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# An Examination of the Influence of Knowledge Recombination on Technical Autonomy in Corporate Entities

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***Abstract:*** *In order to test the proposed hypotheses, the current study builds technical autonomy, measures knowledge recombination based on IPC classification numbers, selects patent data of listed companies in the Chinese automotive industry from 2010 to 2022, and finally suggests the main research conclusions. The relationship between knowledge recombination and technical autonomy is influenced by supply chain position, with the downstream of the supply chain having a positive moderating function and the upstream of the supply chain having a negative moderating impact, as the article found. Recombination of enterprise knowledge significantly improves technical autonomy. Recombining corporate knowledge can increase an organization's technical , enabling it to respond more effectively to technical and market developments and boost its competitiveness.These findings provide important theoretical and practical recommendations on how organizations might strengthen technological autonomy through knowledge restructuring to establish sustainable competitiveness in the context of the Internet and rapid economic development.*

***Keywords:*** *knowledge recombination, supply chain position, technical autonomy*

## 1. Introduction

In the report of the 20th CPC National Congress, "realizing a high level of scientific and technological self-reliance, and entering the forefront of innovative countries" was mentioned as the overarching goal of China's growth in 2035. Under the aegis of this aspirational goal, enterprises must achieve technical autonomy as the principal source of scientific and technological innovation. Technical autonomy, which comprises the ability to independently investigate, develop, produce, and employ significant technologies and industrial fields, is crucial to preserving social stability and national economic security.Csernatoni [1] emphasises the value of technological autonomy in promoting innovation, increasing competitiveness, and reducing dependency on outside technology.The Chesbrough[2] case study adds more evidence that firms need technical autonomy in order to successfully drive technology improvement and product innovation.

In the knowledge economy, information and knowledge are vital manufacturing resources. The strength of knowledge reserves and recombination, as well as the efficient use and management of knowledge resources, are major factors that determine an enterprise's competitiveness[3].The majority of experts believe that in the current period of enterprise rivalry, organizations need to match, integrate, and deploy knowledge resources efficiently in order to overcome technology hurdles and gain a competitive advantage[4].Knowledge recombination is one of the main drivers of technological innovation. Innovation research has therefore turned its attention to enhancing the recombination of essential knowledge resources in order to significantly boost firm technical autonomy.

The effect of knowledge base on technical innovation has been discussed in certain literature, however firms must innovate and become technologically autonomous to become less dependent on external technologies as technology needs increase. Scholarly research has examined the influence of knowledge bases on innovation. Nevertheless, in light of the advent of "key technology chokepoints," organizations must restructure their data and information to facilitate cooperative supply chain models that enhance control and autonomy.Thus, this research investigates the strategy of beginning with enterprise knowledge recombination in order to achieve technological autonomy, explains the role of the supply chain and looks into how it could moderate the relationship between technical autonomy and

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corporate knowledge recombination.

## 2. Theoretical foundations and research hypotheses

### *2.1 The relationship between knowledge recombination and technical autonomy*

The idea of knowledge recombination originated with Schumpeter's claim that "innovation comes from combining existing knowledge"[5]. Nelson and Winter[6]provided the first description of knowledge recombination. They define knowledge recombination as disassembling and reassembling the original non-physical and physical resources. For businesses to engage in innovative activities, knowledge is essential. In order to grow and stay competitive, organizations need a lot of information resources. Businesses can only acquire enough unique knowledge resources to build a strong knowledge foundation for independent company technology research and development and to obtain a competitive advantage after undergoing significant knowledge restructuring[7].According to Carnabuci and Operti[8], knowledge recombination can be divided into two categories: Knowledge-based recombinant creation and reuse. This paper explores these two facets of the link between technical autonomy and knowledge recombination.

