· Article ·

Letting Go for a Big Push: China's Strategic Transformation of Foreign Exchange Reserves and Value Chain Ascension

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Abstract: This paper utilizes data from the UIBE_GVC database covering the period from 1995 to 2020 to calculate Global Value Chain (GVC) indices and empirically examines the impact of foreign exchange reserves on GVC ascension, along with its heterogeneity and mechanisms of action. The findings reveal an inverted U-shaped relationship between foreign exchange reserves and GVC status. In the early stages of GVC integration, foreign exchange reserves facilitate the improvement of GVC position. However, once a certain level of integration is reached, these reserves impede further GVC ascent. Moreover, foreign exchange reserves predominantly influence the manufacturing sector with heterogeneous effects — boosting the GVC position of less technology-intensive industries while exhibiting significant negative impacts on more technology-intensive sectors. Initially, during the GVC integration process, foreign exchange reserves promote a country's GVC climb through enhancing demand for intermediate goods imports—the trade demand effect. Yet, when integration reaches a particular stage, the maintenance and expansion of foreign exchange reserves lead to resource lock-in within low-value-added export-oriented sectors, constraining research and development investments as well as technological advancements. Consequently, the GVC ascension becomes hindered due to the low-end lock-in effect and the restriction of technological progress.

Keywords: Global Value Chain (GVC) Ascension; Foreign Exchange Reserves; Trade Demand Effect Low-end Lock-in Effect; Technological Progress

1. Introduction

The process of global economic integration has transformed traditional trade patterns by separating production activities in terms of function and space. Countries participate in global value chain (GVC) layouts based on their comparative advantages. Developed countries, leveraging their core technologies and brand services, occupy high positions in the GVC, thereby restricting the ability of developing countries to obtain added value. In contrast, developing countries, particularly those in Asia, have integrated into the GVC by taking over low-end manufacturing relocation, and have

achieved industrial upgrading through the "technology spillover" and "learning by doing" effects, thereby climbing up the value chain.

Since China's reform and opening-up, it has embedded into the global division of labor system by taking advantage of its land and labor cost advantages, rapidly becoming the world's largest assembly platform. The expansion of processing and trade brought China significant trade surpluses, and due to the existence of foreign exchange controls, the volume of foreign exchange held by enterprises, institutions, and individuals was limited. The trade surplus thus promoted the accumulation of foreign exchange reserves. On the one hand, foreign exchange reserves serve as a "stabilizer" by regulating international incomes, stabilizing exchange rates, and countering external risks. On the other hand, the large trade surplus and foreign exchange reserves are also considered to be manifestations of the locking of developing countries into the low-end of the global value chain and the waste of manufacturing opportunities. However, deeper integration is not without its drawbacks. The benefits vary among producers at different levels of the GVC. As the US-China decoupling and the "reshoring" strategies of major Western countries are implemented, China's upward climb faces numerous challenges. Meanwhile, China's foreign exchange reserves, which stem from its participation in the GVC, play an important role in the process of climbing the value chain. How should China deal with its large foreign exchange reserves to achieve GVC ascension? These questions remain to be answered.

Against this backdrop, this paper employs panel regression models and heterogeneity analyses to investigate the impact of foreign exchange reserves on participation in and the position in the GVC, as well as the ways in which they operate. The paper also examines the heterogeneity among countries at different positions in the GVC.

2. Review of Existing Literature

Under the backdrop of globalization, the relationship between foreign exchange reserves and global value chains (GVCs) has become a focal point for both academics and policymakers. However, how do we measure a country's current position in the GVC? What factors influence a country's ascent in the GVC? And what role do foreign exchange reserves play in this process? This section reviews pertinent literature domestically and internationally to provide theoretical and methodological guidance for subsequent research.

2.1 Measurement of the Global Value Chain

Hummels et al. (2001) pioneered the definition of narrow vertical specialization (Narrow Vertical Specialization, NVS), identifying domestic product values used for others' intermediate exports as NVS. This idea of segregating inputs for others' intermediate products from total exports laid the theoretical foundation for subsequent systematic decomposition of trade value addition. Koopman et al. (2014) introduced the KWW method for decomposing total exports. They divided a country's total exports into three parts: domestic value-added exports, value-added exported but then re-imported

after processing abroad, and foreign value-added. Further, each part was refined into three indicators based on the final destination of the export value, resulting in nine specific indicators. Building upon the KWW method, Koopman et al. (2014) proposed two metrics: Global Value Chain Participation (GVC participation) and Global Value Chain Position (GVC position). Fally (2012) and Antras et al. (2012) defined upstreamness (Upstream, U) from the perspective of the distance from production to final demand.

Chinese scholars have made remarkable contributions to measuring the GVC. Wang Zhi et al. (2013) presented the WWZ method for decomposing total exports, formulating sixteen department-level formulas for total export decomposition. Four years later, Wang Zhi et al. (2017) also proposed the WWYZ method based on a production dissection model, considering various types of value chain production activities and decomposing production length into purely domestic components, Ricardo-type trade, and GVC-related segments.

2.2 Factors Influencing Global Value Chain Ascension

Some scholars argued that deepening engagement in the GVC can facilitate industrial and economic upgrades. Gereffi (2014), a pioneer in the study of the GVC, emphasized that social economic upgrading should focus on competitiveness within the GVC rather than independently developing production forms. Whittaker (2007) argued that the expansion of the GVC after the 1980s posed a challenge to domestic vertically integrated production systems, making traditional industrial policy-based development models less effective. Other scholars focused on specific influencing factors. For instance, Bamber (2014) and Kummritz (2017) found that domestic policies were important factors affecting the global value chain position of developing countries. Miroudot (2017), Cui Jihong and Zou Kangkuan (2020) demonstrated the significant positive impact of service trade on global value chain ascension, suggesting that increasing productive services investments in capital-intensive and labor-intensive industries would significantly enhance the forward participation of related industries in the GVC. Hao Fenghua et al. (2016) revealed a reverse “U” shape relationship between FDI and China’s position in the GVC.

2.3 The Role of Foreign Exchange Reserves

Since China’s reform and opening-up, it has transformed from a major manufacturer by receiving low-end manufacturing transfers from developed countries and becoming a leading manufacturing power. Since China joined the World Trade Organization (WTO) in 2001, its foreign exchange reserves have entered a period of rapid accumulation, and some scholars have noted the positive roles of foreign exchange reserves during China’s early integration into the GVC. Ba Shushen (1997) believed that during China’s economic transition, foreign exchange reserves could provide the government with foreign exchange funds for its dominant development approach, so the level of foreign exchange reserves needed to take into account developmental needs. Li Yang and Yu Weibin

(2005) found that foreign exchange reserves could promote the internationalization of the renminbi, thereby facilitating China's integration into the global value chain.

