Structural Transformation, TFP and High-Quality Development

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Abstract: *In this paper, we performed an empirical study on the TFP effect of structural transformation based on panel data of economic growth in 169 countries across the world. Our findings are threefold: First, structural transformation has an inverted U-shaped effect on TFP. When the degree of structural transformation is on the left side of the inflection point, structural transformation is conducive to softening industrial structure and inducing TFP; when the degree of structural transformation is on the right side of the inflection point, structural transformation will induce industrial hollowing out and inhibit TFP. Second, since the reform and opening up program was launched in 1978, China's structural transformation has evolved from the stage of adaptation to the stage of strategic adjustment with an increasingly evident trend towards a service-based economy, but structural transformation remains on the left side of the inflection point of the inverted U-shaped curve, i.e. the TFP effect of structural transformation is positive. Third, TFP improvement lies at the heart of high-quality development. In pursuing high-quality development, China should lower growth rate expectations, attach greater importance to supply-side structural reforms, and accelerate structural transformation to promote TFP improvement.*

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1. Introduction

Since the reform and opening up program was launched in 1978, China's economy has maintained rapid investment-driven growth under a "catch-up strategy" over the past four decades. According to Barro (2016), China's economic growth could not permanently deviate from the global historic experience of "regression to the mean," and its annual average growth rate would quickly fall into a range of 3% to 4%. This forecast is questionable since China's economic growth is subject to institutional strengths and other factors, and any assessment of China's long-term economic performance without those factors taken into account could be biased (Cai, 2016). Overall, China's economic growth appears to follow the possible trend shown in Figure 1, i.e. moving from Quadrant I with rapid yet poor quality growth to Quadrant II with slower growth and modest quality. At this moment, economic growth faces two prospects: It may move from Quadrant II to Quadrant III, where economic growth turns upward and becomes stable with higher quality, but this transition cannot happen without sustained TFP growth. Should TFP growth stall, economic growth is likely to slip along the dotted line into the "middle income trap," as shown in Figure 1 (Liu and Fan, 2019).

Structural transformation refers to qualitative change in various sectors of the economy and the overall industrial structure of a country or region (Zhang, 2001). It is usually regarded as one of

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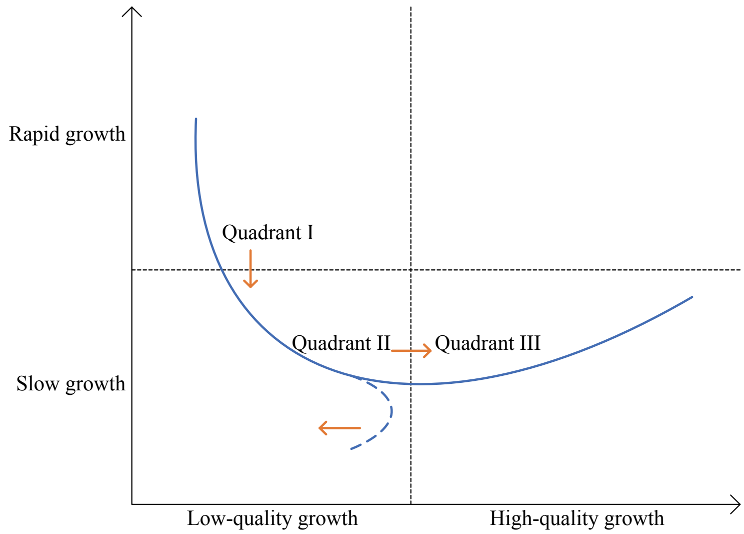

Figure 1: Possible Trends of China's Economic Growth Stages

Source: Drafted by the authors.

the important and independent sources of economic growth (Maddison, 1997) and a milestone of economic development.[1] Structural transformation is important because the equilibrium assumptions of neoclassical economics such as sufficient factor flow and market clearing can almost impossibly be satisfied under real economic conditions and, in a market full of uncertainties and with limited factor flow, only structural transformation can occur under non-equilibrium conditions, which is especially the case in the factor market (Chenery *et al*., 1995). When the economy is in a non-equilibrium state, if the factors of production such as labor and capital move from less productive sectors to more productive ones and technological and organizational innovations occur amid dynamic factor migration, the economy will be able to develop with higher quality with a more advanced economic structure.

