseasset_gross	9,521.00	12.17	2.69	0.00	15.82
	zgzc	9,539.00	0.38	0.49	0.00	1.00
	jjzc	9,539.00	0.25	0.43	0.00	1.00
	lnfp502	10,261.00	2.38	2.99	0.00	9.90
	lnfp503	10,261.00	2.47	3.72	0.00	11.78
	lnfp510	10,261.00	5.65	4.14	0.00	12.90
	lnfp512	10,261.00	1.19	2.66	0.00	11.51
	lnfp513	10,261.00	4.79	2.78	0.00	10.82
1 Experimental Group	lnexp	837.00	11.26	0.90	0.00	13.92
	lnxfscx	837.00	10.43	0.88	0.00	12.23
	lnxffzxl	837.00	10.09	1.15	0.00	12.42
	c1sex	837.00	0.46	0.50	0.00	1.00
	mmage222	837.00	11.40	3.68	3.61	29.16
	edumax	837.00	2.65	1.05	0.00	9.00
	lnfincome1	837.00	10.91	1.75	0.00	13.12
	fr1	837.00	3.16	2.20	0.00	5.00
	tzn	837.00	0.20	0.40	0.00	1.00
	lnfinance_asset	837.00	8.59	4.32	0.00	13.82
	lnhouseasset_gross	771.00	12.68	1.91	0.00	15.82
	zgzc	801.00	0.60	0.49	0.00	1.00
	jjzc	801.00	0.28	0.45	0.00	1.00
	lnfp502	837.00	3.30	3.17	0.00	9.90
	lnfp503	837.00	2.97	3.78	0.00	11.51
	lnfp510	837.00	7.32	3.06	0.00	11.92
	lnfp512	837.00	1.43	2.88	0.00	10.31
	lnfp513	837.00	5.55	2.31	0.00	9.90
Total	lnexp	11,098.00	11.01	0.85	0.00	14.81
	lnxfscx	11,098.00	10.16	0.95	0.00	12.23
	lnxffzxl	11,098.00	9.80	1.14	0.00	12.42
	c1sex	11,098.00	0.52	0.50	0.00	1.00
	mmage222	11,098.00	18.01	6.40	2.89	29.16
	edumax	11,098.00	2.52	1.19	0.00	9.00
	lnfincome1	11,098.00	10.58	2.06	0.00	13.12
	fr1	11,098.00	2.15	2.29	0.00	5.00
	tzn	11,098.00	0.27	0.44	0.00	1.00
	lnfinance_asset	11,098.00	8.06	4.52	0.00	13.82
	lnhouseasset_gross	10,292.00	12.21	2.64	0.00	15.82
	zgzc	10,340.00	0.40	0.49	0.00	1.00
	jjzc	10,340.00	0.25	0.44	0.00	1.00
	lnfp502	11,098.00	2.45	3.01	0.00	9.90
	lnfp503	11,098.00	2.51	3.73	0.00	11.78
	lnfp510	11,098.00	5.77	4.09	0.00	12.90
	lnfp512	11,098.00	1.21	2.68	0.00	11.51
	lnfp513	11,098.00	4.85	2.75	0.00	10.82

on household consumption structure. While the model applied in this paper is a multi-temporal DID, the PSM-DID test method differs from the ordinary PSM-DID in reference to Lu (2015), who applied the year-by-year propensity score matching (PSM) method for family matching to reduce the differences between the experimental and control groups and reduce the sample selectivity bias caused by endogeneity interference.

3.3. Triple Difference Method (*DDD*)

Heterogeneity analysis was further conducted using a triple difference model for different types of households, and the regression model was set as follows.

$$y_{i,t} = \alpha+\beta_1 \cdot streat_i \times post_t \times fami\_character_i + \beta_2 \cdot streat_i \times post_t + fami\_character_i + \gamma \cdot X_{i,t} + u_i + v_t + \varepsilon_{i,t} \quad (2)$$

The fami_characteri represents the level of household wealth. The interaction term reflects the heterogeneity of policy effects for households of different wealth classes and the heterogeneity of policy effects for households of different social status levels.

V. Hypothesis Testing and Data Analysis

1. Descriptive Statistics

Prior to regression analysis, brief descriptive statistics were performed on the original sample of households that were not matched. Figure 5-1 reports descriptive statistics for the experimental group (two-child households affected by the two-child policy) and the control group (households that have remained as one-child households) after grouping.