China's position in the global value chain rises alongside the expansion of its foreign exchange reserves, several scholars have started reflecting on the possible adverse effects of accumulating vast amounts of foreign currency. Researchers discovered that once an economy attains a certain degree of development, foreign exchange reserves can impose detrimental macroeconomic consequences. (Pan Huajun et al., 2016; Li Wei & Zhang Zhichao, 2009; Ma Yechi & Fu Jinghui, 2016) Zhang Shaojun and Luo Xu (2020) conducted empirical analyses to investigate the causal pathway linking global value chains→trade surplus→foreign exchange reserves→ and inflation. Their findings revealed that global value chains might instigate inflationary pressures in the downstream sectors through the mechanism of accumulating foreign exchange reserves. Jia Genliang (2010) argued that China's international grand circulation strategy inadvertently traps the nation in a subordinate role at the lower tiers of the international division of labor. The amassed dollar reserves, he contended, represent an exploitation underpinned by US dollar dominance. Consequently, China's resources, finances, and workforce get channeled towards export-focused industries concentrated along its coastal regions, which in turn restrains the stimulation of internal market demand over extended periods.

2.4 Review of Literature

In summary, existing studies on the measurement of the global value chain have reached a certain level of maturity. Based on China's possible "low-end trap", academia has had intense discussions on how to ascend the global value chain. While existing literature has covered the impact of the global value chain on foreign exchange reserves, few studies have focused on the impact of foreign exchange reserves on China's ascension in the global value chain. Moreover, empirical research usually involves global value chain position indices as a whole in quantitative models without considering the heterogeneity of the impact of variables on countries at different positions in the global value chain. No literature has yet explored the specific impact mechanism of foreign exchange reserves on global value chain ascension.

This paper and significance of this study lie in: First, this paper innovatively examines the reverse causal relationship between foreign exchange reserves and the global value chain, and differentiates between high-end and low-end countries in the global value chain, conducting heterogeneous analysis. Second, this study innovatively investigates the impact mechanism of foreign exchange reserves on ascending the global value chain, providing theoretical guidance for China's ascension in the global value chain and industrial upgrading.

3. Theoretical Analysis and Research Hypotheses

This paper focuses on the impact and mechanisms of foreign exchange reserves on climbing the global value chain, while also noting that the impact of foreign exchange reserves on countries at different positions in the global value chain and at different stages of value chain integration may be

heterogeneous. Therefore, based on this logic, theoretical analysis will be conducted and corresponding hypotheses will be proposed.

During the initial phase of global value chain integration, domestic manufacturing levels are relatively low, and there is a strong dependence on imported intermediate products. As a result, there is an urgent need for adequate foreign exchange reserves to facilitate imports of intermediate goods. Coe and Helpman (1995) argued that imports of advanced equipment exhibit clear learning effects and technology spillover effects, which in turn promoted the growth of the mother country's economy, particularly as imports from developed countries had a significant impact on the indigenous enterprises' innovation capacity through technology diffusion effects. Ba Shushen (1997) found that the early demand for holding foreign exchange reserves in China was primarily transactional. Tang Dongbo (2012) argued that during the early stage of integration, China expanded its exports to acquire foreign exchange, thus promoting the expansion of processing trade.

However, as integration deepens, Jia Genliang (2023) observed that the scale of China's trade surplus equaled the loss of fiscal capability that the Chinese government could otherwise have used for core technology research and development and social security provision. This resulted in a distorted dual economy characterized by a dichotomy between outward orientation and domestic demand, becoming the primary reason why domestic demand remains dormant, investment opportunities for national firms are crowded out by foreign capital, and severe economic bubbles arise. Huang and Wedeman (2004) suggested that China lacked a conversion mechanism to transform savings into efficient resource allocation, leading to wasted foreign exchange reserves. We concur with this line of reasoning; at a certain point in the global value chain, excessive reserve accumulation may lead to the wastage of opportunity costs for technological progress, locking resources in low-end manufacturing and hindering further ascent up the global value chain.

Based on the aforementioned theoretical analysis, the following testable hypotheses are put forward:

H1: The effect of foreign exchange reserves on GVC (Global Value Chain) status exhibits an inverted U-shaped trend, initially rising before declining. During the early stages of GVC integration, foreign exchange reserves positively influence GVC ascent; however, beyond a certain point, they begin to hinder progression.

H2: At the outset of GVC integration, ample foreign exchange reserves boost a country's intermediate good imports, fostering improvements in manufacturing capabilities and enabling GVC advancement—the 'transaction demand effect'.

H3: After reaching a certain level of integration, foreign exchange reserves become the opportunity cost of technological progress, trapping resources in low-end industries—the 'technological progress effect' and 'low-end lock-in effect'.

4. Model Specification, Variable Description, and Data Sources

To test the three hypotheses, this paper utilizes data from the UIBE_GVC database to calculate the relevant indices for global value chains for 76 countries, including China. These indices are then employed as the explained variable to construct empirical models and design robustness tests.

4.1 Econometric Model Specification

Based on the research hypotheses outlined in this paper and referencing pertinent literature, the baseline econometric model constructed herein is as follows:

$$GVC_{irt} = \alpha_0 + \alpha_1 FER_{irt} + \alpha_2 FER_{irt}^2 + \alpha_3 Z + \mu_i + \tau_r + \theta_t + \varepsilon_{irt} \quad (1)$$

The dependent variable set GVC_{irt} onsists of four indices related to the global value chain: the Global Value Chain Participation Index (GVC_participation), the Forward Participation Index (GVC_forward), the Backward Participation Index (GVC_backward), and the Global Value Chain Position Index (GVC_position). FER_{irt} refers to foreign exchange reserves, and FER_{irt}^2 represents its square term. Z is a collection of control variables, including exchange rates, per capita GDP, FDI, and trade surpluses. μ_i indicates country-specific fixed effects, τ_r represents industry-specific fixed effects, θ_t indicates year − specific fixed effects, and ε_{irt} is the random disturbance term.

To empirically examine the impact of foreign exchange reserves on China's ascension in the global value chain, this study considers both mediating and moderating effects when constructing the econometric model:

(1) Mediation Effect Model:

$$GVC_{rt} = \beta_0 + \beta_1 FER_{rt} + \beta_2 Z + \tau_r + \theta_t + \varepsilon_{irt} \quad (2)$$

$$M_{rt} = C_0 + C_1 + C_2 FER_{rt} + C_3 Z + \tau_r + \theta_t + \varepsilon_{rt} \quad (3)$$

$$GVC_{rt} = \delta_0 + \delta_1 FER_{irt} + \delta_2 M_{rt} + \delta_3 Z + \tau_r + \theta_t + \varepsilon_{rt} \quad (4)$$

In this context, M_{rt} denotes the mechanism variable, encompassing technological progress effect, low-end lock-in effect, and transaction demand effect.

(2) Moderation Effect Model:

$$\begin{aligned} GVC_{rt} = {} & \gamma_0 + \gamma_1 FER_{rt} + \gamma_2 M_{rt} + \gamma_3 Z + \gamma_4 FER_{rt} * TD_{rt} \\ & + \gamma_5 FER_{rt} * TFP_{rt} + \gamma_6 FER_{rt} * LOCK_{rt} + \tau_r \\ & + \theta_t + \varepsilon_{rt} \end{aligned} \quad (5)$$

Here, TD_{rt} represents the transaction demand effect, TFP_{rt} symbolizes the technological progress effect, $LOCK_{rt}$ signifies the low-end lock-in effect. Below are definitions and explanations primarily for the dependent variable and control variables.