Hence, this paper attempts to clarify the following questions: (i) Will structural transformation induce TFP improvement in the context of high-quality development? (ii) Is there any non-linear relationship between structural transformation and TFP? (iii) How did China's economic structure evolve since reform and opening up in 1978? Is the approach to pursue high-quality development through structural transformation consistent with China's economic reality? As a major progress, this paper focuses on total factor productivity (TFP) from dual perspectives of developmental economics and industrial economics, incorporates economic growth quality overlooked in previous research into the economic analysis of structural transformation, and investigates the TFP effect of China's structural transformation and its intrinsic relationship with high-quality development in the context of China's shift from rapid to high-quality development. Based on economic growth data of 169 countries across the world, this paper demonstrates the possibility of TFP improvement induced by structural transformation from empirical statistics using a panel model, and further discusses the criticality of structural transformation to high-quality development in light of China's economic reality, which provides scientific and vigorous reference for policymaking.

[1] In the broad sense, economic structure encompasses industrial structure, technological structure, distribution structure and consumption structure; in the narrow sense, it primarily refers to industrial structure. In this paper, structural transformation refers to the transformation of industrial structure in the narrow sense.

2. Literature Review

Traditionally, economic growth and structural transformation are treated as two separate domains. On one hand, economic growth is associated with the "Kaldor facts," i.e. facts that economic growth rate, return on capital, the ratio of capital to output are constant over a long period (Kaldor, 1961). According to the neoclassical growth theory, economic growth is primarily concerned with steady-state economic issues (Solow, 1956; Acemoglu, 2008). To some extent, the Kaldor facts are a description of steady-state economy (Solow, 2005; Mankiw *et al*., 1992) and capture the development experiences of industrialized countries, highlighting steady-state growth under the effect of the market as an "invisible hand." On the other hand, structural transformation is associated with the "Kuznets facts" concerning the changing distribution of capital, labor and other factors of production between agricultural, industrial and service sectors (Kuznets, 1957; Chenery, 1960; Baumol, 1967; Laitner, 2000; Acemoglu and Guerrieri, 2008). The "Kuznets facts" are more an empirical summary of how developing countries may achieve non-equilibrium growth through structural adjustment in pursuing economic catch-up.

In recent years, some scholars have attempted to investigate balanced growth and structural transformation under a unified framework. By creating a model that contains general balanced growth, Kongsamut *et al*. (2001) discussed the possibility of unifying the "Kaldor facts" with the "Kuznets facts." Foellmi and Zweimüller (2008) proved that an economy could reach a general balanced growth path only when its consumption preferences and production technology parameters met the "knife-edge condition." Li and Gong (2012) internalized consumer preference and proved the logical chain that an endogenous change in the preference structure would induce changes in consumption and production structures and thus drive the transformation of economic structure. In combination with the general balanced growth path, they depicted the balanced growth attribute of the overall economy. Moreover, Gan *et al*. (2011) decomposed the transformation of industrial structure into rationalization and sophistication for an empirical study of their effects on China's economic growth, and found that the rationalization of industrial structure was more conducive to stable economic growth. Yet under structural shocks, the transition from "structural dividends" to "structural burdens" such as aging population and falling capital output elasticity would prompt economic growth to shift from structural acceleration to structural deceleration (Yuan, 2012; Lu, 2016).

The above studies have paid inadequate attention to the issue of high-quality development. In particular, the relationship between structural transformation and TFP is left without a vigorous interpretation. From a theoretical perspective, some academics have made initial and inspiring explorations on the quantification and determinants of economic growth quality (Chao and Ren, 2011). Regretfully, none of those studies further touched upon the realization of high-quality development from a structural perspective. From a realistic perspective, China's economy is in a non-equilibrium state of market imperfections and lacks disincentives and budgetary constraints in the corporate sector (Li, 2015), as manifested in the significant non-steady growth features. The role of structural transformation cannot be overlooked if the economy is to transition from rapid growth with extreme disequilibrium to high-quality development with moderate equilibrium. By extending the above-mentioned research approach, this paper carries out an empirical analysis of the TFP effects of structural transformation to reveal the empirical evidences of how empirical transformation propels high-quality development.