From the preliminary descriptive statistics, it can be seen that the mean values of variables reflecting household consumption level and consumption structure, such as total household consumption (lnexp), household survival-oriented consumption (lnxf_scx), and household developmental enjoyment-oriented consumption (lnxf_fzxl) are higher, and the experimental group is higher than the control group in each of the developmental enjoyment-oriented expenditures, such as household cultural and recreational expenditures (lnfp502), travel expenditures (lnfp503), education and training expenditures (lnfp510), health care expenditures (lnfp512), and beauty expenditures (lnfp513). CFPS was able to broadly capture the differences between the two groups due to the unsoundness of the data collected by CFPS at the time of the survey due to the items in each year. This is consistent with the results calculated by Ren (2019) using a gray correlation between fertility policy and population consumption structure (Ren, 2019). For the mean values of variables reflecting household wealth levels, such as household income, household financial assets, and household house value, the experimental group is also higher than the control group. From the first child sex indicator (c1_sex), it seems that on average, more of the experimental group had a girl at first birth than the control group. Looking at the maternal age squared/100 (mmage222) indicator, the age of the mothers in the experimental group is generally smaller than that of the control group, which shows that the "two-child policy" has a stronger effect on young mothers of appropriate age. Finally, regarding the mean values of the two variables, family financial support (jjzc) and family care support (zgzc) reflect that the experimental group has more family financial support and care support than the control group. This leads to the preliminary conclusion that there are differences between the experimental and control groups in terms of family wealth, family support, mother's age, and sex of the first child. The above variables can be selected as the matching feature variables when doing PSM test matching.

2. PSM-DID Test Results and Analysis

Table 3 presents the results of the mean tests for the main variables before and after matching.

The first two columns of the results are the results of the mean tests of each variable before matching. It can be found that the mean values of the experimental group (two-child families) and the control group (one-child families) differ significantly in terms of family size and mother's age before matching, so the experimental group is considered to be different from the control group before matching. To exclude the problem of sample self-selection for the above factors, referring to the studies of Yin and Guo (2021), Wang et al. (2020), and Jia et al. (2021), matching variables of mother's age (mmage222), number of family members (fml_count), and other properties of the family (fr1) were selected to join the regression analysis, and it was tentatively concluded that there were differences between the experimental and control groups in terms of family wealth, family support, mother's age, and sex of the first child. The calculated propensity scores were then matched using the radius matching method with a caliper range of 0.05, resulting in 3,773 sample observations, including 1,022 for the experimental group, and 2,751 for the control group.

Table 3. Means Test of Variables before and after PSM

Variable	t Value	p Value	t Value	p Value
lnpce	1.44	0.1506	0.84	0.4007
fml_count	2.41	0.0158**	0.53	0.5984
c1_sex	0.49	0.6269	0.01	0.9909
mmage222	2.63	0.0087***	0.85	0.3945
edu_max	1.18	0.2367	1.02	0.3085
lnfincome1	1.15	0.2512	0.73	0.4650
fr1	0.20	0.8415	0.31	0.7597
tzn	1.06	0.2908	0.67	0.5044
zc_3df	1.33	0.1824	0.60	0.5510
provcd	0.89	0.3751	0.50	0.6188

Note: *p<0.1, **p<0.05 and ***p<0.01.
Source: Chandler (1990).

It can be found that after matching, there are no significant group differences in the variables, and the matching results are overall more satisfactory. On this basis, Table 4 reports the empirical results of the double-difference after propensity matching

Table 4 reports the results of the PSM-DID test. Among these, columns (1), (3), and (5) are fixed effects estimates without control variables, and columns (2), (4), and (6) are fixed effects estimates with control variables taken into account. Column (2) shows the impact of the two-child birth policy on total household consumption. The empirical results show that the two-child birth policy significantly increases total household expenditure by 12.3%, and the coefficient is significant at the 1% significance level, indicating that the two-

Table 4. Estimated Results of the Impact of Fertility Policy on the Consumption of Households with Two Children (PSM-DID)

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	lnpce	lnpce	lnxf_scx	lnxf_scx	lnxf_fzxl	lnxf_fzxl
did	0.199***	0.123***	0.263***	0.128***	0.215***	0.147**
	(4.23)	(2.58)	(4.39)	(2.69)	(3.23)	(2.18)
c1_sex		-0.123**		-0.062		-0.098
		(-2.15)		(-1.04)		(-1.16)
mmage222		-0.010*		-0.010***		-0.017***
		(-2.81)		(-2.63)		(-3.19)
edu_max		0.025		0.052**		0.015
		(1.98)		(2.31)		(0.82)
lnfincome1		0.011*		0.005		0.012*
		(2.68)		(1.07)		(1.69)
fr1		-0.025***		-0.030***		-0.010
		(-4.12)		(-4.28)		(-1.19)
tzn		-0.020		-0.013		-0.010
		(-0.73)		(-0.46)		(-0.25)
jzc_3df		0.122***		0.084***		0.170***
		(8.29)		(5.28)		(7.51)
provcd		-0.007		-0.008*		-0.001
		(-1.39)		(-1.79)		(-0.12)
Constant	11.014***	11.217***	10.350***	10.646***	10.051***	10.008***
	(892.01)	(50.66)	(728.93)	(49.05)	(518.83)	(28.07)
Observations	11,095	11,095	11,095	11,095	11,095	10,802
R-squared	0.126	0.147	0.079	0.106	0.054	0.069