4.2 Variable Definition and Calculation Description

The central dependent variable in this study is calculated through the KWW method based on the UIBE_GVC database, representing countries' indices related to the global value chain. The explanatory variable is each country's foreign exchange reserves, valued in U.S. dollars. Following previous literature, we select foreign direct investment, trade surplus, exchange rate, and per capita GDP as control variables. Additionally, this paper introduces mechanism variables such as

technological advancement, low-end locking, and transaction demand to measure the pathways through which foreign exchange reserves influence the global value chain.

4.2.1 Dependent Variable

This paper constructs four indicators using the KWW methodology: the Global Value Chain Participation Index (GVC_participation), the Forward Participation Index (GVC_forward), the Backward Participation Index (GVC_backward), and the Global Value Chain Position Index (GVC_position). These metrics comprehensively and accurately depict a country's role and degree of involvement within the global value chain division of labor. The specific calculation formulas are as follows:

$$\begin{aligned} GVC_{participation_{irt}} &= GVC_{forward_{irt}} + GVC_{backward_{irt}} \\ &= \frac{IV_{irt}}{E_{irt}} + \frac{IF_{irt}}{E_{irt}} \end{aligned} \tag{6}$$

$$GVC_{position_{irt}} = \ln\left(1 + \frac{IV_{irt}}{E_{irt}}\right) - \ln\left(1 + \frac{IF_{irt}}{E_{irt}}\right) \tag{7}$$

Here, i represents a country, r represents an industry, and t represents time. E_{irt} denotes a country's total exports, IV_{irt} represents the domestic indirect added value within a country's exports, IF_{irt} represents the foreign added value within a country's exports.The GVC_position index, when higher, indicates that a country provides more intermediate products for other countries, indicating a stronger role as a connector within the global value chain division of labor network, and a higher position within the global value chain. The GVC_participation index, when higher, implies that a country's participation in the global value chain is deeper, with closer economic ties to other countries. The GVC_backward index, estimated by the proportion of foreign added value within a country's exports, is generally considered a commonly used indicator for measuring integration into the global value chain and the degree of manufacturing vertical specialization; in contrast, the GVC_forward index is more reflective of the global value chain participation of the service sector.

4.2.2 Mechanism Variables

The mechanism variables selected in this study include the effects of technological progress (TFP), low-end lock-in effect (Lock), and transaction demand effect (TD). The specific indicators are as follows:

(1) Technological Progress Effect:

This study employs the total factor productivity (TFP) to gauge the level of technological progress in a country or industry. For calculating TFP, this article adopts the approach of Fare et al. (1994), using the DEA-Malmquist method to estimate TFP. The input variables are capital and labor, with expected output being the gross output. Capital input is measured by capital stock, while labor input is measured by the end-of-year employment numbers in the industry. Based on this, the Malmquist index is constructed below:

$$Malmquis_{i,t+1} = \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)}\right]^{t/2} \quad (8)$$

Among them, x^t represents the vector of capital and labor inputs in period t, y^t represents the vector of total output, $D^t(x^t, y^t)$ represents the technical reference value of period t.

(2) Low-End Lock-In Effect:

Following the methods of Xie Huiqiang et al. (2018), this study constructs the low-end lock-in indicator as follows:

$$Lock_{rt} = \frac{GVC_{position_{rt}}}{sale_{rt}} \quad (9)$$

In these equations, $sale_{rt}$ denotes the sales revenue of the industry. A larger low-end lock-in index suggests less pronounced low-end lock-in conditions for the country; conversely, a smaller index indicates more severe low-end lock-in conditions.

(3) Transaction Demand Effect

Transaction demand measures a country's reliance on imports of foreign intermediates. This study quantifies transaction demand through the ratio of intermediate goods imports to intermediate goods exports. A greater transaction demand index signifies higher dependency on imported intermediates for the country, whereas a lower index indicates lesser dependence.

4.2.3 Control Variables

In this study, four control variables are chosen: foreign direct investment (FDI), trade surplus (TS), exchange rate (ER), and per capita GDP (gdp). Foreign direct investment can promote a country's position in the global value chain through "technological spillover effects" and "learning-by-doing effects". Trade surplus serves as an important source of foreign exchange reserves for a country. Exchange rates significantly influence a country's imports and exports. Per capita GDP is a key indicator of a country's level of economic development. Countries with higher per capita GDPs possess more high-end productive factors, which are conducive to their participation in global value chain division of labor, and therefore enjoy higher positions in the global value chain.

4.2.4 Sample Selection and Data Sources

The global value chain-related indicators in this study are calculated based on the UIBE_GVC database, which is maintained by the UIBE Global Value Chain Research Institute. The data in this database is based on the OECD's original data and covers the period from 1995 to 2020, including China and 76 other countries. The mechanism variables and control variables in this study are sourced from the CEIC database, the World Bank Development Indicators Database, and the China Statistical Yearbook. Missing data is filled using linear or moving average interpolation methods.

5. China's Participation in the Global Value Chain

Based on the KWW method and using the UIBE_GVC database, the global value chain-related indices for China and the other 76 countries were calculated. The basic distribution of each index was visualized, and the results are shown in **Figure 1**:

In particular, **Figure A** displays the changes in China's global value chain position index for each manufacturing sector from 1995 to 2020 (the polar coordinates are ordered from inner to outer). It can be observed that most of China's manufacturing sectors have undergone a global value chain upgrade over the past two decades. The coke and refined petroleum product industry (C19), the pharmaceuticals, pharmaceutical chemicals and plant products industry (C21), and the electrical equipment industry (C27) have made particularly remarkable jumps from low to high positions. The wood and wood and softwood products industry (C16) and the paper and printing industry represented by paper products (C17_18) represent China's strong suit in low-tech industries. The computer, electronic and optical equipment industry (C26), representing the high-tech industry, remains a weak point for China.