3. Stylized Facts and Research Hypothesis

3.1 Degree of Structural Transformation and TFP Change for the US and Japan

3.1.1 The United States

US economic growth increasingly depends on knowledge-based technological and organizational innovations underpinning its transition from extensive to intensive economic growth. This process

Table 1: US Workforce Distribution from 1950 to 1990 (in 1,000 persons)

Year	Agricultural sector	Industrial sector		Service sector			Sum
	FFF	PPCR	OFL	MPS	TSAS	SO	TCLF
1950	6,649	7,954	15,030	10,149	11,119	5,847	56,746
1960	3,843	8,708	14,864	12,587	13,766	7,047	60,814
1970	2,349	10,351	16,949	17,872	19,210	9,538	76,270
1980	2,174	11,717	18,527	27,106	25,287	12,567	97,379
1990	1,811	12,062	18,305	38,227	29,431	15,246	115,083

Source: Hughes and Cain (2011), page 582.

Note: FFF refers to farming, forestry and fishery; PPCR refers to the precision, production, craftwork and repair; OFL refers to operators, fabricators and laborers; MPS refers to managers, professionals and specialists; TSAS refers to technology, sales and administrative support; SO refers to sales sector; TCLF refers to total labor force.

manifests in the continuous increase of TFP in the US over the past half a century. Meanwhile, there has been a general increase in the degree of US industrial restructuring, which was positively correlated with TFP in most years. According to Hughes and Cain (2011), agriculture, industry and services accounted for 3.1%, 35.8% and 61.1%, respectively, of US labor force in 1970. By 1990, agriculture and industry as a share of total US workforce further fell to 1.6% and 26.4%, respectively, and the service sector's share of total employment jumped to 72.0%. A close examination of the occupational structure would reveal far more profound changes within the economic structure than the aggregate change. Table 1 shows the occupational distribution of US labor force from 1950 to 1999. As can be seen from the table, employment in the US agricultural sector significantly decreased, and the number of skilled artisans and technical workers in the industrial sector increased sharply. In the service sector, managers, professionals, specialists and sales persons increased the most. Among them, the combination of MPS (managers, professionals and specialists) and TSAS (technology, sales and administrative support) columns - usually regarded as white collar jobs - approached 68 million by 1990, accounting for 58.8% of total US employment. Relatively increases in white-collar jobs reflect growth in service sectors and the fact that those jobs also increased in the manufacturing sector. For instance, more and more physicians and chemists were employed in universities and the R&D department of manufacturing companies, and attorneys increasingly practiced at law firms and as in-house corporate legal counsels (Hughes and Cain). Obviously, US economic restructuring is characterized by "softening," and the entities of its industrial system also transformed from traditional material production in the industrial era to technological and knowledge production, enabling a swift TFP increase (Zhang and Ding, 2013).

3.1.2 Japan

Japan's development journey can be divided into two typical stages: In Stage I (from World War II to the late 1960s), Japan adopted pro-industry policies to vigorously introduce advanced foreign technologies, especially critical technologies in the heavy and chemical industries. Japan's industrial productivity growth is estimated to average 9.4% from 1955 to 1966, of which 56% derived from equipment improvement and 44% from the adoption of new processes (Sun, 2006). In this period, Japan's workforce migrated from the less productive and low-wage agricultural sector to the industrial sector. Agriculture as a share of Japan's total employment shrank from 41.0% in 1955 to 13.9% by 1975 (Yasuba and Inoki, 1997). With the industrial policy support, Japan's TFP increased swiftly amid industrial restructuring during this period. Yet in the second stage since the 1970s, Japan's TFP decreased continuously. While many factors such as the oil crisis and resource limitation for heavy chemical industries had contributed to falling TFP, an important reason for Japan's TFP decline lies in the "industrial hollowing out." Japan's industrial hollowing out manifests in its industrial structure as the chronic decline of the secondary industry led by manufacturing and the sharp increase of the tertiary industry as a share of the economy over the years, as well as the secular stagnation of the Japanese economy (Hu *et al.*, 2013). Despite the increasing degree of industrial restructuring in this stage, Japan's TFP failed to keep up.

3.2 TFP Effects of Structural Transformation

Based on the stylized facts, the TFP effects of structural transformation could be twofold:

First, structural transformation induces TFP by softening the industrial structure. Compared with service-based industrial development, the softening of industrial structure is characterized by an increasing proportion of high-value links such as R&D, design, branding and marketing, especially knowledge and technological innovations. In other words, the softening of industrial structure can be seen as the substitution of traditional commodities, including goods and services, by knowledge-based products (Yuan *et al.*, 2016). Figure 2 is the annual average growth rates of value-added in major sectors of the US economy from 1960 to 2017 and value-added in major sectors in 2017 as a share of GDP. Professional and commercial services recorded the highest annual average growth rates of value-added, followed by educational services, all of which are typical knowledge- and technology-intensive sectors. In comparison, value-added growth rates were relatively low in traditional sectors such as transportation, warehousing, retail and manufacturing. While real estate and leasing sectors contributed the most to economic growth, professional and commercial services contributed the second-largest share. In this process, structural softening induced inter-industry interaction and integration, contributing productivity improvement. For instance, industrialization and ICT integration has lowered the cost of social coordination and generated increasing returns. On the other hand, structural softening has created demand for more knowledge-intensive products and services under the effects of consumption upgrade and accelerated the development of knowledge- and technology-intensive industries, thus raising overall productivity. By softening the industrial structure, structural transformation has facilitated intensive

