Analysis of The Impact of The New Infrastructure on Economic Growth——Based on Empirical Test Charging Pile of New Energy Vehicles

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Abstract. Nowadays, with the digital economy gradually involving in the original economic state in China, Chinese industries have been undergoing economic transformation and upgrading. Specifically, Chinese society has a stronger demand for new information technologies such as 5G, big data and artificial intelligence accordingly. In the future, the new infrastructure is expected to play a key role in the high-quality development of China's economy. Based on the information above, this paper summarizes the current academic research on the new infrastructure and explains the transmission mechanism of it to promote economic growth from six different effects. To verify the theory, this paper takes the charging pile of new energy vehicles as an example, using regression analysis of China's provincial panel data from 2016 to 2020 to draw a significant positive conclusion, which is aimed to better meet the new infrastructure era and realize a new round of great development.

Keywords: The new infrastructure; economic growth; digital economy; new energy vehicle charging pile.

1. Introduction
In recent years, with the economic structure continuously optimized and upgraded, many scholars have come to the same conclusion that China's economy has entered a new level and will turn to a high-quality and sustainable development. For example, there are people arguing that the driving force of economic growth has shifted from factor-driven to innovation-driven (Daniel, 2019; Feng and Wu, 2018). Similarly, Guo and Shi (2018) also argue that the marginal benefit of traditional infrastructure like high-speed rail has been decreasing. Much more specific cases can be found in research such as the one from Liao et al. (2018) that before 2012, the investment per unit of new infrastructure can increase by about 0.4 units of GDP, but after 2012, it has declined to a situation that can hardly promote economic growth, which can also be precisely seen in figure 1.
Fig. 1. Infrastructure investment growth and its impact on the economy  
Data source: Wind database  

Under the background mentioned above, the intelligent economy based on artificial intelligence, 5G, and big data center is expected to take the place of traditional ones to be a new economy driver. What is more, focusing on a much more comprehensive and multifaceted development, the new infrastructure is high likely to enter an unprecedented height by all walks of life, because of both the political support from the central government and the sufficient investment from the capital market.  

The proposal of the new infrastructure has experienced two years of development and is still under discussion. Dated back to December 2018, Chinese central government originally put forward the concept of the new infrastructure in the Central Economic Work Conference. Under two years of modification, this proposal was finally defined by the National Development and Reform Commission (NDRC) that the new infrastructure would include 5G base station, UHV, intercity high-speed railway, and urban rail transit, charging pile of new energy vehicles, big data center, artificial intelligence, and industry Internet, which has also been officially grouped as table 1. Though this concept is likely to be amended in the future, the given definition above now represents the current direction of China’s economic transformation.  

Table 1. The connotation of New infrastructure construction  

| Type                | Subdivision type                              | Representative infrastructure                                |
|---------------------|-----------------------------------------------|------------------------------------------------------------|
| Information infrastructure | Communication network infrastructure | 5G, IoT, industry Internet, Satellite Internet |
|                     | New technology infrastructure                | Artificial intelligence, cloud computing, blockchain       |
|                     | Computing infrastructure                      | Datacenter, intelligent computing center                   |
| Converging infrastructure |                              | Intelligent transportation infrastructure, smart energy infrastructure |
| Innovation infrastructure |                              | Major science and technology infrastructure, science and education infrastructure, industrial technology long sleeve infrastructure |

The new infrastructure has many advantages compared with the traditional one. Specifically, it is systematically connected with smart economy and digital economy, highly driven by the newest and the most technological innovation, perfectly built on information network and specially designed to meet the needs of high-quality development. Thus, the Research Institute of Bank of China estimated that the total investment in seven key areas of the new infrastructure would be about 1.2 trillion (yuan) large in 2020, and the proportion of new infrastructure investment will gradually increase from the
current 7% to about 15%-20%. Moreover, the growth rate of several subdivisions may be even higher, causing that the substitution role of infrastructure investment will also be further enhanced.