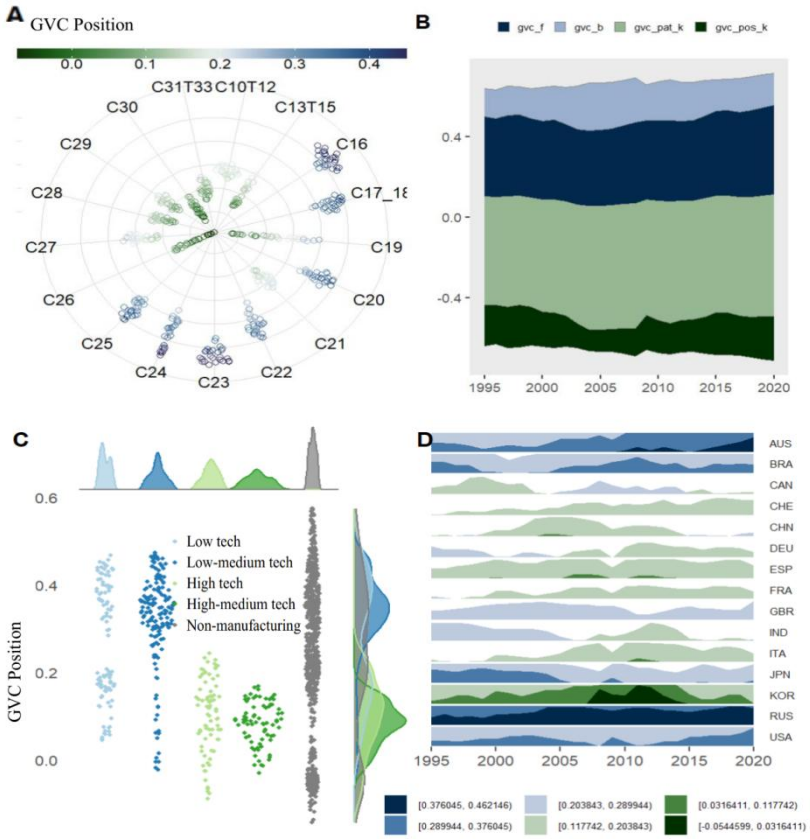
Figure B depicts the changes in China's four global value chain-related indices (covering overall situation without sectoral differentiation) from 1995 to 2020. It can be inferred that China's degree of participation in the global value chain – whether in backward linkages, forward linkages, or overall – experienced a process of expansion followed by contraction from 1995 to 2020. The proportion of foreign-added value in domestic exports, estimated for backward linkages, is generally considered a common indicator of a country's integration into the global value chain and its level of manufacturing vertical specialization; forward linkages are better indicators of the global value chain participation of service sectors. This further demonstrates the rapid integration of China into the global value chain following its accession to the WTO at the beginning of the century. Intriguingly, China's overall global value chain position index shows an opposite trend. This also suggests that a deeper integration into the global value chain does not necessarily lead to a higher position in the global value chain, but may instead increase the risk of "low-end locking".

Figure C focuses on the distribution of China's global value chain position index in terms of technology intensity categories, while **Figure D** compares China with other countries in terms of global value chain position. These results further illustrate China's current state of participation in the global value chain: it lacks a clear advantage in the mid-to-high end, and there is still significant room for upgrading in the manufacturing sector, especially in high-tech industries. Moreover, China's positive engagement with the global value chain has not led to a significant improvement in its value chain position, so blindly pursuing "internationalization" as a means of upgrading may be a pipe dream.

In summary, China is currently positioned at the mid-low level of the global value chain, accompanied by a clear advantage in low-end manufacturing. There is significant potential for upgrading in mid-to-high-end manufacturing, especially in high-tech industries. Furthermore, China's

active engagement with the global value chain has not resulted in a significant improvement in its value chain position, so blindly pursuing "internationalization" as a means of upgrading may be a pipe dream.

Figure 1: Participation of China in the Global Value Chain



Source: Created by the author using R.

6. Empirical Analysis

According to the variable calculation methods and econometric model settings outlined above, we tested the hypotheses proposed earlier.

6.1 Descriptive Statistics of Variables

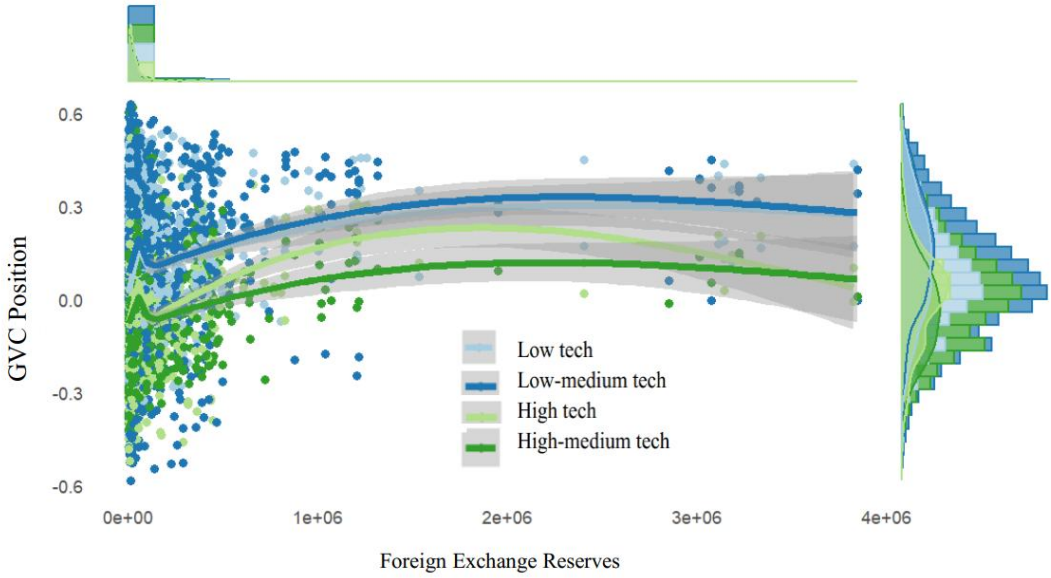
Table 1 reports the descriptive statistics for our variables. The results show that the maximum and minimum values of the global value chain participation index（GVCparticipation） are 0.998 and 0.021 respectively; the mean values of the global value chain forward participation index （GVCforward) and backward participation index (GVCbackward) are 0.429 and 0.211, with medians of 0.44 and 0.18, and modes of 0.001 and 0.097 respectively, indicating substantial disparities among economies in GVC participation levels, with a majority demonstrating poor performance. The data distributions for global value chain participation degrees and division of labor statuses are relatively flat, suggesting a certain uniformity exists in the division of labor across economies within the global

value chain. The distributions of foreign exchange reserve (FER) and exchange rate (ER) are highly concentrated and extremely right-skewed, indicating some economies have extreme figures for these metrics. The trade surplus (TS) data display negative values and are extremely left-skewed, suggesting that most economies operate under trade deficits. The data distributions for gross domestic product per capita (gdp) and foreign direct investment (FDI) exhibit high concentration and right-skewness, revealing that certain economies have distinct advantages in these areas. The distributions of transaction demand (TD) and low-end lock-in (Lock) similarly indicate concentrations and skewness, reflecting differences in demand and lock-in degrees among economies. The mean total factor productivity (TFP) reveals the overall level of economy-wide TFP. However, discrepancies between median and mode, along with kurtosis and skewness values, suggest considerable heterogeneity in the data. Some economies display exceedingly high productivity (such as the mode at 5.79), yet most economies' TFP values cluster at lower ranges (as seen in the median of 0.09). Additionally, the skewness indicates right-skewness, meaning economies with high productivity exert significant impact on the mean.