#### *2.1.1 Relationship between knowledge recombinant creation and technical autonomy*

The primary objective of knowledge recombinant creation is to reorganize and create novel combinations of knowledge pieces. First, an enterprise's technical autonomy is increased by this procedure, which also helps to create new and better technologies. In order for businesses to recognize and accept new ideas, recombinant creation can break through the barriers imposed by their past intrinsic creative thinking. It does this by fusing new and existing knowledge and enabling businesses to break through their cognitive framework. In addition, businesses can broaden their knowledge base, investigate the connections between technologies, and encourage the recombinant of their knowledge to produce inventions with greater value[9].Second, the "diversity selection effect"[10], which produces a unique knowledge base, improves the knowledge base of other domains, and generates associated technical advantages[11], serves as the foundation for knowledge recombinant creation and reuse. Finally, knowledge recombinant creation can increase competitive advantage in the market and reduce R&D expenses. The organization can work together and share knowledge through the creation and recombination of knowledge in order to better fulfil consumer demand, minimise market risk, and assess if the new knowledge portfolio is fitted to practice.

H1: Increasing a firm's technical autonomy is positively impacted by knowledge recombinant creation.

#### *2.1.2 The relationship between knowledge recombinant reuse and technical autonomy*

A limited degree of cooperative integration is achieved by knowledge recombinant reuse, which entails a gradual deepening and partial modification to the original knowledge base[12]. Businesses are encouraged to innovate along well-established technical routes by utilising their current knowledge portfolios more frequently, which solidifies their knowledge utilisation patterns into organisational practices[13]. Technology barrier-breaking and independent research and development might be hindered by rigidizing a company's innovation approach. The successive creation of the same combination of knowledge elements has impacts that lower marginal returns and increase marginal costs. These technological combinations have also been studied and applied in a range of innovative contexts[14]. The ability of an enterprise to rely on its own innovation and research and development, as well as independently master and use technology, is a key indicator of technical autonomy. If existing knowledge elements are reused, the enterprise will become entrenched in its original technological track and become less sensitive to changes in market demand, which will lead to internal and external dysfunction. The enterprise's technical autonomy and controllability deteriorate when both internal and external adjustments fail and technology does not meet market demand.

H2: Knowledge recombinant reuse has a detrimental effect on improving enterprises' technical autonomy.

### *2.2 Moderating effects of supply chain position*

A supply chain is an integrated network that centres on a single firm and includes manufacturers, distributors, retailers, suppliers, and end users. Supporting components are the first, followed by

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intermediate and final goods, which are subsequently delivered to clients via a distribution network[15]. A portion of them have arrived to look into how the supply chain's shift may affect manufacturing. For instance, Chenyu Zhang et al[16] demonstrated how a company's position in the supply chain has a big impact on the kind of innovation it uses, with downstream firms favouring incremental innovation and upstream firms favouring radical innovation.

Upstream companies that manufacture components or handle raw materials are essential to the development and upkeep of fundamental technologies. Radical innovation requires significant R&D and ongoing funding since it creates complexity and challenges for interdepartmental collaboration[16].To acquire new knowledge and technology, businesses must make use of a variety of learning resources, which raises expenses and prolongs the time it takes for innovations to be developed.Typically, downstream companies oversee the assembly, sales, distribution, and support of their products, placing a strong focus on market orientation and prompt customer response across the supply chain. These companies actively seek out outside data on consumer demands and industry trends. They also benefit from information sharing and technological cooperation with upstream suppliers. Consequently, downstream companies can leverage a substantial number of external learning resources. They can combine internal and external knowledge through knowledge recombination to provide innovative solutions and differentiate their products and technologies to meet customer and market expectations.

H3: Firms' upstream position reduce the influence of knowledge recombination on technical autonomy.

H4: Firms' downstream position positively modifies the influence of knowledge recombination on technical autonomy.

In summary, we have constructed a theoretical conceptual diagram, as shown in Figure 1.