In terms of the impact, the new infrastructure is the product of the digital economy era in which society moves towards digitalization and intellectualization. At the same time, it also has become the necessary condition for the high-quality development of China's economy through high-end science and technology. In the short run, the new infrastructure can slow down the negative impact of COVID 19 on the social economy, help expand demand, promote consumption upgrading and improve employment; And in the long run, with the support of the new generation of information technology innovation such as 5G, big data, cloud computing, the new infrastructure can inject new digital power into the industrial development and realize the structural transformation and industrial upgrading of traditional industries (Guo and Wang, 2019). Thus, the new infrastructure can provide lasting innovation for China's economic growth and promote the sustained and healthy development of the national economy.

The marginal contributions of this paper are as follows: Firstly, this paper summarizes and comments the most current academic research on the new infrastructure. Secondly, this paper analyzes the power shortage of the traditional infrastructure and the advantages of new infrastructure from a theoretical point of view, which clarifies the contribution of the new infrastructure to economic growth and discusses promotion mechanism in depth. Thirdly, this paper takes the charging pile of new energy vehicles as an example and demonstrate the significant role of promoting economic development through descriptive analysis and empirical test. Fourthly, this paper points out the shortcomings of the current development of the new infrastructure and discusses how to form a new driving force for domestic demand as well as build a new engine for China's economy, in order to finally provide suggestions for the government to formulate policies for the new infrastructure.

2. Literature Review

Sustainable economic growth depends on the healthy development of basic industries. Since the reform and opening up, the development of infrastructure construction is a typical feature of China's economy. Studies have shown that infrastructure construction has a significant role in promoting a country’s economy, showing a great increase in returns to scale (Li et al., 2011). There are mainly two channels for infrastructure construction to promote economic growth: one is to improve the existing infrastructure conditions and optimize the material basis of economic growth while the other is to directly act on economic growth as a kind of production factor input (Roohnavaz, 2018).

However, does infrastructure construction in the traditional sense always promote China's sustainable economic growth? Based on the industrial dynamics, Ju and Lin (2015) found that the traditional infrastructure has gradually been unable to provide powerful support for the sustained and high-quality development of China's economy since Economic Reform and opening-up, especially in the current situation of China's new normal economy. Therefore, other forms of innovation like the new infrastructure are needed to seek breakthroughs.

Guo and Wang (2019) demonstrated the economic mechanism of the new infrastructure promoting the upgrading of manufacturing and service industries and found that compared with the traditional infrastructure, the new infrastructure will greatly increase the marginal output of capital relative to labor, finally promoting the replacement of capital-intensive industries for labor-intensive industries to promote economic development. Also, some scholars researched on the new infrastructure from other different subdivision angles. To illustrate, by establishing the multi-sector general equilibrium model including the new infrastructure, these papers quantitatively analyze the ways in which the new infrastructure affects industrial structure transformation respectively from the perspectives of price effect (Noktehdan et al., 2019), investment effect (Ferko et al., 2019), income effect (Mehdi et al., 2020) and employment effect (He et al.,2019).

To sum up, according to the existing literature, under the background of the new normal economy, the contribution of the traditional infrastructure to economic growth is gradually smaller, with disadvantages are more obvious. By contrast, the new infrastructure plays an increasingly important
role in the process of economic transformation and upgrading. However, since the current research on the new infrastructure mainly focuses on the theoretical analysis of the concept and connotation, empirical analysis is relatively less. Therefore, based on relevant theoretical research, this paper empirically tests the significant role of one of the new infrastructure’s fields in promoting economic development, to fill in the blank of relevant research and make a certain contribution.

3. Theoretical logic
Infrastructure construction is a fundamental issue related to the economic development and social welfare of a country. Good infrastructure not only helps to drive the upgrading of regional industrial structure economy with much more investment, consuming demand and employment, but also improves production efficiency through reducing the cost of economic activities and improving the trading environment, making the development of national economy and people's living standard better improved. The transmission mechanism of infrastructure investment promoting Chinese economic development is as follows in figure 2:

![Diagram: Transmission mechanism of infrastructure construction promoting economic growth]

**Fig.2.** Transmission mechanism of infrastructure construction promoting economic growth

From the perspective of the investment consumption effect, infrastructure construction has triggered new consumption growth points by expanding many new fields, boosting the demand for public expenditure; meanwhile, the derived infrastructure investment is also conducive to the capital accumulation of emerging industries and contributes to the national economy.

From the perspective of the production supply effect, infrastructure construction promotes production efficiency and service level of each factor in the link, which helps to produce a supply effect and serve the economy.