Note: *p<0.1, **p<0.05 and ***p<0.01.
Source: Chandler (1990).

child birth policy has a catalytic effect on the consumption level of households having two children, thus testing hypothesis H1a. Based on the results in columns (4) and (6), we find that the two-child birth policy increases household subsistence consumption by 12.8% and developmental hedonic consumption by 14.7%, and the coefficients are both significant at the 1% significance level, verifying hypothesis H1b. Empirical data show that the two-child birth policy has had a positive

effect on upgrading the consumption structure of two-child households. This refutes the quantity of children in lieu of quality theory and supports the findings of Liu and Lu (2008).

In terms of control variables, the gender of the first child in the household is negatively related to the explanatory variable total household consumption, meaning that it may have a negative effect on the overall household consumption level if the first child in the household is a boy. This is because Chinese family traditions and marriage market sentiments dictate that parents of families whose first child is a boy typically save in advance for the son to save for a house or cover the down payment (Chen & Qiu, 2011; Chen & Yang, 2013). Looking again at the square of mother's age/100 (mmage222) is significantly and negatively correlated with all explanatory variables. It reflects that the younger the mother of a child, the greater the household consumption and expenditures. This is related to the consumption habits and concepts of different age groups, and may also be related to the demonstration effect of the same group. The highest education of parents in the household (edu_max) is significantly and positively associated with the explanatory variables total household consumption and household survival-oriented consumption at the 5% significant level, which may be related to higher income with higher education, and may also be related to the fact that people with higher education also have a stronger consumption mindset. The coefficient of highest household education and developmental enjoyment consumption, although positive, is not significant, which may be due to the large household income gap or asset gap, while people with high income or assets are not necessarily those with high education. Household income (lnfincome1) mainly plays a positive role in developmental consumption, thus increasing the overall household consumption level. This is because regardless of income level, food, clothing, housing, and transportation in subsistence consumption are the items that must be spent on, and the reduction is limited if the income is small, while the development of hedonistic consumption will increase if the income increases because the subsistence consumption of urban households has been greatly satisfied. The variable of whether the household owns other properties besides the owner-occupied house (fr1) plays a significant positive role in promoting total household expenditure and household subsistence consumption, but not in developing hedonic consumption; that is, the more houses the higher the consumption level, which is basically in line with common sense, and the reason why it does not play a significant role in developing hedonic consumption is probably that property prices vary greatly from place to place, and the quantity does not represent overall household wealth. However, from the perspective of household wealth class (jzc_3df), it was found that the higher the household wealth class, the higher the consumption level, and consumption structure will be significantly higher. Finally, the variable for whether the parents are institutional employees (fr1) is also significantly and positively correlated with all explanatory variables, which is very much in line with the Chinese context. Since institutional employees (government agencies, state-owned enterprises, and institutions) generally have special status and invisible benefits and treatment, institutional employee household consumption is higher than that of households of employer nature, but not significantly.

3. Robustness Tests

3.1. Parallel Trend Test

The double-difference method (DID) is based on the premise that the parallel trend assumption is satisfied. The idea of multi-period DID to test the parallel trend hypothesis and single-period DID both decompose and analyze the dynamic trend by the event study method, but differ in calculating the number of periods before and after the policy point in time. Single-period DID is the current time minus the time when the policy was implemented uniformly, while multi-period DID is the current time minus the time when the respective policy was put into effect. Based on the above ideas, we draw on Beck and Levkov (2010) and Cerulli and Ventura (2019) to construct the

following model to test for parallel trends before and after the effect of the policy.

where Y denotes the level of consumption and is expressed as the natural logarithm of total

$$Y_{it}=a+\sum_{j=-M}^{N}\delta j REFORM_{i,\,t-j}+\gamma Z_{it}+\lambda_i+v_t+\varepsilon_{it} \quad (3)$$

household consumption. REFORM_(i, t-j) is a dummy variable that takes the value of 1 if the household had a second child in period t-j, and is 0 otherwise (M and N denote the number of periods before and after the policy point in time, respectively). As an example, when j = -2, the dummy variable REFORM_ (i, t+2) measures the effect of household i having a second child for two years, indicating that household i had a second child in period t+2 by implementing the two-child birth policy. Thus, δ_0 measures the policy effect in the period when the household has two children, δ_(-M) to δ_(-1) measures the policy effect in the period 1-M before the birth of two children, and δ_1 to δ_N measures the policy effect in the period 1-N after the household has two children. If δ_(-M) to δ_(-2) is significantly zero, it means that there is no significant difference between the treatment and control groups in period 2-M before policy implementation (with period -1 as the base group); therefore, the parallel trend hypothesis holds.