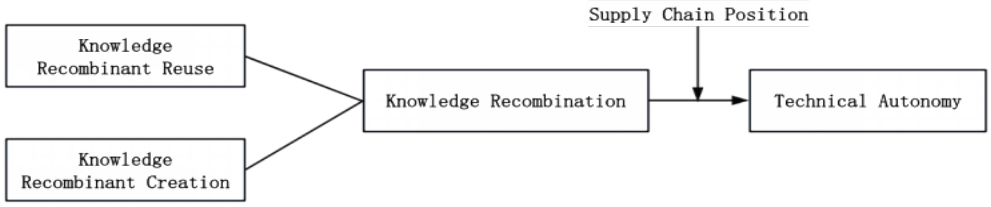


*Figure 1. Theoretical conceptual diagram*

## 3. Research design

### *3.1 Sample Selection and Data Sources*

The automobile industry in China is the subject of this paper. China's cornerstone industry, the automobile sector, makes up a large portion of the GDP domestically, and new energy vehicles and driverless technologies are driving the country's rapid innovation. The goal of Made in China 2025 is to boost production's intelligence and digitization while emphasising the value of technological knowledge integration.In this knowledge-intensive industry, where technical patents are crucial to a company's core competitiveness, data collection is made easier by the distinctive nature of vehicle products. The research object is listed firms in China's car manufacturing industry from 2010 to 2022 in order to objectively portray the technical output and knowledge recombination of enterprises. The "National Key Industry Patent Information Service Platform" is the source of authorised patent data, including utility model and invention patents.This procedure consists of four steps. First, to get research samples for this study, 171 A-share listed corporations are first screened out, removing "ST" organizations. Second, we gather the IPC classification number data for these companies' issued utility model and invention patents between 2010 and 2022. Subsequently, compute the indicators of technical autonomy and contrast them with the enterprise data.In the end, 23,965 granted patents from 82 companies are collected as study samples, and the information is combined to omit businesses that have too few patents.

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### *3.2 Variable measurement*

#### *3.2.1 Explained Variables*

Technical autonomy. The ability of an enterprise to carry out innovative research and development in the pertinent technological field while retaining autonomous control over technological standards, intellectual property rights, and market competitiveness is the definition of technical autonomy given in this paper.This research utilises Chen Yunqing's two-dimensional (competitiveness and innovation capability) measure of technical autonomy[17]. The quantity of new patent applications, patent citations, and patent grants are the measurement indices for innovation capability. These indicators show the enterprise's power in innovation and its long-term influence on external technologies. The overall number of patents awarded, the overall number of times cited, and the overall number of patents are used as measuring indicators to demonstrate the enterprise's technological reserve in market competition as well as the allure of outside technological resources in terms of competitiveness. Independent controllability is quantitatively evaluated using the upgraded TOPSIS method and the objective assignment method-entropy value approach. It provides greater objectivity to the evaluation findings of the independent controllability of the company that manufactures high-end equipment, using the following unique calculating processes:

(1) Calculation of indicator weights

1) Data standardization. Intervalization is employed since the raw data's number of new patents includes a negative indicator with a value of 0.

$$\mathrm{x_{ij}} = \mathrm{a} + \frac{(\mathrm{b}-\mathrm{a})(\mathrm{x}-\mathrm{x_{min}})}{\mathrm{x_{max}}-\mathrm{x_{min}}}$$

Note:$\mathrm{x_{min}}$ indicates the minimum value.$\mathrm{x_{max}}$ denotes the maximum value, and the default a and b are 1 and 2, respectively.

2) weighting

a) Weighting of calculations :

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} (i = 1,2,\ldots m；\ j = 1,2\ldots n)$$

b) Calculate the entropy value of the ith indicator :

$$e_i = -\frac{1}{lnn \sum_{j=1}^{n}(p_{ij}\, ln\, p_{ij})}$$

c) Calculate the weight of the ith indicator:

$$w_i = \frac{1-e_j}{\sum_{j=1}^{m}(1-e_j)}$$

(2) Technical autonomy calculations:

1) Compute the weighted normalization matrix:

$$Z = (Z_{ij})_{m\times n}$$

$$\textit{included among these}\ \ Z_{ij} = w_i \times x_j$$

2) Calculate the positive and negative ideal solutions of the weighted normalized matrix:

$$Z_j^+ = \{maxZ_{ij}|i = 1,2,3\ldots,n\}$$

$$Z_j^- = \{minZ_{ij}|i = 1,2,3\ldots,n\}$$

3) Calculate the Euclid distances to the positive and negative ideal solutions for each scheme:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(Z_{ij}-Z_j^+)^2}$$

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$$d_i^- = \sqrt{\sum_{j=1}^{n}(Z_{ij} - Z_j^-)^2}$$

4) Calculate the proximity of the ith evaluation object to the optimal solution:

$$C_i = \frac{d_i^+}{(d_i^+ + d_i^-)}$$

5) Evaluation Index of Autonomous Control Capability of Automobile Industry:

$$Q_i = \frac{1}{C_i}$$

As shown in Table 1, the techniques and procedures for calculating indicator weight are used to determine the weight values of indicators at different levels utilising the patent data gathered in the database.