From the perspective of the economic cost effect, when social economy is in the upgrading stage, infrastructure reduces the cost of social and economic activities to a certain extent. For example, increasing investment in infrastructures such as transportation and communications can reduce the barriers brought about by production and trading and create a space for low-cost cross-regional transactions.

From the perspective of the industrial structure effect, expanding the scale of infrastructure construction and updating infrastructure technology are bound to accelerate the upgrading of industrial structure, build a new growth point for the national economy. For example, infrastructure has improved rural transportation, irrigation, electricity, and other aspects, which has changed the basic structure system and industrial structure of agricultural farming.

From the perspective of the transaction efficiency effect, the efficiency of a country's market economy is largely determined by the efficiency of infrastructure construction. For instance, China’s expressways are greatly improving market transaction efficiency. Besides, the efficiency of information exchange is also critical to the economy. The emergence of new service formats such as Didi, Mobike, and Baidu takeaway are all business models that emerged after the efficiency of information transaction being greatly improved, reflecting on economic growth.
From the perspective of the employment opportunity effect, infrastructure construction has created a large number of new employment opportunities, such as live bloggers on e-commerce platforms, making the economy more sustainable and flexible.

4. Empirical analysis

4.1. Econometric model

This paper selects new energy vehicle charging pile, which is one of the sub areas of the new infrastructure, for empirical study. Because using panel data has the advantages of ensuring more information, controlling individual heterogeneity is more easily and analyzing dynamical adjustment is more markedly, this paper constructs a static panel data model:

\[
growth_{i,t} = \alpha_i + W_{i,t}'\beta + \epsilon_{i,t}
\]

\(i\) represents province, \(t\) represents month, \(\alpha_i\) stands for the individual effect which is difficult to control and observe; \(W_{i,t}\) is the explanatory variable, including: \(W_{1,i,t}\) represents the logarithm of the number of new energy vehicle charging pile; \(W_{2,i,t}\) is the total retail sales of social consumer goods, representing the consumption level; \(W_{3,i,t}\) is the fiscal revenue, which is used to control the impact of government capital investment; \(W_{4,i,t}\) is the consumer price index, which reflects the impact of the price level of each region on the economy; \(W_{5,i,t}\) is the cumulative import and export amount to indicate the degree of regional economic openness; \(W_{6,i,t}\) is the cumulative growth rate of completed fixed asset investment, reflecting the scale of fixed asset investment; \(\epsilon_{i,t}\) is the model error.

| Table 2. Definition of main variables |
|---------------------------------------|
| Variables                             | Symbol   | Definition                                |
| Explained variable                   |          |                                         |
| Industrial output                    | IVA      | industrial added value                   |
| Core explanatory variable            |          |                                         |
| New energy vehicle charging pile     | lncharge | the logarithm of the number of new       |
|                                      |          | energy vehicle charging piles            |
| Social consumption level             | retail   | Total retail sales of consumer goods     |
| control variables                    |          |                                         |
| Government revenue                   | gov      | fiscal revenue                           |
| price level                          | CPI      | consumer price index                     |
| Trade                                | trade    | Import and export amount                 |
| investment                           | invest   | Completed fixed assets investment        |

4.2. Data sample and descriptive analysis

This paper selects the monthly balanced panel data of 31 provinces, municipalities, and autonomous regions in China from 2016 to 2020 as the research sample. All variable data are from Wind database and National Bureau of statistics, adjusted by balancing the panel and problematic ones are removed. Moreover, the natural logarithm of the new energy vehicle charging pile is taken in this paper.

| Table 3. Descriptive statistical characteristics of main variables |
|---------------------------------------------------------------|
| Variables | observed value | mean value | standard deviation | minimum value | maximum value |
| IVA       | 1457.000      | 5.747      | 4.990              | -46.900       | 22.500        |
| lncharge  | 1536.000      | 7.895      | 1.984              | -2.197        | 11.184        |
| retail    | 589.000       | 5.456      | 9.309              | -44.900       | 15.100        |
| gov       | 1719.000      | 0.031      | 0.551              | -1.000        | 19.333        |
| CPI       | 1767.000      | 2.226      | 1.051              | -0.300        | 6.900         |
| trade     | 1736.000      | 4.298      | 25.918             | -80.500       | 272.900       |
| invest    | 1612.000      | 4.270      | 13.237             | -82.800       | 33.300        |