Fig. 1 to Fig. 3 plot the trends in household consumption levels and consumption structure before and after the effect of the policy, respectively. It can be seen that there is no significant difference in the level and structure of household consumption between the experimental group and the control group before the policy shock, which satisfies the parallel trend hypothesis better, while the household consumption of the experimental group increases significantly in the year of the policy effect (i.e., the year of having two children), and in the years after. This indicates that the implementation of the two-child birth policy significantly promotes the upgrading of

Fig. 1. The Parallel Trend Test for Total Household Consumption

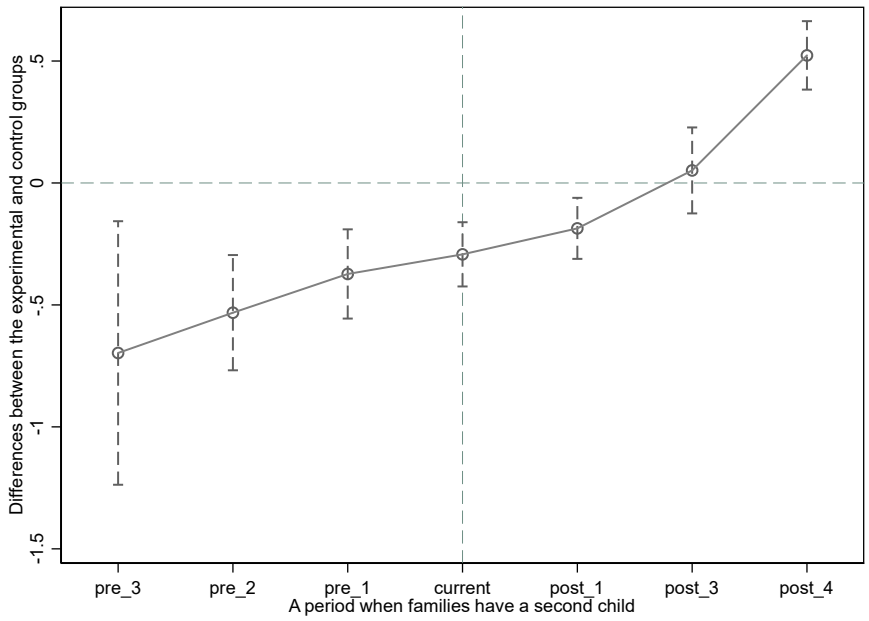


Fig. 2. The Parallel Trend Test for Household Subsistence Consumption

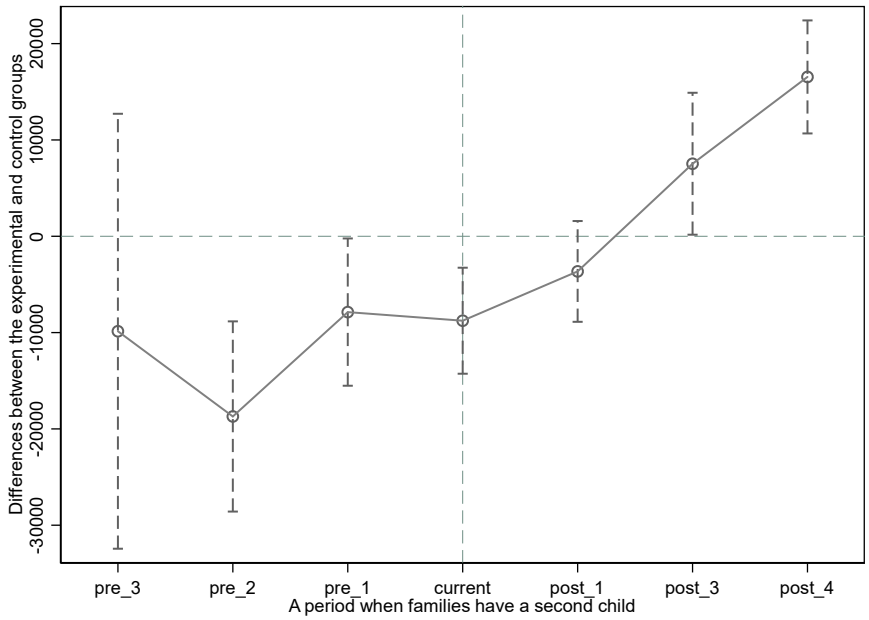
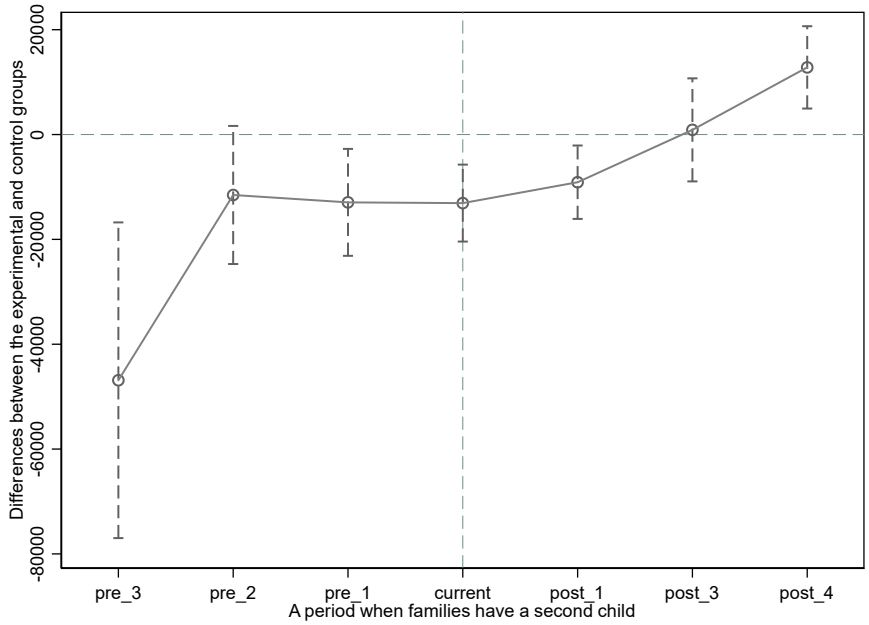