*Table 1: Evaluation Indices Weights by Technical Autonomy Levels in Automotive Industry*

| norm | Secondary indicators | weights | Tertiary indicators | weights |
|---|---|---|---|---|
| Technical autonomy | innovation capacity | 0.5838 | New Patent Applications | 0.2500 |
| | | | New Patent Grants | 0.2500 |
| | | | Number of new patent citations | 0.5000 |
| | competitiveness | 0.4162 | Patent grants | 0.3333 |
| | | | Number of patents | 0.2592 |
| | | | Number of citations | 0.4074 |

The patent data in the database is used to generate the weight values of indicators at different levels, and the results are indicated in Table 2.

*Table 2: Calculation results of technical autonomy*

| company identification | Qingdao Guoen Technology Co. | Qinchuan Machine Tool Group Corporation | Ningbo Yibin Electronic Technology Co. |
|---|---|---|---|
| 2018 | 2.180183574 | 2.036626872 | 2.108146067 |
| 2019 | 1.210262878 | 1.220869542 | 1.221417155 |
| 2020 | 1.979463628 | 1.971576057 | 1.972084238 |
| 2021 | 1.996669743 | 2.0020526 | 1.992966318 |
| 2022 | 2.200915343 | 2.124875156 | 2.124874508 |

### *3.2.2 Explanatory variables*

Knowledge Recombiantion. This paper is based on Carnabuci et al.'s[18]]assessment of knowledge recombiantion, reuse, and creation in firms and Verhoeven's[19] research approach, which uses the patent IPC categorization number for determination. The specific stages are as follows: 1. Establish a knowledge recombination discrimination experimental and control group, with the experimental group selecting the enterprise's patent grant data from 2017 to 2022 and the control group selecting data prior to the patent grant year. 2. Exclude patent data with only one classification number and extract the piece of the IPC classification number before "/" as the knowledge element to be combined. 3. Examine the knowledge element combinations in the experimental and control groups to ascertain whether or not the combinations in the experimental group are novel; 4. Classify any combinations of knowledge elements that appear in the patents for the first time as knowledge recombinant creation; otherwise, classify them as knowledge recombinant reuse; 5. Note how many patents are classified as knowledge recombinant creation and how many as knowledge recombinant reuse.

### *3.2.3 Moderating variables*

Supply chain position. Supply chain position refers to the tier or link in the supply chain that reflects the enterprise's position and role in the overall supply chain. It is categorised as either downstream or upstream. According to this study's use of the 0-1 assignment approach, the automotive industry is divided into two segments: the downstream comprises automakers, distributors, retailers, and after-sales service providers, while the upstream comprises suppliers of raw materials and component manufacturers.

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#### *3.2.4 Control variables*

In this paper, three control variables were chosen: firm age, firm size, and ownership type .The logarithm of the employee count was used to determine the size of the firm. Different firms' age and type, as well as the resources they have amassed within the sector and their unique characteristics, will all influence how each firm makes innovation decisions, which in turn will affect the firms' technical autonomy.

### *3.3 Empirical modeling*

The dependent variable in this paper is technical autonomy, a continuous variable with non-negative values that should be regressed using a continuous model. This requires consideration of the following factors: there is no over-dispersion; the dependent variable's mean and variance differ (mean = 2.071, variance = 1.418); the independent variable is a count variable with a small proportion of zero; the sample is from the short-panel data (N = 410, T = 5); Hausman's test was used to select the final multiple regression model for analysis. The production chain position moderator variable is a dichotomous variable. It is coded 0-1, the interaction term variable is centered, and stepwise regression analysis and model selection are performed using STATA/SE 18 econometric software. The following lists the pertinent models:

Using the following formula, build the regression model for the study's main effect to examine the direct relationship between knowledge recombination and technical autonomy:

$$Y_{it}= \beta 0 + \beta 11X_{it} + \varepsilon_{it}$$

Next, to examine the moderating effect of supply chain position, the model incorporates knowledge recombination, supply chain position, and their interaction

$$Y_{it}=\beta_0 + \beta_1 U_{it} + \beta_2 Z_{it} + \varepsilon_{it}$$

$Y_{it}$ denotes the technical autonomy of firm i in year t, and $X_{it}$ denotes firm's knowledge recombination including knowledge recombinant reuse and knowledge recombinant creation in year t, and$U_{it}$ denotes firm's position in the supply chain in year t.