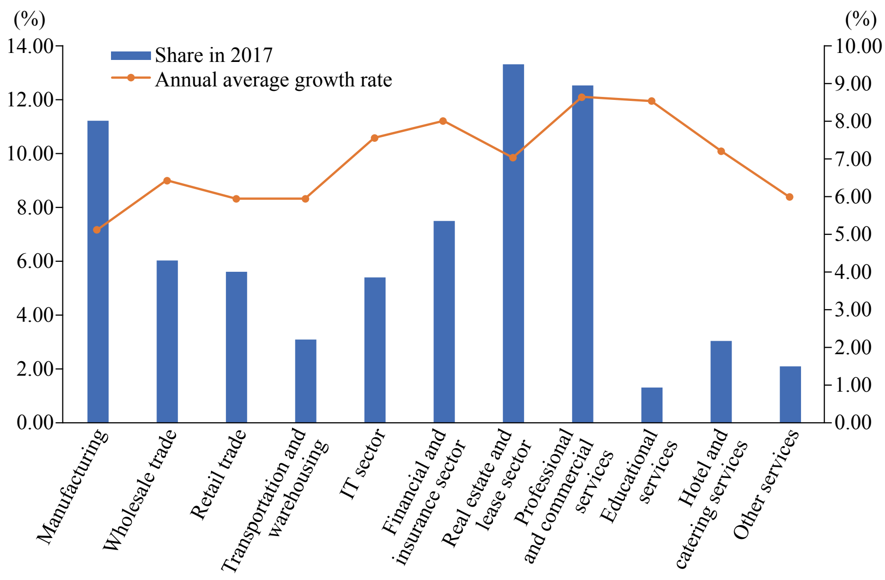

Figure 2: Growth Rates of Value-Added in Key US Sectors (%)

Note: Left axis is share in 2017, and right axis is annual average growth rate.

Source: Drafted based on data from the US Bureau of Economic Analysis (BEA).

economic growth underpinned by productivity improvement.

Second, structural transformation may inhibit TFP under the effect of industrial hollowing out. According to Bluestone and Harrison (1982), the extensive outflow of capital and other factors of production from the fundamental sectors of production will lead to a recession in material production and give rise to industrial hollowing out. In effect, industrial hollowing out as an efficiency collapse stems from the misallocation of factor resources amid hasty structural transformation. Manifestations of industrial hollowing out are twofold: first, an outflow of industrial capital. In the wave of economic globalization, the fragmented value chain mode of production has increased the specialization of firms but also led to an outflow of local production capacities and industrial capital to foreign countries. Such outflow, if unchecked, is likely to result in an inventory disequilibrium on the basis of dynamic disequilibrium between domestic and outbound investments, depriving domestic industries of necessary conditions for capital deepening. Another manifestation is the virtualization of industrial economy. Excessive expansion of the virtual economy is a more serious misallocation of scarce resources in a simple circulation of monetary capital without creating material wealth. Such speculative arbitrage impedes firms from expanding production and renovating technology, making the economy less productive. A typical example is real estate bubbles. Japan's secular economic stagnation is largely attributable to the burst of its land price bubbles after the rampant expansion of the virtual economy (Li *et al*., 2008).