Fig. 3. The Parallel Trend Test for Household Development of Hedonic Consumption



consumption level and consumption structure of two-child households, further validating the robustness of the DID results. In addition, we find that consumption levels first increase slowly from the period when the policy is in effect, and then increase further, possibly because households consume more as the age of the second child increases, and possibly because of the lagged impact of the policy.

3.2. Reduced Sample Test

In this paper, we further processed the experimental group families based on individual characteristic variables and the community variables of CFPS. For the existing full sample of families with at least one child, the experimental group of families with two children after the implementation of the gradual liberalization of the "two-child policy" in 2011, but from the statistics of new births nationwide after the implementation of the policy, the effect of the "only child of one party" two-child policy is poor (Qiao, 2015). The empirical results also show that the "only child of one party" two-child policy has no significant impact on household survival and developmental enjoyment consumption, while the "Universal" two-child policy has achieved more significant effects than the "only child of one party" two-child policy (Wang et al., 2020). Due to the small audience for the "only child of both parties"[2] two-child policy, the effect of the "only child of one party" two-child policy was not satisfied until the "Universal" two-child policy was liberalized in 2016, the effect of the "two-child birth policy" gradually emerged, and the two-child birth rate exceeded the one-child birth rate. The effect of the "two-child birth policy" has only gradually emerged since the full "two-child birth policy" was liberalized in 2016, and the two-child birth rate has exceeded the one-child birth rate. Therefore, the sample in this section is further narrowed down to families that have two children since the full liberalization of the "two-child birth policy" in 2016.

The sample is narrowed down to families with two children before the implementation of the "Universal" two-child policy. The results show that the effect of the two-child birth policy on household consumption level and consumption structure remains similar to the main regression results. However, with the inclusion of the control variables, the effect on the consumption structure of subsistence consumption and development of hedonic consumption is positive at the 5% level of significance, while the policy effect is not as significant as in the full sample with the inclusion of the "full two-child" policy. The reason for this may be because some scholars use demographic indicators to examine the policy effects of the "two-child policy" on fertility rather than household consumption (Qiao, 2015). On the other hand, the scope of the sample is only for the "only child of one party" two-child policy and does not consider the "only child of one party" group. The "only child of one party" two-child policy was implemented after the "only child of both parties" two-child policy, and the interval was shorter. The "only child of one party" two-child policy was implemented after the "only child of both parties" two-child policy, and the interval was short, such that families that obtained the right to give birth did not immediately give birth to a second child, as if many of the newborns after the implementation of the "Universal" two-child policy were "only child of both parties" or "only child of one party" families.

4. Further Heterogeneity Analysis

4.1. Heterogeneity Analysis of the Wealth Gap

Further, a triple difference model was used for heterogeneity analysis for households with different wealth disparities. The model is as follows.

$$y_{i,t}=\alpha+\beta_1\cdot streat_i\times post_t\times fami\_character_j+\beta_2\cdot streat_i \times post_t+fami\_character_j+\gamma\cdot X_{i,t}+u_i+v_t+\varepsilon_{i,t} \quad (4)$$

Where $streat_i\times post_t\times fami\_character_j$ is our

2. The term "only child of both parties" refers to a situation wherein both spouses were the only child in their respective families before marriage, i.e., a new family formed by an only child.