Table 1: Descriptive Statistics of Variables

Variable	Mean	Median	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
Dependent Variable							
$GVC_{position}$	0.14	0.138	0.670	-0.528	-0.05	2.06	0.23
$GVC_{participation\_}$	0.62	0.664	0.998	0.021	-0.70	2.56	0.26
$GVC_{forward}$	0.43	0.440	0.964	0.001	-0.02	2.02	0.24
$GVC_{backward}$	0.21	0.172	0.829	0.004	1.18	4.29	0.15
Explanatory Variables							
FER	89737.75	19754.303	3.84e+06	0.130	8.25	83.54	301832.64
ER	563.85	3.750	23155.000	0.000	6.32	46.30	2469.24
FDI	5868.76	1307.358	1.82e+05	-1.45e+05	3.58	37.44	16537.25
TS	-245.38	-128.535	49491.977	-7.52e+04	-4.36	43.22	8057.21
gdp	19849.79	11248.667	1.24e+05	243.986	1.54	5.78	21452.49
TD	3.06	1.132	82.150	0.085	5.67	40.91	7.89
Lock	0.00	0.000	0.000	-0.000	4.18	27.02	0.00
TFP	1.05	1.034	1.362	0.514	-0.29	8.65	0.09

Figure 2: Scatter Plot of Global Value Chain Position Index vs. Foreign Exchange Reserves



Source: Created by the author using R.

Figure 2 displays a scatter plot of the Global Value Chain Status Index against foreign exchange reserves, accompanied by fitted curves (classified by technology intensity). It is evident that there is a fairly obvious inverse U-shaped relationship between the Global Value Chain Status Index and foreign exchange reserves, and this pattern is more pronounced in high-tech industries. This further highlights the need for heterogeneity analysis of countries at different positions within the global value chain and different industry types.

6.2 Baseline Regression and Interpretation

Before delving into the regression results, this study first conducts a Hausman test to assess the credibility of the fixed-effects model. The null hypothesis is that the random-effects model and fixed-effects model are equivalent. If the null hypothesis is rejected, the fixed-effects model is adopted; otherwise, it is the random-effects model. The test yields a p-value of 0.0235, which is less than 0.05, thus rejecting the null hypothesis. Therefore, this study employs the fixed-effects model.

6.2.1 Baseline Regression

Table 1 presents the baseline regression analysis results without considering differences in value chain position and industry type. Column (1) shows the regression result with the Global Value Chain Position Index as the dependent variable; Column (2) features the Global Value Chain Participation Index as the dependent variable; Column (3) uses the Global Value Chain Forward Participation Index as the dependent variable; and Column (4) takes the Global Value Chain Backward Participation Index as the dependent variable. From the regression outcomes, it is clear that our focal explanatory variable—foreign exchange reserves—has significant impacts on all variables. Specifically, increased

foreign exchange reserves exert a negative effect on both the Global Value Chain Position Index and the Global Value Chain Participation Index, indicating that higher foreign exchange reserves hinder a country's advancement in the global value chain and its integration into global value chains. Moreover, foreign exchange reserves negatively affect forward participation in the global value chain, suggesting they impose burdens on services sectors integrating into global value chains; however, they positively influence backward participation, implying a supportive role for manufacturing. This outcome may initially appear contradictory to those in Columns (1) and (2), but it is not so in reality. Higher forward participation in global value chain division implies greater production of intermediate goods by manufacturing sectors, necessitating research investment and innovation—the mechanism through which foreign reserves function might align with previous hypotheses (further tested below); conversely, higher backward participation requires substantial imports of intermediate goods, hence demanding ample foreign reserves. These differing outcomes highlight how foreign reserves play distinct roles across various stages of a country's engagement in global value chains.

The square term of foreign exchange reserves was also introduced into the baseline regression models for examination, revealing significant effects on each of the Global Value Chain-related indices. This further substantiates the potential inverted-U relationship between foreign exchange reserves and global value chain dynamics.

Table 2: Results of Baseline Model Regressions

	(1)	(2)	(3)	(4)
	GVC_pos	GVC_par	GVC_f	GVC_b
FER	-0.000***	-0.000***	-0.000***	0.000***
	(-7.79)	(-7.31)	(-7.75)	(2.73)
FER^2	0.000***	0.000***	0.000***	-0.000***
	(7.48)	(5.28)	(6.82)	(-3.72)
ER	-0.000***	0.000***	-0.000***	0.000***
	(-7R.07)	(2.65)	(-4.08)	(8.75)
FDI	0.000***	-0.000	0.000*	-0.000***
	(3.11)	(-0.47)	(1.65)	(-3.19)
TS	0.000***	0.000***	0.000***	-0.000
	(3.84)	(4.75)	(4.60)	(-0.62)
gdp	0.000	0.000*	0.000	0.000
	(0.92)	(1.81)	(1.26)	(0.79)
Constant Term	0.150***	0.617***	0.435***	0.204***
	(57.87)	(276.79)	(176.06)	(116.07)
Time FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Country FE	Yes	Yes	Yes	Yes
N	39674	39760	37627	39760
R^2	0.782	0.860	0.813	0.743
Adj. R^2	0.78	0.86	0.81	0.74

Note: *** , ** , and * denote significance levels of 1%, 5%, and 10% respectively; standard errors of corresponding coefficients are presented in parentheses.

Regarding control variables, the exchange rate, trade surplus, and foreign direct investment (FDI) significantly impact all global value chain status indices. Per capita GDP only significantly affects the Global Value Chain Participation Index. For the Global Value Chain Position Index specifically, FDI and trade surplus exhibit positive effects, while the exchange rate shows a negative one. This suggests that a stronger currency, coupled with abundant FDI and trade surpluses, can enhance a country's standing in the global value chain. Concerning the Global Value Chain Participation Index, the exchange rate, trade surplus, and per capita GDP have positive influences, whereas the effect of FDI is insignificant. This indicates that robust economic development and capital accumulation from exports can positively contribute to a country's level of integration into global value chains. For both forward and backward participation in the global value chain, the effects of the exchange rate, FDI, and trade surplus are significant yet opposite in direction, while the impact of per capita GDP remains unclear or negligible.

6.2.2 Robustness Check

To ensure the reliability of the baseline regression results, we conduct a robustness check using the following methods:

Firstly, inspired by Wang et al. (2013), alternative measures for the aforementioned GVC-related indicators are calculated using the WWZ method, including WWZ _pos(WWZ-based GVC position index), WWZ_par (WWZ-based GVC participation index), WWZ_f (WWZ-based GVC forward participation index), and WWZ_b (WWZ-based GVC backward participation index). These alternative indicators replace the dependent variables in the baseline regression models.

Secondly, acknowledging that lagged GVC indices could influence current period GVC indices and to address any biases caused by omitted variable issues, we follow Liu & Han (2021)'s approach by employing a one-period lag of core variables to test for endogeneity.

Finally, System Generalized Method of Moments (System GMM) is applied to re-estimate the models. As shown in **Table 2**, the robustness check regression results largely mirror the baseline regression findings. The key explanatory variable, foreign exchange reserves, exhibits significant effects on all four GVC metrics, with coefficient signs consistent with the baseline results. The squared term of foreign exchange reserves also shows significant effects, further solidifying the reliability of an inverted U-shape relationship between foreign exchange reserves and the global value chain dynamics. Thus, our baseline regression results are robust and reliable.