Which of the above TFP effects of structural transformation dominates has to do with the stage of structural transformation. When structural transformation stays at a relatively low level, the flow of production factors across economic sectors is relatively static. If structural transformation is accelerated at this moment to speed up the flow of factors across various sectors following market-based principles, the adjustment of inventory structure is expected to yield considerable effects of structural softening. The degree of structural transformation is modest and insufficient for any serious industrial hollowing out to occur. In this stage, therefore, the positive TFP effect of structural transformation holds sway. Yet when structural transformation reaches a high level and occurs too abruptly, inter-industry interaction and integration will suffer. For instance, rising factor cost in some large cities will cause the service sector to crowd out manufacturing activity, giving rise to a spatial disintegration between the secondary and tertiary industries (Chen and Tang, 2016) and compromising the structural softening effect. Profit-seeking capital tends to move overseas and into the virtual economy, aggravating industrial hollowing out and inhibiting TFP improvement. When structural transformation occurs too abruptly, the TFP restrictive effect of structural transformation will hold sway. Based on the above analysis, this paper puts forth the following hypothesis to be tested: Structural transformation has major TFP effects in a non-linear inverted U-shaped relationship. Within a moderate range, a higher degree of structural transformation is more conducive to TFP improvement; beyond this moderate range, the opposite is true.

4. Empirical Test

4.1 Variable Selection

Among common measurement indicators, the Moore index put forth by Moore (1978) based on the spatial vector measurement method contains both possibilities of inducing or inhibiting TFP without prior assumption of the direction of structural change, making it suitable for testing the inverted U-shaped curve hypothesis. This paper references this measurement method for calculating the degree of industrial restructuring with the following equation:

$$STR_t = \sum_{i=1}^{n} W_{i,t} \times W_{i,t+1} \Big/ \left(\sum_{i=1}^{n} W_{i,t}^2\right)^{1/2} \times \left(\sum_{i=1}^{n} W_{i,t+1}^2\right)^{1/2} \tag{1}$$

Where, $W_{i,t}$ is the share of industry i in period t, and $W_{i,t+1}$ is the share of industry i in period t+1.

In addition, this paper adopts constant price for calculating total factor productivity (*TFP*) as the core explained variable. Since TFP is also subject to the impact of some other factors, we have included the size of country (*POP*), capital stock (*TKP*), trade volume (*IEP*), government size (*XPN*), human capital (*HC*), R&D level (*XPD*) and the level of participation in globalization (*BXM*) as the model's control variables.

4.2 Data Sources and Explanations

TFP data of various countries are from the latest version of Penn World Table (PWT9.0). Where, *TFP* is the actual TFP index of this table, and *POP*, *TKP* and *HC* are respectively the total population, total capital formation as a share of GDP, and human capital index in this table. Shares of industrial sectors for calculating *STR* and other control variables are from the World Bank's database. Among them, *STR* is obtained based on value-added from the primary, secondary and tertiary industries as a share of GDP; trade volume is measured by the imports and exports of goods and services as a share of GDP; government size is measured by fiscal spending as a share of GDP; R&D is measured by R&D spending as a share of GDP; participation in globalization is measured by the sum between outbound direct investment (ODI) outflows and foreign direct investment (FDI) inflows as a share of GDP. Notably, the time span of data samples employed in this paper is from 1960 to 2014 covering 169 countries across the world. Natural logarithms are taken for all variables to exclude the impact of sample outliers.

4.3 Model Specification

Based on the research hypothesis put forth in this paper, the econometric model for testing the TFP effects of structural transformation is specified as follows:

$$Y_{it} = \beta_1 STR_{it} + \beta_2 SQE + \beta_3 X_{it} + \gamma_2 D2_t + \cdots + \gamma_T DT_t + \mu_i + \varepsilon_{it} \qquad (2)$$

Where, explained variable Y_{it} denotes TFP, of which subscript i denotes country and t denotes year. Core explanatory variable *STR* denotes a country's degree of structural transformation, and *SQE* is the corresponding quadratic term. Control variable X includes $\{POP_{it}$, TKE_{it}, IEP_{it}, XPN_{it}, HC_{it}, XPD_{it}, $BXM_{it}\}$. The dummy variable of time controls for the time effect that does not change with individuals, where $D2_t$=1 if $t=2$; $D2_t$=0 if $t \neq 2$; and so on and so forth. μ_i is the individual effect that does not change with time. ε_{it} is the stochastic disturbance term.