Table 5. Reduced Sample Test for Consumption of Households with Two Children

Variable	(1) lnpce	(2) lnpce	(3) lnxf_scx	(4) lnxf_scx	(5) lnxf_fzxl	(6) lnxf_fzxl
did	0.247***	0.171***	0.270***	0.164**	0.275***	0.196**
	(3.97)	(2.68)	(3.64)	(2.53)	(3.06)	(2.20)
c1_sex		-0.121**		-0.058		-0.100
		(-2.13)		(-0.98)		(-1.19)
mmage222		-0.011***		-0.010***		-0.017***
		(-2.88)		(-2.67)		(-3.34)
edu_max		0.025**		0.052**		0.015
		(2.01)		(2.33)		(0.82)
lnfincome1		0.011***		0.005		0.012*
		(2.71)		(1.10)		(1.71)
fr1		-0.024***		-0.030***		-0.010
		(-4.08)		(-4.28)		(-1.13)
tzn		-0.019		-0.013		-0.009
		(-0.71)		(-0.44)		(-0.24)
jzc_3df		0.122***		0.085***		0.170***
		(8.31)		(5.30)		(7.51)
provcd		-0.007		-0.007*		-0.000
		(-1.27)		(-1.68)		(-0.04)
Constant	11.021***	11.195***	10.363***	10.624***	10.058***	9.996***
	(930.55)	(50.39)	(753.35)	(49.29)	(546.73)	(27.89)
Observations	11,098	11,098	11,098	11,098	11,098	11,098
R-squared	0.126	0.148	0.078	0.106	0.054	0.070

Note: *p<0.1, **p<0.05 and ***p<0.01.
Source: Chandler (1990).

$DDD_{i,t,j}$ of interest and $streat_i \times post_t$ is the previous core explanatory variable $DID_{i,t}$. Thus, model (4) can be further rewritten as the model (5) as follows.

$$y_{it}=\alpha+\beta_1 \cdot DDD_{i,t,j}+\beta_2 \cdot DID_{i,t}+fami\_cf_i +\gamma \cdot X_{i,t}+u_i+v_t+\varepsilon_{i,t} \quad (5)$$

The level of household wealth is indicated by fami_*cf* in the results, and the total household property value is used to measure the level of household wealth. After removing the missing values, the judgment criterion of high or low wealth level uses whether the total property value of the household is higher than the median, and the variable of interest in the results, *DDD_cf*, reflects whether there is policy heterogeneity among households with different wealth levels.

Table 6. Analysis of Household Wealth Gap Heterogeneity (DDD)

Variable	(1) lnpce	(2) lnxf_scx	(3) lnxf_fzxl
DDD_cf	0.069	-0.011	0.195*
	(1.09)	(-0.15)	(1.67)
fami_cf	0.153***	0.149***	0.131***
	(6.73)	(4.88)	(3.91)
c1_sex	-0.125**	-0.113	-0.093
	(-2.25)	(-1.56)	(-1.13)
mmage222	-0.012***	-0.013**	-0.019***
	(-3.25)	(-2.52)	(-3.81)
edu_max	0.024*	0.049**	0.015
	(1.90)	(2.22)	(0.81)
lnfincome1	0.011***	0.004	0.012*
	(2.69)	(0.82)	(1.82)
fr1	-0.027***	-0.035***	-0.015*
	(-4.60)	(-5.02)	(-1.80)
tzn	-0.026	-0.020	-0.019
	(-0.97)	(-0.68)	(-0.51)
provcd	-0.011*	-0.009**	-0.003
	(-1.69)	(-2.12)	(-0.37)
Constant	11.539***	10.867***	10.419***
	(44.32)	(48.71)	(28.83)
Observations	11,072	11,072	11,072
R-squared	0.145	0.094	0.062

Note: *p<0.1, **p<0.05 and ***p<0.01.
Source: Chandler (1990).

Table 6 shows the analysis of heterogeneity in household wealth levels of consumption levels and consumption structures by the "two-child birth policy", and we focus on the interaction term DDD_cf. Column (1) shows the heterogeneity of the impact of different household wealth levels on household consumption levels, and columns (2) and (3) show the heterogeneity of the impact of different household wealth levels on household consumption structure (subsistence consumption and developmental hedonic consumption). Based on the first two columns, we find that the

Table 7. Further Analysis of Consumption Structure Heterogeneity Based on Household Wealth Grouping