Table 3: Robustness Check Regression Results

	(1)	(2)	(3)	(4)
	WWZ _pos	WWZ _par	WWZ _f	WWZ _b
L.FER	-0.000***	-0.000***	-0.000***	0.000**
	(-11.91)	(-4.0)	(-28.95)	(2.6)
$L.FER^2$	0.000***	0.000***	0.000***	-0.000**
	(2.4)	(8.77)	(1.8)	(-5.51)
ER	-0.000***	0.000***	-0.000***	0.000***
	(-4.40)	(4.97)	(-4.25)	(11.67)
FDI	0.000***	0.000***	0.000***	-0.000***
	(9.96)	(8.18)	(6.58)	(-7.86)
TS	0.000***	-0.000	0.000***	-0.000***
	(6.68)	(-0.96)	(5.96)	(-2.1)
gdp	0.000***	0.000***	0.000**	0.000
	(3.44)	(2.43)	(1.69)	(0.58)
Constant Term	0.156***	0.628***	0.405***	0.211***
	(37.04)	(79.95)	(62.86)	(15.63)
Time FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
N	1229	1230	1170	1230

Note: *** , ** , and * denote significance levels of 1%, 5%, and 10% respectively; standard deviations of corresponding coefficients are presented in parentheses.

6.3 Heterogeneity Analysis

Existing studies often focus on heterogeneity based on industry types, with less consideration given to the heterogeneity associated with different positions in the global value chain and industry technology intensities. This study categorizes countries and industries based on the Global Value Chain Position Index into those at high and low positions in the global value chain; according to the OECD technology density standards, industries are classified into low, medium-low, high, and medium-high technologies; and industries are grouped into services and manufacturing sectors for separate regression analyses, with the regression results presented in **Tables 2** and **3**.

Table 4: Heterogeneity Regression Results by Countries

	(1)	(2)
	GVC Low Position	GVC High Position
FER	0.000***	-0.000**
	(22.97)	(-2.09)
ER	-0.000***	-0.000***
	(-23.48)	(-5.69)
FDI	0.000***	0.000
	(9.78)	(1.22)
TS	-0.000***	0.000
	(-17.84)	(0.05)
gdp	0.000***	0.000**
	(3.55)	(2.05)
Constant Term	-0.055***	0.357***
	(-42.62)	(142.74)
Time FE	Yes	Yes
Industry FE	Yes	Yes
N	20330	19343
R^2	0.224	0.556
Adj. R^2	0.22	0.55

Note: *** , ** , and * denote significance levels of 1%, 5%, and 10% respectively; standard deviations of corresponding coefficients are presented in parentheses.

Table 4 presents the regression results for country heterogeneity, where Column (1) shows the regression results for countries in a lower position in the global value chain, and Column (2) displays the regression results for countries in a higher position in the global value chain. The regression results indicate that the impact of foreign exchange reserves on both groups of countries is significant at the 1% level. Specifically, for countries in a lower position in the global value chain, foreign exchange reserves have a significant positive effect; for countries in a higher position, foreign exchange reserves exhibit a significant negative effect. This finding validates Hypothesis H1 and demonstrates that the effect of foreign exchange reserves on a country's global value chain position indeed follows an inverted U-shape pattern. Regarding control variables, the exchange rate shows a significant negative effect on the global value chain status index for both groups of countries, whereas per capita GDP has a significant positive effect. Foreign direct investment and trade surplus have a significant impact on the global value chain for countries in a lower position, but their impact on countries in a higher position does not pass the 10% significance level. This suggests that the impact

of foreign direct investment and trade surplus on a country's global value chain position may be stage-specific, which is consistent with the conclusions of most scholars.

Table 5: Industry Heterogeneity Regression Results

	(1) Low Technology	(2) Lower-Middle Technology	(3) High Technology	(4) Upper-Middle Technology	(5) Manufacturing	(6) Non-Manufacturing
FER	0.000***	0.000***	-0.000**	-0.000***	0.000***	-0.000
	(3.20)	(8.84)	(-2.20)	(-3.11)	(19.10)	(-0.34)
ER	-0.000	-0.000	-0.000***	-0.000***	-0.000***	-0.000***
	(-0.46)	(-1.41)	(-2.66)	(-4.46)	(-11.95)	(-7.29)
FDI	0.000	0.000***	0.000	-0.000	0.000***	0.000***
	(0.93)	(3.98)	(1.02)	(-0.44)	(9.98)	(3.44)
TS	-0.000	-0.000***	0.000**	0.000***	-0.000***	0.000
	(-0.79)	(-3.88)	(2.56)	(4.33)	(-10.21)	(0.77)
gdp	0.000	0.000***	0.000**	0.000***	0.000***	0.000**
	(0.81)	(-8.10)	(-2.47)	(-4.25)	(-5.11)	(-1.98)
Constant Term	0.100***	0.125***	-0.036***	-0.047***	0.031***	0.228***
	(25.78)	(38.67)	(-16.69)	(-19.53)	(23.40)	(199.19)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
N	3739	4297	3276	3628	15652	22789
R^2	0.468	0.477	0.740	0.574	0.516	0.776
Adj. R^2	0.45	0.47	0.73	0.57	0.52	0.78

Note: *** , ** , and * denote significance levels of 1%, 5%, and 10% respectively; standard deviations of corresponding coefficients are presented in parentheses.

Table 5 showcases the heterogeneity regression results considering both industry type and technology intensity. Columns (1) to (4) present heterogeneity results categorized by industry technology intensity; Columns (5) and (6) depict the heterogeneity results for the manufacturing and service sectors, respectively. Looking at Columns (1) to (4), foreign exchange reserves have a significant positive effect on the global value chain position index for low-tech and medium-low tech industries, passing the 1% significance test; conversely, they exert a significant negative effect on high-tech and medium-high tech industries' global value chain position indexes, achieving at least a 5% significance level. This finding reveals that foreign exchange reserves promote the global value chain position elevation of industries with lower technology intensity, while inhibiting the position enhancement of industries with higher technology intensity. A possible reason is that industries with

lower technology intensity typically leverage cheap labor or natural resource costs as comparative advantages to integrate into the global value chain from downstream segments, engaging in processes such as low-value-added, energy-intensive assembly and processing (Li et al., 2024). Under these circumstances, foreign exchange reserves act as facilitators due to the considerable demand for intermediate product imports. For industries with higher technology intensity, embedding into the global value chain occurs through technologically intensive production phases like R&D design and critical component supply, which require high investments in research and innovation. According to earlier hypotheses, foreign exchange reserves might represent an opportunity cost for R&D investment, hindering technological progress and thus impeding improvements in global value chain positions. This mediating effect warrants further investigation, and subsequent sections will delve deeper into this topic.