4.4 Empirical Results and Analysis

4.4.1 Main regression results

Table 2 reports the main regression results of the TFP effects of economic restructuring of 169 countries.[2] According to the test results of Model 1 through Model 4, it can be determined that putting aside its non-linear effect, structural transformation has a significantly positive TFP effect. This mean reversion result also suggests that for most countries around the world, structural transformation has a significantly positive TFP effect, which is consistent with the trend of their softening industrial structure. As mentioned in the above analysis, if excessive structural transformation results in industrial hollowing out, TFP improvement is likely to be inhibited. In other words, structural transformation has a non-linear effect on TFP. To test this hypothesis, this paper includes the quadratic term of the degree of structural transformation into the model for another regression with results shown in Models 5 and 6. As can be seen from the results, the estimated coefficient of *STR* becomes significantly positive at 1% level after

[2] Since the Hausmann test significantly rejects RE estimation, this paper simultaneously reports the results of hybrid regression (Models 1 and 2) and fixed-effect regression (Models 3 through 6) for an intuitive comparison of the difference of the individual effect. In addition, the likelihood ratio test result suggests the existence of time effect. Hence, our use of the two-way fixed effect model is justified. In the interest of length, the coefficient of the dummy variable of time is not reported.

Table 2: Main Regression Results of Structural Transformation's TFP Effects

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
STR	0.2148***	0.2543***	0.4197***	0.2185	0.1494	5.3861***
	(0.02)	(0.03)	(0.14)	(0.15)	(0.94)	(1.13)
SQE					0.0915	-1.6463***
					(0.31)	(0.37)
Control variable		Controlled		Controlled		Controlled
CONS	-0.5366***	-0.4803***	-0.6610***	1.8166**	-0.4658	-2.1238*
	(0.08)	(0.10)	(0.22)	(0.69)	(0.70)	(1.24)
N	3,550	927	3,550	927	3,550	927
R^2	0.1025	0.3469	0.1586	0.5477	0.1588	0.6023

Notes: (i) Numbers in parentheses are robust standard errors; (ii) ***, ** and * denote significance at 1%, 5% and 10% levels; (iii) in the interest of length, the specific coefficients of control variable regression are not reported in this table, and the same below.

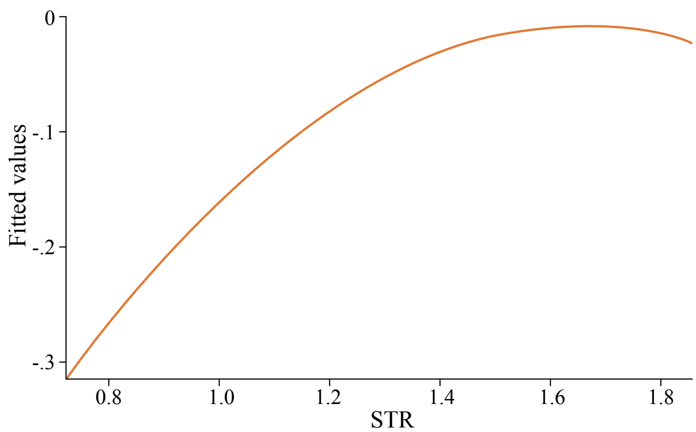

Figure 3: Inverted U-shaped Curve of Structural Transformation's TFP Effects

Source: Drafted by the authors.

introducing the control variable, and the estimated coefficient of *SQE* becomes significantly negative at 1% level. This proves that a significant inverted U-shaped relationship exists in the TFP effect of structural transformation. Based on the estimated coefficients of *STR* and *SQE*, the inflection point of the inverted U-shaped curve is 1.6357. Below this value, structural transformation's TFP effect will be in the upward stage on the left side of the inverted U-shaped curve, where accelerating structural transformation helps increase TFP; above this value, structural transformation's TFP effect will be in the downward stage on the right side of the inverted U-shaped curve, where structural transformation inhibits TFP improvement[3] (see Figure 3).

4.4.2 Endogenous deviation and GMM estimation

While the fixed-effect method may to some extent ease the endogenous deviation due to the omission of variables, the more important endogenous deviation may stem from a reverse causality relationship. Following Arellano and Bond's (1991) method, this paper employs the first-order and

[3] While this inflection point is obtained based on the economic growth data of many countries and cannot serve as a precise value for general benchmarking for various countries, it is sufficient to serve as an important reference value in the average sense.