	High Wealth Level			Low Wealth Level		
	(1)	(2)	(3)	(4)	(5)	(6)
Variable	lnfp510	lnfp502	lnfp512	lnfp510	lnfp502	lnfp512
did	2.132***	-0.011	0.247	1.345***	0.788**	0.541**
	(5.58)	(-0.04)	(0.70)	(3.43)	(2.29)	(2.11)
c1_sex	0.966**	0.021	0.423	0.580	-0.294	0.112
	(2.22)	(0.06)	(1.08)	(1.13)	(-0.93)	(0.46)
mmage222	-0.118***	-0.091***	-0.046*	-0.156***	-0.031	-0.003
	(-2.96)	(-3.90)	(-1.76)	(-4.30)	(-1.21)	(-0.19)
edu_max	-0.178	-0.011	0.145	0.065	0.064*	-0.012
	(-1.16)	(-0.14)	(1.39)	(0.79)	(1.73)	(-0.27)
lnfincome1	0.061*	0.047	0.018	0.015	0.031	0.027*
	(1.80)	(1.61)	(0.62)	(0.53)	(1.61)	(1.88)
fr1	0.036	-0.019	-0.036	-0.033	-0.037	-0.042
	(0.79)	(-0.59)	(-0.90)	(-0.51)	(-0.67)	(-0.87)
tzn	-0.418*	0.001	-0.210	0.247	0.256	-0.086
	(-1.80)	(0.01)	(-1.11)	(1.04)	(1.27)	(-0.46)
jzc_3df	0.171	0.223*	0.084	0.239*	0.124	-0.004
	(1.17)	(1.75)	(0.62)	(1.71)	(1.26)	(-0.05)
provcd	-0.050	-0.006	0.033	0.003	-0.098*	-0.015
	(-1.40)	(-0.11)	(0.49)	(0.11)	(-1.83)	(-1.17)
Constant	9.184***	5.275**	1.064	7.768***	6.057***	1.096*
	(4.94)	(2.24)	(0.38)	(6.89)	(2.93)	(1.73)
Observations	5,470	5,470	5,470	5,335	5,335	5,335
R-squared	0.036	0.227	0.036	0.027	0.110	0.011

Note: *p<0.1, **p<0.05 and ***p<0.01
Source: Chandler (1990).

DDD regression coefficients are not significant, indicating that the level of household wealth does not affect the effectiveness of the "two-child birth policy" on household consumption levels and household survival consumption. Based on the results in column (3), we find that the DDD regression coefficient is significantly positive at the 10% level of significance. Every 1% increase in household wealth is associated with a 19.5% increase in household development hedonic consumption. The higher the level of wealth, the more significant the contribution of the "two-child birth policy" to the development of hedonic consumption. As a result, hypothesis H2a fails the test and hypothesis H2b is verified.

Table 7 reports the statistical results of education consumption expenditure, culture, entertainment consumption expenditure, and health care consumption expenditure for target households with different levels of wealth as a result of the "two-child birth policy", respectively. First, regardless of household wealth, fertility policy has a significant positive effect on education consumption at the 1% significant level. The coefficients are all greater than 1, and in particular, among families with high wealth levels, the coefficient reaches 2.132, which indicates that families attach great importance to education regardless of wealth level, and the higher the wealth level, the more willing they are to pay for higher levels and prices for education. Even families with lower levels of wealth pay as much as they can to meet the fierce competition for education by spending more on education than they would for one child. In terms of household expenditure on cultural and recreational consumption and household expenditure on health care, fertility policy does not induce higher wealth households, while it acts as a significant positive pull at the 5% significant level for both low wealth households. This may be due to the fact that these two types of developmental and hedonistic consumption of households with higher levels of wealth were higher before and did not change much after the birth of the second child, but for households with lower levels of wealth, in addition to education, they also value family cultural and recreational activities and health care after the birth of the second child, and the "two-child birth policy" has played a positive role in upgrading the consumption of households with lower levels of wealth. However, we should also recognize that although the development of hedonic consumption items increases more in households with lower levels of wealth, by combining this with the previous analysis, we can know that education, cultural and entertainment, and health care consumption crowd out other household consumption; specifically, education consumption has a strong crowding-out effect, and education consumption in households with higher levels of wealth also has a crowding-out effect on other consumption. Hypothesis H2c was verified.

VI. Conclusions

This study assesses the effect of the "two-child birth policy" on the consumption level and consumption structure of urban households, the mechanism of the effect of the "two-child birth policy" on the consumption level and consumption structure of urban households based on consumption theory, and the theory of the relationship between fertility policy and consumption in the context of the long-term low consumption rate of Chinese residents with the increasing aging of the population and the decreasing birth rate. To improve sample selection bias and endogeneity problems as much as possible, a combination of a progressive double difference method and propensity score matching (PSM-DID) were used to construct the experimental and control groups as a measure of the impact effect of fertility policies. Robustness tests were also conducted by parallel trend tests and reduced sample size. On this basis, further heterogeneity analysis of the policy action mechanism was conducted using the triple difference method and a grouping test. This led to the following conclusions.