Table 3 reports the descriptive statistical characteristics of the main variables. The standard deviation of \(IVA\) is 5.747 and the standard deviation of the core explanatory variable \(lncharge\) is 7.895.
It can be seen that lncharge and IVA also has certain fluctuations, but they are relatively stable. From the descriptive statistics of control variables, the standard deviation of trade is 1.984, gov is 0.551, CPI is 1.051, trade is 25.918, invest is 13.237, which shows that aside from invest, other data distribution is relatively symmetrical, which provides a good test material for static panel model.

### 4.3. Empirical process

Firstly, carry out the regression analysis of fixed effect model and mixed effect test. The fixed effect model is based on the assumption that there are significant differences among individuals, but there is no time series difference for a specific individual. If the difference between individuals is not obvious, use OLS to estimate pooled OLS. After running, get the result of prob > F = 0.0000. From F statistics and P-value, we can see that the fixed effect model is better than mixed effect model, rejecting the original hypothesis.

The basic purpose of fixed effect model is to estimate the parameters of the model under the premise of controlling individual effects, and one important purpose of using the panel data model is to separate the long-term and the short-term component of variance, so the random effect model may be more suitable. Therefore, this paper carries out the random effect model regression analysis to test whether the random effect was significant, and the result showed that prob > chibar2 = 0.0001. Hausman test is used to test whether the fixed effect model or the random effect model is suitable. After running, the result P-value = 0.0000 is obtained, which rejected the original hypothesis, namely the basic hypothesis of the random effect model. Therefore, the fixed effect model was used because the individual effect and explanatory variables were correlated.

After carrying out regression analysis on the model, the regression result (1) is estimated by the intragroup difference method (FE), and the regression result (2) are added with year dummy variables. At the same time, considering the continuity and dynamics of industrial growth, the GMM method is used to estimate the model. The regression result (3) adopts the one-step GMM method, and result (4) adopts the two-step GMM method. The Hansen J test of the dynamic panel model method cannot reject the original hypothesis that tool variables are valid. Therefore, there is no over-identification of tool variables in the estimation results, which has good robustness.

| Model selection | (1) | (2) | (3) | (4) |
|-----------------|-----|-----|-----|-----|
|                 | FE  | FE  | 1-step GMM | 2-step GMM |
| IVA growth lag  |     |     | 0.324*** | 0.648*** |
|                 |     |     | (-0.0412) | (-0.0414) |
| lncharge        | 1.350*** | 0.343 | 0.873*** | -0.0142 |
|                 | (4.76) | (-0.448) | (-0.0228) | (-0.114) |
| retail          | 0.133*** | 0.318*** | 0.263*** | 0.129*** |
|                 | (3.25) | (-0.0916) | (-0.0487) | (-0.0406) |
| gov             | 0.070 | 0.0934 | 0.012 | 0.205 |
|                 | (0.33) | (-0.209) | (-0.0745) | (-0.218) |
| CPI             | -1.053*** | -0.989** | 0.817*** | -0.504* |
|                 | (-3.78) | (-3.96) | (-0.018) | (-0.266) |
| trade           | -0.011 | -0.00586 | 0.741*** | 0.00402 |
|                 | (-1.13) | (-0.0105) | (-0.0395) | (-0.00906) |
| invest          | 0.185*** | 0.165*** | 0.608*** | 0.178*** |
|                 | (9.43) | (-0.0206) | (-0.0562) | (-0.0178) |
| Constant term   | -4.316* | 1.511 |     |     |
|                 | (-1.91) | (-3.352) |     |     |
| Observations    | 500  | 500  | 393  | 393 |
| Number of provinces | 31  | 31  | 31  | 31 |
| R-squared       | 0.286 | 0.359 |     |     |

* t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1
As the results of fixed effect, the industrial added value increases by 0.792-1.907 percentage points for each percentage point increase in the number of new energy vehicle charging piles. According to the regression results in Table 4, it can be seen from column (1) that the estimated coefficients of retail, CPI and invest are all significant at the level of 1%, which has a strong effect on IVA, i.e. economic growth. The control variables in column (2) are similar to those in column (1), but the significance of the coefficient of charge is weak, which indicates that the number of new energy vehicle charging piles varies greatly in different regions in the same month, but on the whole, it still promotes IVA. To sum up, the construction of new energy vehicles charging pile in China from 2016 to 2020 does have a significant effect on economic growth, and other control variables also have a certain impact on economic growth.