Table 3: GMM Estimation Results of Structural Transformation's TFP Effects

	Model 1	Model 2	Model 3	Model 4
STR	0.5285***	-0.5096	12.1831***	9.5756***
	(0.06)	(0.42)	(2.94)	(1.93)
SQE			-3.6616***	-2.6564***
			(0.78)	(0.49)
Control variables		Controlled		Controlled
CONS	1.7049	3.6717	-9.9910**	-7.1378
	(1.19)	(2.31)	(4.20)	(4.59)
Anderson LR	516.783***	15.910***	27.917***	11.340***
Hansen J	0.137	3.135	1.643	1.916
N	3,358	919	2,113	919
R^2	0.1510	0.4780	0.0455	0.4460

Notes: (i) Numbers in parentheses are robust standard errors; (ii) ***, ** and * denote significance at 1%, 5% and 10% levels; (iii) Anderson LR and Hansen statistics are intended to test whether the problems of under-identification and over-identification exist for the instrumental variables in GMM estimation.

second-order lag terms of the explanatory variable as instrumental variables for a GMM estimation.[4] After a comparison between the regression results in Table 3 with those in Table 2, it can be found that the sign and significance of the estimated coefficients of the core explanatory variable are highly consistent, but the absolute values of coefficients are obviously higher. This not only attests to conclusion that structural transformation is conducive to TFP improvement, but reveals an underestimation of such positive effect in the previous FE estimation. Table 3 also reports the test results of whether the problems of under-identification and over-identification exist for the instrumental variables, and the Anderson LR and Hansen J statistics justify the use of first-order and second-order lag terms as instrumental variables in this paper.

4.4.3 Robustness test

To ensure the reliability of this paper's main findings, we performed a robustness test by substituting measurement indicators. In calculating the estimation indicators of the degree of economic structure transformation (*STR*), we reselected the number of employed persons as a share of total employment in the primary, secondary and tertiary industries to denote the share of each industry. Meanwhile, we also substituted the TFP variable in the previous section with the TFP index from the Total Economy Database (TED) and the labor productivity data before conducting a re-estimation using a two-way fixed model. Results indicate that no fundamental change has occurred in the estimated results of both the core explanatory variable and the control variable, whose sign and significance are generally consistent. That is to say, our empirical findings are rather robust.

5. Further Discussions on China's High-Quality Development

The above analysis has implications for China's current priority of high-quality development. If China's economic restructuring is on the left side of the inverted U-shaped curve, the country may induce TFP improvement and shift from rapid growth to high-quality development by accelerating structural transformation. Hence, three specific questions warrant further discussions: First, what is

[4] Table 3 is the regression results, where Models 1 and 2 list the circumstances without including the quadratic term and Models 3 and 4 include the quadratic term.

the current development stage of China's economic structure transformation and what are the trends of structural transformation and TFP change? Second, what is high-quality development and to what extent does TFP represent high-quality development? Third, does the so-called "structural deceleration" exist in China's economic transformation and does it contradict with the inverted U-shaped curve hypothesis of this paper? In this section, we will discuss these three important questions one by one.

5.1 China's Economic Restructuring and Current Stage

Since the reform and opening up program was initiated in 1978, the structural transformation of China's economy has gone through two stages. In the first stage of adaptive adjustment from 1978 to around 2000, the degree of China's structural transformation stayed at a relatively low level. In the second stage of strategic adjustment from 2001 to the present day, the degree of China's structural transformation has increased. In 2008, value-added from agricultural, industrial and service sectors accounted for 10.6%, 46.9% and 42.8% of China's total value-added and 39.6%, 27.2% and 33.2% of China's total employment, respectively. By 2016, the structure of the value-added ratios became 8.6%, 39.9% and 51.6%, and the structure of employment ratios became 27.7%, 28.8% and 43.5%, respectively. Judging by those figures, the tertiary industry has replaced the secondary industry as China's biggest economic sector, and agriculture came last. Such transformation demonstrates a significant trend towards structural softening. As can be learned from the results of empirical research in this paper, China's degree of economic structural transformation peaked as a mere 1.4357 in 2014, which was far below the global average turning point of 1.8024. It can be thus expected that China's economic structural transformation has a positive TFP effect. As shown by data from the Penn World Table (PWT), China's TFP was on the rise throughout the adaptive adjustment stage of industrial structure since reform and opening up in 1978 except for a brief decline in the late 1980s and late 1990s and maintained the same trend with structural transformation. In the stage of strategic industrial structure readjustment, China's TFP increased at a quickening pace before slowing after 2008 in tandem with slowing structural transformation. The deep-seated reason lies in the intrinsic disequilibrium of China's economic structure in the context of profound adjustment in the global economy. After the global financial crisis of 2008, developed countries led by the US have hastened the pace of "re-industrialization," which would slow China's structural transformation and TFP after the country became the factory floor of the world by integrating to the global value chains. This shows significant room for improving TFP structure transformation.