In general, the "two-child policy" significantly contributed to the upgrading of household consumption structure. The "two-child policy"

has a significant positive impact on the total consumption of urban households, the production-oriented consumption expenditure of urban households, and the development of hedonic consumption expenditure. In other words, the birth policy has promoted the growth of household consumption level and the upgrading of household consumption structure. This result affirms the result of the substitution effect of the number of children on savings in the theory of household saving demand (Samuelson, 1958). Current empirical data from China disprove that children are "consumer goods" or "investment goods" for their parents, and that child consumption is substitutable for their own consumption (Becker & Lewis, 1973). In China, parents' altruistic assumptions about raising children differ greatly from the actual situation, and under the profound influence of traditional culture, parents are more altruistic and "consumer" in their investment in education. Parents give to children without cost or expectation of return, and even leave an inheritance to their children in old age, so the assumption that parent investments in their children is altruistic is more in line with reality (Ren, 2019). In conclusion, the increase in the number of children causes parents to save less for retirement, and households prefer current consumption (Wang et al., 2020). From the perspective of structural change, which supports the tradition of Chinese households that have traditionally valued education (Liu & Lu, 2008), the birth of a second child increases household investment in human capital, causing household expenditure on culture and education to rise. An increase in the number of children can significantly increase the per capita consumption level of the family and the proportion of the development of hedonic consumption expenditure. This shows that the increase in the number of children reduces the preventive savings of the family, increases the level of family consumption, and optimizes the consumption structure (Wang & Zhan, 2021). This confirms that the implementation of the "two-child policy" has significantly promoted upgrading the consumption structure of urban households.

The effect of the "two-child policy" on urban families of different wealth classes is obviously heterogeneous. Educational consumption expenditure has a crowding-out effect on households with different wealth levels, and the crowding-out effect is more obvious the lower the wealth level. Based on the increase in housing prices, the gap in household wealth has widened, which in turn has complex heterogeneity in the impact on resident consumption. The results show that the "two-child birth policy" only enhances the developmental hedonic consumption of households with higher wealth levels. It was proven that housing appreciation can bring wealth accumulation to a family (Zhang & Cao, 2012). The impact of family property on consumption is significantly positive (Nie, 2015).. The asset effect produced by the increase in the value of a real estate can effectively increase the overall consumption level of the household (Bi & Wang, 2021).

However, using group regressions to look specifically at the development of hedonic consumption items results in a significant increase in household spending on education, regardless of household wealth levels due to the "two-child policy". It is clear that the theory of quantity replacing quality of children does not apply to the current situation in China due to the increased competition in education. Families with higher levels of wealth are willing to pay more to choose a higher level of education, while families with lower levels of wealth are willing to pay a higher percentage of the cost of education to provide a better education whenever possible because education is an effective way to prevent class entrenchment. However, the results of the wealth gap heterogeneity test show that the growth of developmental hedonic consumption of households with lower wealth levels is not significant, which may be due to the crowding out of other developmental hedonic expenditures by education consumption expenditures of households with lower wealth levels. In contrast, the growth of other subcomponents of developmental hedonic consumption is also insignificant for households with higher levels of wealth in the group test. This proves that the crowding-out effect of household

education consumption exists in households of different wealth levels, and the crowding-out effect is more pronounced for households with lower wealth. This result is inconsistent with the study of Ren (2019) that the main household expenditure on a "second child" is basic living consumption rather than education-based expenditure, but supports the study of Long and Liand (2019) on the consequences of household investment in education, or the squeeze on parental consumption by investment in education. It also supports the conclusion of Fang (2009) that the education expenses borne by families are negatively correlated with the consumption needs of other families, especially for urban residents.

In terms of the effect of the "two-child policy" on other developmental hedonic consumption expenditures, the fertility policy has a significant positive effect on the cultural and recreational consumption and health care consumption of households in the lower wealth group. Still, the effect is not significant for households with higher levels of wealth. This reflects that households with lower levels of wealth have a higher demand for family culture, entertainment, and health care consumption, but cannot fully satisfy all needs to develop hedonic consumption due to wealth constraints and the crowding-out effect of education consumption. In contrast, households with higher levels of wealth had their cultural and recreational consumption and health care consumption needs met before the birth of the second child, and were not constrained by their wealth. Therefore, family cultural and entertainment consumption and health care consumption have not changed significantly after the second child.

In summary, the results of the overall consumption level and consumption structure data tests show that the two-child birth policy has promoted the upgrading of household consumption structure. However, it is known from the heterogeneity analysis that households with lower levels of wealth cannot have all household development hedonic consumption satisfied due to the presence of budget constraints, especially in the face of the increasingly competitive situation in education. Education spending is a development of hedonic consumption. Although education spending is developmental hedonic consumption, the crowding-out effect of education spending on other developmental hedonic consumption is increasing as education becomes more competitive, and this crowding-out effect is more pronounced among households with lower levels of wealth. Therefore, in order to increase the fertility rate, which in turn boosts consumption and economic growth, the government must fundamentally develop policies that are conducive to relieving the stress of child-rearing and parenting for a wide range of families. In this way, a substantial upgrade of consumption for all households can be achieved.

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