4.4. Robustness test

Through the fixed effect model regression of IVA, it is found that the new energy vehicle charging pile can promote economic growth. In order to further enhance the reliability of the research conclusion, OLS, FIX EFFECT and GMM are used to regress. The results of robustness test are shown in Table 5. The results show that the regression results of each measurement method are basically consistent with the previous analysis content and the significance is high. The hypothesis of new energy vehicle charging pile promoting economic growth has been verified, which shows that the conclusion drawn in the previous paper has good robustness.

Table 5. Robust estimation results

| Model selection | (1) | (2) | (3) | (4) | (5) | (6) |
|-----------------|-----|-----|-----|-----|-----|-----|
| OLS             | OLS | FE  | FE  | GMM | GMM | GMM |
| In charge       | -0.014 | -0.285** | 1.350*** | 0.343 | -0.306** | -0.184* |
|                 | (-0.10) | (-2.38) | (3.35) | (0.56) | -0.122 | -0.107 |
| retail          | 0.129 | 0.421*** | 0.133** | 0.318*** |
|                 | (1.47) | (3.02) | (2.26) | (2.76) |
| gov             | 0.205 | 0.208* | 0.070 | 0.093 |
|                 | (1.50) | (1.69) | (0.61) | (0.70) |
| CPI             | -0.504 | -0.908* | -1.053* | -0.989 |
|                 | (-1.38) | (-1.80) | (-1.89) | (-1.18) |
| trade           | 0.004 | -0.001 | -0.011 | -0.006 |
|                 | (0.52) | (-0.15) | (-1.00) | (-0.42) |
| invest          | 0.178*** | 0.157*** | 0.185*** | 0.165*** |
|                 | (6.33) | (6.15) | (3.48) | (3.10) |
| Constant term   | 5.396*** | 4.656*** | -4.316 | 1.511 | 8.681*** | 8.196*** |
|                 | (3.85) | (2.74) | (-1.60) | (0.32) | -1.001 | -0.886 |
| Observations    | 500 | 500 | 500 | 500 | 500 | 500 |
| R-squared       | 0.313 | 0.429 | 0.286 | 0.359 | 0.012 | 0.002 |
| Number of provinces | 31 | 31 | 31 | 31 | 31 | 31 |
| Company FE      | YES | YES |
| Year FE         | YES |

Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

5. Conclusions

Nowadays, China’s economy is facing many challenges such as whether it is transforming the driving force of economic growth or further leading a new round of industrial transformation. Therefore, it is necessary to continuously stimulate investment and innovation vitality, promote consumption and industrial upgrading. As the basis for the digital economy to play its production potential and an important means to stabilize the economy in the post epidemic era, the new infrastructure will be an
effective combination point for China to stabilize its economic growth and optimize its economic structure. It will undertake the dual mission of stimulating short-term demand and increasing long-term supply and inject new momentum into the high-quality development of China's economy.

Theoretically, this paper expounds on the transmission mechanism of the economic impact of the new infrastructure from six aspects: investment consumption effect, production supply effect, economic cost effect, industrial structure effect, transaction efficiency effect and employment opportunity effect. In addition, this paper also selects the field of new energy vehicle charging pile for empirical test, in order to show that the new infrastructure has a significant role in promoting the economy. By establishing the fixed effect panel model, significant promotion results are obtained.

However, in the face of the current new round of infrastructure construction, various new concepts have emerged endlessly. Therefore, it is necessary for us to consider how to promote the integration and innovation of the new and traditional infrastructure, so as to finally build a new infrastructure system of "Internet of all things", which will support the high-quality development of China's economy and the construction of urban agglomerations.

Acknowledgments
New infrastructure definition source: press conference of innovation and high technology development department of national development and Reform Commission on April 20, 2020.
Source: Bank of China Research Institute https://www.boc.cn/fimarkets/summarize.

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