5.2 High-Quality Development and TFP Improvement

Though academics have yet to agree on its definition, high-quality development must "meet people's ever-growing needs for a better life, reflect new development concepts, and be characterized by innovation as the primary driving force, coordination as the intrinsic attribute, green as the general form, openness as the sure path, and shared development as the fundamental goal."[5] Among them, the most critical implication is the steady improvement of TFP since quality refers to not only the value of use, but cost effectiveness in terms of quality desirability and competitiveness, which means that quality ultimately has to be reflected in productivity (Jin, 2018). The manifestations are fivefold: (i) From the perspective of innovative development, TFP is a direct manifestation of technological innovation; (ii) from the perspective of balanced development, TFP improvement is intrinsically consistent with balanced development; (iii) from the perspective of green development, internalizing ecological environment as economic wealth implies TFP improvement; (iv) from the perspective of open development, all-round progress in open economic development and ascension to the high-

[5] See the *People's Daily* editorial: *Firmly Grasping the Fundamental Requirement High-Quality Development*, http://theory.people.com.cn/n1/2017/1221/c40531-29719990.html.

end links of global value chains are consistent with TFP improvement; (v) from the perspective of shared development, the level of productivity development is the basis for shared development; on the other hand, shared development ensures more equitable return for all economic participants, which is conducive to society-wide creativity and dynamism.

5.3 Inverted U-Shaped Curve and the Structural Deceleration Theory

Among a multitude of theoretical explanations on China's economic slowdown in recent years, the "structural deceleration" theory has elicited extensive debates. Proponents believed that given its "cost disease," the rapid expansion of the service sector would drive down society-wide labor productivity (Yuan, 2012; Lu, 2016); opponents argued that since the service sector was no less productive than the industrial sector, service sector growth would not lead to an economic deceleration (Maroto-Sánchez, 2012; Pang and Deng, 2014). Beyond those controversies, this paper has identified an inverted U-shaped curve of structural transformation's TFP effects, thus demonstrating the existence of "structural deceleration" in economic growth, but China has yet to reach this stage. In fact, the degree of China's economic restructuring remains at a relatively low stage, and its TFP effect remains on the left side of the inverted U-shaped curve, where accelerating structural transformation is conducive to TFP improvement. Aside from Barro's (2016) "regression to the mean," China's economic deceleration also stems from inadequate structural transformation. Having followed the static comparative advantage theory to guide its industrial adjustment over the years, China has become trapped under the path dependence of low-end OEM links of global value chains. Mismatch between industrial and supply and demand has put a damper on productivity improvement. Limited factor liquidity has taken a toll on market competition efficiency.

6. Conclusions and Policy Implications

On the basis of drawing upon the research of existing literature on the intrinsic relationship between structural transformation and economic growth, this paper put forth a research hypothesis with the facts and the rationales of structural transformation and TFP changes in the US and Japan as entry points, and performed an empirical test of the research hypothesis based on an econometric model with panel data of economic growth in 169 countries around the world. Our empirical research results suggest that structural transformation is vitally important for TFP improvement, and the relevant effects are characterized by a non-linear inverted U-shaped curve. When structural transformation is on the left side of the inverted U-shaped curve, it will induce TFP; when structural transformation is on the right side of the inverted U-shaped curve, it will inhibit TFP. The reason is that structural transformation has accelerated the softening of industrial structure, induced knowledge production and consumption in the economy, and thus propelled intensive economic growth underpinned by TFP improvement. Yet if industrial restructuring occurs too abruptly as to trigger industrial hollowing out, it will inhibit TFP improvement by causing an outflow of industrial capital to other countries and the "virtualization" of the economy.

As can be found from the effects of China's economic structural transformation since reform and opening up in 1978, China's structural transformation has experienced an upward trend in tandem with TFP improvement. Such consistency stems from the fact that the relationship between China's industrial restructuring and TFP has been on the left side of the inverted U-shaped curve, i.e. structural transformation has a positive effect on TFP. For China's economy on its way to cross the middle-income stage, it must continue accelerating economic restructuring if it is to steadily increase TFP and pursue high-quality development. Specifically, China should further deepen supply-side structural reforms and reduce the burden of tax and fees for the service sector while striving to reduce overcapacity, inventory and leverage ratio, lower cost and bolster weak areas for the manufacturing sector. Second, China should accelerate the innovation and reform of income distribution system, address the inadequacies of people's livelihoods and boost effective domestic household demand as the essential elements of high-quality development. Third, policymakers should strive to create a balanced regulatory mechanism featuring a "capable government plus strong market" based on a correct understanding of government-market relationship in the new era.

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