From the results depicted in Columns (5) and (6), without accounting for heterogeneities in technology intensity and positioning within the global value chain division, foreign exchange reserves show a significant impact on the global value chain position of the manufacturing sector; however, their effect on the global value chain position index of the service sector fails to pass the 10% significance test, indicating insignificance. The probable cause behind this result is that the primary targets of foreign exchange reserves' influence pertain mainly to specific production aspects such as input procurement and technology research and development. Services, on the other hand, predominantly function as interlinking components within the global value chain, particularly in relation to manufacturing, encompassing distribution services (transportation, storage, logistics, wholesale and retail trade), producer services (e.g., management consulting, finance, insurance, real estate services), and consumer services (such as accommodation and food services, entertainment, personal services), thereby rendering the role of foreign exchange reserves less pronounced.

In terms of control variables, the exchange rate exhibits substantial effects, notably displaying a significant negative impact on both manufacturing and services sectors. Direct foreign investment manifests a notable negative effect exclusively on the medium-low tech industry regarding technology intensity heterogeneity, while it exerts consistently adverse impacts across both manufacturing and service sectors when viewed through the lens of industry type. Trade surplus predominantly influences the global value chain position of the manufacturing sector, showcasing significant effects especially on medium-low tech, high tech, and medium-high tech industries. Meanwhile, per capita GDP's positive and significant impact remains homogeneous across manufacturing and services, except for its non-significant effect on the low tech industry.

6.4 Extension Analysis and Mechanism Testing

To explore the precise mechanisms through which foreign exchange reserves impact the global value chain position, this paper introduces mediator variables—transaction demand, technological advancement, and low-end lock-in—to analyze mediation and moderation effects. Specific regression outcomes are illustrated in **Table 6**.

Columns (1) to (6) display the mediation effect regression results, wherein Columns (1) to (3) examine the association between the central explanatory variable, i.e., foreign exchange reserves, and three mediator variables (transaction demand, low-end lock-in, technological advancement), as delineated by equation (3); Columns (4) to (5) then assess whether adding these mediator variables alongside foreign exchange reserves enhances the explanatory power concerning the principal response variable, as stipulated by equation (4). Furthermore, building upon previous assumptions and heterogeneity analysis findings, the paper primarily investigates if transaction demand acts as a mediator variable during a nation's early phase of integration into the global value chain division, specifically when positioned lower in the value chain hierarchy, affecting upward movement in the global value chain. Additionally, it examines if low-end lock-in and technological advancement serve as mediator variables impacting global value chain ascent during periods when a nation holds a more advanced position within the global value chain division. Given that the selected low-end lock-in indicator was derived from calculations involving the Global Value Chain Position Index (GVC_position), directly regressing it against the position index would be problematic. Instead, since greater forward participation implies higher production of intermediate goods, reflecting a country's capability for Research and Development (R&D) investment, it can indirectly indicate advancements toward the higher ends of the value chain. Hence, the Global Value Chain Forward Participation Index (GVC_forward) is chosen as the dependent variable in regressions involving the low-end lock-in index. Results from Columns (1) to (3) reveal that foreign exchange reserves significantly influence each of the three mediator variables. There exists a significant positive effect of foreign exchange reserves on transaction demand, signifying that adequate reserves can facilitate importation of intermediate products during a country's initial stages of integrating into the global value chain. Moreover, foreign exchange reserves display significant negative effects on both low-end lock-in and technological advancement. This indicates that once a nation reaches a certain level of integration into the global value chain, increased foreign exchange reserves lead to reduced low-end lock-in indices, implying intensified effects of being locked into lower tiers. Simultaneously, growing reserves hinder total factor productivity, thereby obstructing technological progress. Columns (4) to (6) demonstrate that after incorporating the mediator variables alongside the core explanatory variable—foreign exchange reserves—the effects of transaction demand and technological advancement remain statistically significant, yet the low-end lock-in index fails to pass the 10% significance threshold, suggesting negligible impact. Notably, transaction demand exhibits a significant positive correlation with the global value chain position index. Coupled with the outcome from Column (1), this underscores that in the nascent stages of a country's integration into the global value chain, ample foreign exchange reserves foster the importation of intermediate goods, facilitating production process upgrades and propelling upward movement within the global value chain framework—a conclusion affirming hypothesis H2. Similarly, technological advancement bears a significant positive relationship with global value chain positioning. In conjunction with the finding from Column (3), it

becomes evident that upon reaching a particular level of integration, heightened foreign exchange reserves precipitate a stall in technological progress, thereby hindering ascension along the global value chain—an observation corroborating hypothesis H3. The rationale behind this phenomenon could stem from the fact that one major source of increased foreign exchange reserves is the accumulation of trade surpluses. To maintain or expand the scale of foreign reserves, sustaining the magnitude of trade surplus is essential. In China's context, colossal export volumes are predominantly comprised of low-margin manufacturing activities, leading to skewed allocation of resources towards coastal low-end manufacturing enterprises. Consequently, resources that could potentially fund research and development efforts become depleted. Column (6)'s findings validate hypothesis H3, revealing that concurrently introducing foreign exchange reserves and the low-end lock-in index yields a significant positive impact on the global value chain forward participation index. This implies that following a nation's progression to a certain juncture within global value chain dynamics, augmented foreign exchange reserves exacerbate low-end lock-in phenomena, impairing capabilities related to intermediate goods production, including crucial component fabrication, ultimately thwarting further ascendency within the global value chain landscape.

Table 6: Mediation Effect and Moderation Effect Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TD	Lock	TFP	GVC_P	GVC_P	GVC_f	GVC_P	GVC_P	GVC_f
FER	0.000***	-0.000***	-0.000***	0.000***	-0.000***	-0.000***	0.000***		-0.000***
	(4.04)	(-5.18)	(-5.62)	(9.03)	(-6.26)	(-6.40)	(5.99)		(-5.97)
TD				0.027***			0.037***		
				(2.87)			(2.83)		
TFP					2.576***			2.530***	
					(6.46)			(6.07)	
Lock						260.860***			895.994***
						(5.53)			(3.05)
TD*FER							0.000***		
							(4.70)		
TFP*FER								-0.000***	
								(-10.08)	
Lock*FER									-0.001***
									(-4.73)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	475	109	170	190	236	236	102	236	236
R^2	0.665	0.827	0.250	0.983	0.370	0.950	0.988	0.309	0.955
Adj. R^2	0.64	0.80	0.17	0.98	0.36	0.95	0.99	0.30	0.95