## 4. Rmpirical analysis

### *4.1 Descriptive statistics and correlation analysis*

#### *4.1.1 Descriptive analysis*

The sample firms' technical autonomy, as displayed in Table 3, varies from a maximum of 21.53 to a mean of 2.071. This indicates that the sample firms' capacities for technological innovation are considerably different from one another. The knowledge recombinant reuse and creation mean values of 19.52 and 22.90, respectively, and the accompanying standard deviations of 68.27 and 55.95, demonstrate the wide variation in knowledge recombination across enterprises. Most enterprises are located upstream in the supply chain, as indicated by the supply chain position mean value of 0.339 and standard deviation of 0.474.

*Table 3: Descriptive Statistical Analysis*

| Variable | N | Mean | SD | Min | Max. |
|---|---|---|---|---|---|
| Technical autonomy | 410 | 2.071 | 1.418 | 1.001 | 21.53 |
| Reuse | 410 | 19.52 | 68.27 | 0 | 699 |
| Creation | 410 | 22.90 | 55.96 | 0 | 486 |
| Supply Chain | 410 | 0.339 | 0.474 | 0 | 1 |
| Size | 410 | 7.073 | 1.295 | 3.434 | 13.17 |
| Age | 410 | 19.05 | 5.617 | 5.250 | 37.33 |
| Type | 410 | 1.841 | 0.366 | 1 | 2 |

#### *4.1.2 Correlation analysis*

Prior to examining the regression analysis, a correlation analysis was carried out. As shown in Table 4, the findings show that technical autonomy and knowledge recombination were positively correlated for both reuse (r=0.325, ρ<0.01) and production (r=0.376, ρ<0.01).Regression analysis is required to confirm the initial finding of a connection between technical autonomy and supply chain position. Since

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they were part of the model as control variables, factors including business size, age, and type were linked to technical autonomy. The independent, moderating, and control variables were found to be correlated; multicollinearity has to be evaluated. The VIF results show a mean of 3.10 and a maximum of 7.11, with the variable coefficients being less than 10,so that the problem of multicollinearity is not significant and regression can be analyzed.

*Table 4: Correlation Analysis*

| | Technical autonomy | Reuse | Creation | Supply Chain | Size | Age | Type |
|---|---|---|---|---|---|---|---|
| Technical autonomy | 1 | | | | | | |
| Reuse | 0.325*** | 1 | | | | | |
| Creation | 0.376*** | 0.920*** | 1 | | | | |
| Supply Chain | 0.146** | 0.232** | 0.278*** | 1 | | | |
| Size | 0.231*** | 0.451*** | 0.494*** | 0.112** | 1 | | |
| Age | 0.0116 | 0.111** | 0.113** | 0.149*** | 0.188*** | 1 | |
| Type | 0.0329 | -0.0210 | 0.0112 | 0.0993** | -0.183*** | -0.349*** | 1 |
| VIF | 3.10 | 6.55 | 7.11 | 1.13 | 1.40 | 1.20 | 1.21 |

Standard errors in parentheses$^{*}$ $p < 0.1$,$^{**}$ $p < 0.05$,$^{***}$ $p < 0.01$

### 4.2 Regression analysis

#### 4.2.1 Test of the main effect of knowledge recombination on technical autonomy

Table 5 shows the empirical results of the regression using the multiple linear model: According to Model 1, a simple model with only control variables, technical autonomy is significantly positively impacted by company size and type. This finding is in line with findings from previous research. The results indicate that knowledge recombinant reuse has a positive and significant effect on technical autonomy (β=0.006, ρ<0.05); Model 2 is a regression model that combines the independent variable knowledge recombinant reuse, the dependent variable technical autonomy, and the control variables. The results of Model 3's regression model, which includes technical autonomy, knowledge recombinant creation, and control variables, indicate that knowledge recombinant creation has a positive and substantial Significant and beneficial effects are observed (β=0.009, ρ<0.01). Model 4—a regression model that looks at both recombinant creation and reuse—shows that the positive and negative conditions of the regression coefficients stay unchanged. Regression results from Models 2 and 3 are also reliable.

*Table 5: Knowledge Recombination and Technical Autonomy: Regression Analysis*

| | Technical Autonomy | | | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 |
| Reuse | | 0.006** | | 0.003 |
| | | (0.001) | | (0.002) |
| Creation | | | 0.009*** | 0.012*** |
| | | | (0.001) | (0.003) |
| Age | -0.002 | -0.006 | -0.007 | -0.007 |
| | (0.013) | (0.012) | (0.013) | (0.013) |
| Size | 0.269*** | 0.132* | 0.080 | 0.078 |
| | (0.054) | (0.059) | (0.060) | (0.060) |
| Type | 0.291** | 0.196 | 0.125 | 0.106 |
| | (0.201) | (0.199) | (0.193) | (0.197) |
| cons | -0.330 | 0.778 | 1.218* | 1.250* |
| | (0.648) | (0.632) | (0.664) | (0.671) |
| *N* | 410 | 410 | 410 | 410 |

Standard errors in parentheses$^{*}$ $p < 0.1$,$^{**}$ $p < 0.05$,$^{***}$ $p < 0.01$

#### 4.2.2 Moderating effects of supply chain position

Table 6 shows the regression result.The supply chain is given values of 0 for upstream and 1 for downstream by the study. The regression results for the relationship between knowledge recombination in creation and reuse and supply chain position are shown in Models 1 and 2. The findings point to a positive but negligible influence of supply chain position on these relationships, with downstream enterprises benefiting more from knowledge recombination in terms of technical autonomy.Models 3 and 4 provide the regression results for the interaction terms between supply chain position and knowledge

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recombination in reuse and creation, with a value of 1 for the upstream and 0 for the downstream. These findings indicate a negative and insignificant link for upstream enterprises. These findings indicate that as enterprises are further up the supply chain, the favourable effect of knowledge recombination on technical autonomy is reduced.

*Table 6: Regression Results of Supply Chain Location Adjustment Effect*

| | Technical autonomy | | | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 |
| Reuse | 0.0050 | | 0.0054*** | |
| | (0.0047) | | (0.0011) | |
| Reuse* Supply Chain | 0.0003 | | -0.0004 | |
| | (0.0052) | | (0.0045) | |
| Creation | | 0.0057* | | 0.0085*** |
| | | (0.0032) | | (0.0014) |
| Creation* Supply Chain | | 0.0028 | | -0.0028 |
| | | (0.0045) | | (0.0057) |
| Supply Chain | 0.2165 | 0.1095 | -0.1980 | -0.0940 |
| | (0.1384) | (0.1107) | (0.1491) | (0.1614) |
| Age | -0.009 | -0.0094 | -0.0083 | -0.0087 |
| | (0.0103) | (0.010) | (0.0128) | (0.0126) |
| Size | 0.1313* | 0.0838 | 0.1535** | 0.0853 |
| | (0.0766) | (0.0576) | (0.0590) | (0.0598) |
| Type | 0.1507 | 0.0985 | 0.1535 | 0.1012 |
| | (0.092) | (0.1022) | (0.1998) | (0.1957) |
| cons | 0.8619 | 1.2662** | 1.0216 | 1.3349* |
| | (0.6664) | (0.6659) | (0.6867) | (0.6871) |
| *N* | 410 | 410 | 410 | 410 |

Standard errors in parentheses* $p < 0.1$,** $p < 0.05$,*** $p < 0.01$

#### ***4.2.3 Robustness Tests***

Firms with increasing levels of technical autonomy may have an impact on knowledge recombinant creation and reuse, as well as possible endogeneity difficulties. To theoretically exclude the potential that the dependent variable will alter the independent variable, the dependent variable, technical autonomy, is addressed with a one-year lag.Table 7 illustrates that Model 1 includes both the control and dependent variables, technical autonomy, and the outcomes are in line with previous research. Models 2 and 3 in the regression model include technical autonomy, knowledge recombinant creation, and reuse, along with control variables. Results show that knowledge recombinant creation (β=0.0061, ρ<0.01) and reuse (β=0.0050, ρ<0.01) have a positive and significant effect on technical autonomy. These findings are consistent with the previous section and show that the regression results are robust.