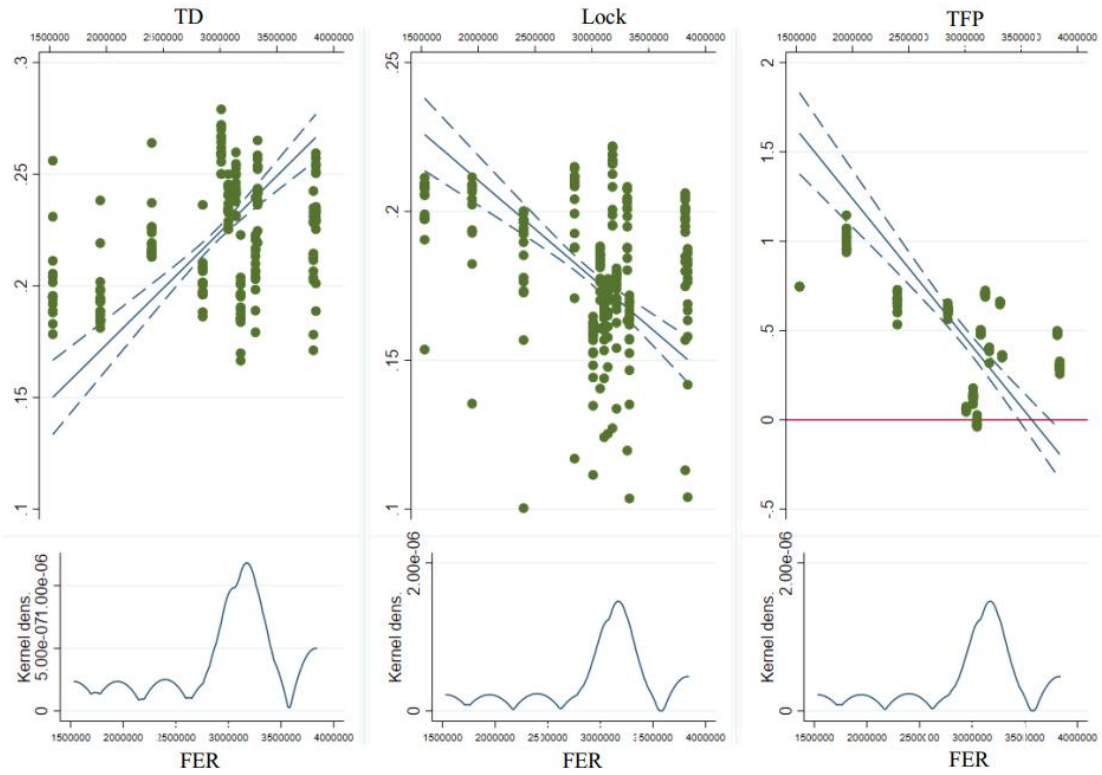
Note: *** , ** , and * signify significance levels at 1%, 5%, and 10% respectively; standard errors for respective coefficients are reported in parentheses; "Control" denotes control variables, whose full reporting is omitted here for brevity.

Moderation effect regression outcomes are displayed in Columns (7) to (9). Based on these findings, the interaction terms between moderator variables and foreign exchange reserves yield significant effects on their respective dependent variables. Specifically, the interaction term between transaction demand and foreign exchange reserves exhibits a significant positive effect on the global value chain position index, suggesting that foreign exchange reserves amplify the positive impact of

transaction demand on global value chain standing. Conversely, the cross-term between low-end lock-in and foreign exchange reserves carries a significant negative effect, indicating that post-attaining a specific integration level in the global value chain, foreign exchange reserves intensify the hindering effect of decreasing low-end lock-in (or worsening low-end lock-in condition) on ascending the global value chain ladder. Similarly, the interaction between technological advancement and foreign exchange reserves also shows a marked negative effect, denoting that following an established presence in the global value chain, any gains in global value chain position attributed to technological progress become obscured due to expanding foreign exchange reserves.

Figure 3 illustrates the specifics of the moderating effects for the trio of mediator variables. As evidenced, with the escalation of foreign exchange reserves, the positive effect associated with the transaction demand index grows progressively stronger, the positive impact linked to the low-end lock-in index gradually diminishes, and the positive effect tied to the technological advancement index likewise wanes until it falls below zero. These observations imply that in the initial stages of integration, foreign exchange reserves bolster the beneficial effect of transaction demand on the global value chain position index. Conversely, at later stages of integration, alleviated low-end lock-in (signified by a larger low-end lock-in index) and technological progress-induced enhancements in global value chain position encounter impediments due to mounting foreign exchange reserves. Thus, the conclusions regarding the moderation effects reinforce our hypotheses H2 and H3.

Figure 3: Moderation Effects of Three Mediator Variables



7. Conclusions and Implications

This study employs the UIBE_GVC database from 1995 to 2020 to empirically examine the impact of foreign exchange reserves on global value chain ascension and the heterogeneous nature of this effect across different countries and industries. Utilizing the KWW and WWZ methods to measure the degree and status of participating countries in the global value chain, the study finds: (1) Foreign exchange reserves significantly influence a country's global value chain position, with a hump-shaped relationship between reserves and global value chain status. This suggests that excessive reserves are not necessarily beneficial, as they can impede further ascension in the global value chain. Robustness tests conducted by replacing GVC-related index calculation methods, dealing with endogeneity, and changing the estimation model confirm this conclusion. (2) The impact of foreign exchange reserves on global value chain status varies according to the country's position within the global value chain. At the initial stages of integration, when countries are positioned lower in the global value chain hierarchy, reserves positively contribute to status improvement. However, once countries reach a certain level of integration, reserves hinder further ascension in the global value chain. (3) The effect of foreign exchange reserves on global value chain status is industry-specific, with reserves having a positive impact on the global value chain position of industries with lower technology intensity but a negative effect on those with higher technology intensity. Moreover, reserves primarily impact the manufacturing sector, whereas their effect on the service sector is insignificant. (4) Transaction demand, low-end lock-in, and technological advancement are identified as the mechanisms through which foreign exchange reserves influence global value chain ascension. During the initial stages of global value chain integration, reserves facilitate the import of key intermediate goods, supporting domestic processing industries and enabling ascension in the global value chain. However, as countries integrate to a certain extent, the maintenance and expansion of reserves lock resources into low-value-added export-oriented sectors, constraining R&D investment and technological progress, thus hindering further ascension in the global value chain.

Based on the aforementioned conclusions, the policy implications are as follows: Firstly, in the face of structural changes in the global economy such as the decoupling between China and the United States, there should be continued proactive acceptance of international high-tech industrial transfers, focusing on optimizing the manufacturing industry's industrial structure. Drawing lessons from the experience of the electronics information industry, simple assembly and processing steps should be outsourced, allowing for concentrated resources to enhance the capacity for producing high-end components and parts, thereby extending and perfecting the domestic production chain and value chain length. Secondly, there ought to be a measured reduction in the scale of foreign exchange reserves, further promoting a domestically driven large circulation pattern to stimulate internal demand. Emphasis should shift towards high technology-intensive industries such as semiconductors and new energy vehicles, avoiding the entrapment of resources and innovative elements in low-value-added export sectors. Governmental policy support and financial subsidies can be provided

to encourage corporations to increase investment in research and development (R&D) and foundational studies, transitioning the manufacturing sector from reliance on factors and investments to innovation-driven growth, propelling Chinese manufacturing up the global value chain. Lastly, the full potential of domestic industrial relocation must be tapped, with tailored policies formulated for central and western regions to attract eastern industries westward. Taking the textile and apparel industry as an example, labor-intensive production processes in the eastern coastal areas can be progressively relocated to central and western regions, while these coastal areas focus on design, branding, and market expansion – segments offering higher added value. This strategy will help balance regional development, fully mobilize domestic demand, form a unified domestic market, and ensure smooth domestic circulation, contributing to a more resilient and self-sufficient national economy.

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Author Contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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