*Table 7: Lagged Explanatory Variable Regression Results*

| | Technical autonomy | | | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 |
| Reuse | | | 0.0050*** | 0.0008 |
| | | | (0.0015) | (0.0041) |
| Creation | | 0.0061*** | | 0.0067** |
| | | (0.0016) | | (0.0044) |
| Age | -0.0021 | -0.0104 | -0.0050 | -0.0062 |
| | (0.0131) | (0.0122) | (0.0130) | (0.0130) |
| Pro | 0.2913 | | 0.2422 | 0.1923 |
| | (0.2008) | | (0.1990) | (0.2013) |
| Size | 0.2692*** | 0.1476** | 0.1806*** | 0.1573** |
| | (0.0541) | (0.0604) | (0.0598) | (0.0616) |
| cons | -0.3298 | 1.1036** | 0.3676 | 0.6012 |
| | (0.6485) | (0.4474) | (0.6746) | (0.6907) |
| *N* | 410 | 410 | 410 | 410 |

Standard errors in parentheses* $p < 0.1$,** $p < 0.05$,*** $p < 0.01$

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### *4.3 Results and Discussion*

A mechanism model for knowledge recombination driving technical autonomy was established in this paper. The paper investigates its influence mechanisms using the empirical analysis presented above, and it comes to the following conclusions:

#### *4.3.1 The direct impact of knowledge recombination on technical autonomy*

Based on empirical findings, knowledge recombination promotes technical autonomy, hence supporting H2 by assisting businesses in overcoming mental obstacles, expanding their knowledge bases, and becoming more technologically competitive.Empirical evidence reveals that the reuse of knowledge recombination enhances technical autonomy, contradicting H1.Maybe the auto industry’s high competition and technological intensity, coupled with short product life cycles, necessitate continuous updates to maintain market competitiveness. Utilizing existing knowledge combinations and reuse can reduce redundant labor and basic research costs, expediting technological breakthroughs and positively impacting technical autonomy. This will have a positive impact on technical autonomy. Furthermore, as there might be a lag between a technical innovation breakthrough and the repurposing and restructuring of knowledge, there may be a temporal component at work. While knowledge recombinant reuse can speed up small advances in the short term, they don't amount to a major innovative breakthrough. However, it is a major factor in advancing the achievement of technical autonomy.

#### *4.3.2 Moderating effects of supply chain position*

The empirical findings refute the theoretical claims that the impact of technical autonomy on knowledge recombination is positively moderated by firms' downstream position and negatively moderated by firms' upstream position, respectively. These claims are also statistically insignificant. In addition, because of globalized competition and the creation of exclusive supply chains for businesses, there may be negligible differences in knowledge recombination between upstream and downstream firms, masking the particular effects of supply chain position. This could be because the data do not sufficiently capture the differences in knowledge recombination and creation between upstream and downstream firms.While the current analysis does not statistically validate the moderating role of supply chain position, we highlight the need for future research to explore how upstream and downstream positions affect knowledge recombination and technical autonomy. This should involve more precise data and metrics, as well as a broader sample size.

## 5. Conclusion

Using patent data from 82 A-share listed automotive firms from 2010 to 2022, this research assesses the moderating role of supply chain position and investigates the implications of knowledge recombination on technical autonomy. The paper's findings indicate that knowledge recombination enhances an organization's technical autonomy while supply chain position has a modest moderating influence. These findings provide credence to the notion that increasing an organization's technological independence necessitates both the creation and application of knowledge. Businesses must effectively respond to market and technological changes by integrating technological advancements with organizational and management changes, as well as securing their place within the supply chain, in order to maintain a sustained competitive advantage and long-term profitability.

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